Health, Wellness and Organic Diets

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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March 2013
Declaration

I, Liza Oates, certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

__________________________________________________________________________

Liza Oates
01/03/2013
Acknowledgements

I would like to acknowledge the generous support and encouragement of my supervisors Professor Marc Cohen and Dr Lesley Braun.

My sincere appreciation goes out to the all of the respondents who donated their valuable time to complete the surveys and especially to the participants in the biomonitoring trial whose contribution and commitment to the project was extensive.

I would like to thank Professor Neil Mann (Head of Food Science, RMIT University) for his expert opinion in the development of the Organic Food Intake Survey and Dr Lucy van de Vijver (Louis Bolk Institute, The Netherlands) for her feedback on the Organic Health and Wellness Survey. For their statistical guidance I would like to thank Associate Professor Anthony Bedford, Dr Adrian Schembri and James Baglin; and for their assistance in promoting the studies, Gosia Kaszubska and colleagues in the College of SEH Marketing and Communications Department.

I would also like to thank the RMIT University staff in the School of Health Sciences and the School of Graduate Research, and my colleagues and students in the Wellness Group who have provided support and inspiration throughout my candidature.

Finally I would like to thank my friends and family whose support and gentle reminders to take care of my own wellness allowed me to complete this thesis with my sanity and health intact (more or less).

Financial support:

The biomonitoring trial was supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd. The Australian Postgraduate Award Scholarship program provided financial support during my studies.

Conflicts of interest:

I have received payment from the Organic Federation of Australia for the preparation of a document summarising the current evidence base for the health effects of organic foods.
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<th>Full Form</th>
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<tbody>
<tr>
<td>AChE</td>
<td>acetylcholinesterase enzyme</td>
</tr>
<tr>
<td>ADHD</td>
<td>Attention Deficit Hyperactivity Disorder</td>
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<td>ADI</td>
<td>Acceptable Daily Intake</td>
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<tr>
<td>AGHE</td>
<td>Australian Guide to Healthy Eating</td>
</tr>
<tr>
<td>AIMA</td>
<td>Australasian Integrative Medicine Association</td>
</tr>
<tr>
<td>AMPA</td>
<td>aminomethyl phosphonic acid</td>
</tr>
<tr>
<td>AOMR</td>
<td>Australian Organic Market Report</td>
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<tr>
<td>APVMA</td>
<td>Australian Pesticides and Veterinary Medicines Authority</td>
</tr>
<tr>
<td>AQIS</td>
<td>Australian Quarantine &amp; Inspection Service</td>
</tr>
<tr>
<td>ARID</td>
<td>Acute Reference Dose</td>
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<tr>
<td>ATDS</td>
<td>Australian Total Diet Survey</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<td>BMT</td>
<td>Intrapersonal variation in pesticide residues in response to an organic diet: a biomonitoring trial</td>
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<tr>
<td>CDC</td>
<td>Center for Disease Control (US)</td>
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<tr>
<td>CEFBeS</td>
<td>Chemical Exposure &amp; Food Behaviour Survey</td>
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<tr>
<td>CI</td>
<td>confidence interval</td>
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<tr>
<td>CPES</td>
<td>Children’s Pesticide Exposure Study</td>
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<tr>
<td>DAFF</td>
<td>Department of Agriculture Fisheries and Forestry</td>
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<tr>
<td>DAP</td>
<td>dialkylphosphate metabolites of organophosphate pesticides</td>
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<tr>
<td>DEDTP</td>
<td>diethylthiophosphate</td>
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<td>DEP</td>
<td>diethylphosphate</td>
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<td>DETP</td>
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<td>DMP</td>
<td>dimethylphosphate</td>
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<td>DMTP</td>
<td>dimethylthiophosphate</td>
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<tr>
<td>DPI</td>
<td>Department of Primary Industries (Victoria)</td>
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<tr>
<td>EDC</td>
<td>endocrine-disrupting chemicals</td>
</tr>
<tr>
<td>FFQ</td>
<td>food frequency questionnaire</td>
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<td>FPQ</td>
<td>food propensity questionnaire</td>
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<tr>
<td>FQH</td>
<td>Organic Food Quality and Health</td>
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<td>FSA</td>
<td>Food Standards Authority in the U.K</td>
</tr>
<tr>
<td>FSANZ</td>
<td>Food Standards Australia New Zealand</td>
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<td>GAP</td>
<td>good agricultural practice</td>
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<tr>
<td>GC-MS/MS</td>
<td>gas chromatography tandem mass spectrometry</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>GMOs</td>
<td>genetically modified organisms</td>
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<td>HGPs</td>
<td>hormonal growth promotants</td>
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<tr>
<td>IFOAM</td>
<td>International Federation of Organic Agriculture Movements</td>
</tr>
<tr>
<td>KOALA</td>
<td>Child, Parent and Health: Lifestyle and Genetic Constitution (Dutch acronym)</td>
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<tr>
<td>LOD</td>
<td>limits of detection</td>
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<td>LOQ</td>
<td>limits of quantification</td>
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<tr>
<td>M</td>
<td>mean</td>
</tr>
<tr>
<td>MRL</td>
<td>maximum residue limit</td>
</tr>
<tr>
<td>N</td>
<td>number of participants/respondents</td>
</tr>
<tr>
<td>n</td>
<td>number of participants/respondents in subgroup</td>
</tr>
<tr>
<td>ND</td>
<td>non-detectable</td>
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<tr>
<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
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<tr>
<td>NHS</td>
<td>National Health Survey</td>
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<tr>
<td>NQ</td>
<td>non-quantifiable</td>
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<tr>
<td>NRS</td>
<td>National Residue Survey</td>
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<td>OCS</td>
<td>Organic Consumption Survey</td>
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<td>OFIS</td>
<td>Organic Food Intake Survey</td>
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<tr>
<td>OHWS</td>
<td>Organic Health and Wellness Survey</td>
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<tr>
<td>OP</td>
<td>organophosphate</td>
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<tr>
<td>OR</td>
<td>odds ratio</td>
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<tr>
<td>PARSIFAL</td>
<td>Prevention of Allergy - Risk Factors for Sensitisation Related to Farming and Anthroposophic Lifestyle</td>
</tr>
<tr>
<td>POEA</td>
<td>polyethyloxylated tallowamine</td>
</tr>
<tr>
<td>PON-1</td>
<td>paraoxonase-1</td>
</tr>
<tr>
<td>PWI-A</td>
<td>Australian Unity Personal Wellbeing Index for adults</td>
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<tr>
<td>PYR</td>
<td>synthetic pyrethroid</td>
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<tr>
<td>RDI</td>
<td>recommended daily intake</td>
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<tr>
<td>SA</td>
<td>South Australian</td>
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<tr>
<td>SD</td>
<td>standard deviation</td>
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<tr>
<td>SDR</td>
<td>socially desirable responding</td>
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<tr>
<td>SOM</td>
<td>soil organic matter</td>
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<tr>
<td>The Standard</td>
<td>‘The National Standard for Organic and Bio-Dynamic Produce’</td>
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<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<tr>
<td>VPMP</td>
<td>Victorian Produce Monitoring Program</td>
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<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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<tr>
<td>Unit</td>
<td>Description</td>
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<td>------------</td>
<td>--------------------------------------------</td>
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<tr>
<td>μg/g creatinine</td>
<td>micrograms per gram of creatinine</td>
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<td>μg/L</td>
<td>micrograms per litre</td>
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Publications and Presentations

Executive Summary

Public concern for human health, environmental protection, social responsibility and food security has raised debate over organic versus conventional (non-organic) food and their associated production systems. According to the most recent Australian Organic Market Report, sales of organic food are estimated to have risen 35% in the past two years with 65% of Australians having consumed some organic food in the previous year.

A key factor driving organic food consumption is the belief that organic diets are healthier, yet very few studies have investigated health outcomes from organic food consumption and recent reviews report a lack of strong evidence that organic foods are significantly more nutritious than conventional foods. While there is increasing evidence of adverse health effects from pesticides, it is unknown if these effects occur at levels associated with dietary exposure. To date there are no published studies comparing pesticide exposure in adults consuming organic and conventional food, and it is unclear whether studies in children that suggest organic diets reduce exposure to organophosphate pesticides (OPs) apply to adults, who have lower exposures and more efficient detoxification pathways.

This thesis aimed to answer two main questions: do dedicated organic consumers in Australia believe that an organic diet is healthier, and if so, why? and; does consumption of a diet containing at least 80% of food servings from organic produce for 7 days reduce urinary OP metabolites in Australian adults? To answer these questions and explore associated issues, three surveys and one biomonitoring study were conducted.

Two online surveys explored the attitudes and behaviours of people who identified as dedicated consumers of organic produce, the Organic Consumption Survey (OCS) (N=318) and the Organic Health and Wellness Survey (OHWS) (N=404). The information collected by these surveys suggests that dedicated organic consumers exist across socio-demographic segments. Respondents were predominantly female, tertiary educated, in a healthy weight range; and had a higher than average rating on the Personal Wellbeing Index for adults (PWI-A), especially with regard to community connectedness, sense of safety and future security. The OHWS also found that 75.7% of respondents perceived their overall health to be better since moving to an organic diet, with an average improvement of 2.5 points on a 10-point scale. Respondents reported the dietary change was associated with improvements in: resistance to and recovery from illness (71.1%),
physical energy (61.1%), condition of skin/ hair/ nails (58.4%), mental alertness (56.7%), mood stability (56.3%), and sense of satiety (55.4%) with around a quarter of respondents claiming that specific health concerns influenced their decision to consume organic foods. Many respondents referred to psychological benefits from purchasing products they believe reflect their values, and 62.5% had made other dietary or lifestyle changes around the time they moved to an organic diet that may positively impact their health. Despite the non-representative, self-selected sample used, these results are consistent with similar studies in Australia and abroad.

When questioned on their beliefs, dedicated organic consumers expressed substantial concerns about the effects of pesticides on human health and the environment, with the vast majority of respondents agreeing with the statements: ‘organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ (95.4%); and ‘organic foods are better for the environment than conventionally grown foods’ (97%). Respondents also indicated that their decision to purchase organic food was driven more by risk aversion (especially to pesticides), rather than nutritional superiority. Beliefs about the preventative effects of organic diets echoed current research on organic diets and pesticides.

In order to clearly differentiate organic consumers from conventional consumers, a third survey was conducted to quantify the extent of consumption of organic produce and provide a breakdown by food category. Nineteen respondents recruited from the previous OCS completed the ‘Organic Food Intake Survey’ (OFIS), providing a total of 57 sampling days. Organic fruit and vegetables had the highest uptake and animal flesh products the lowest. Many of the OCS respondents did not eat various food categories unless they were organic and those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit (OR 3.565; 95%CI 1.433, 8.867) and vegetables (OR 3.456; 95%CI 1.61, 7.418). The survey results suggest that a 100% organic diet is rare, yet many self-proclaimed dedicated organic consumers, consumed a diet consisting of mostly (>65%) organic produce. During the OFIS recording period the mean intake of organic food was 76.3% (95%CI 68.0, 84.5).

To explore whether consuming a largely organic diet reduces OP pesticide exposure in adults, a prospective, randomised, single-blinded, crossover, biomonitoring study was performed. The study involved thirteen Australian adults who consumed a largely (>80%) organic diet or a largely conventional diet for 7 days and were then crossed over to the alternate diet for a further 7 days. Urinary levels of six dialkylphosphate (DAP) metabolites
produced from OP pesticides, were analysed in first-morning voids collected on day 8 of each phase using GC-MS/MS, with limits of detection at 0.11-0.51 μg/L. Results, which were creatinine corrected to account for urine dilution or concentration, revealed that consumption of organic food for 7 days resulted in a statistically significant reduction in urinary OP metabolites. The mean total DAP results in the organic phase were 89% lower than in the conventional phase ($M=0.032$ and 0.294 respectively, $p=.013$). There was a significant 96% reduction in urinary dimethyl DAPs in the organic vs. conventional phase ($M=0.011$ and 0.252 respectively, $p=.005$), and a 49% reduction in diethyl DAPs which was not significant ($M=0.021$ and 0.042 respectively, $p=.170$).

These studies confirm that dedicated organic consumers in Australia believe that organic diets are healthier due to reduced pesticide exposure and that they provide contextual and psychological benefits. Findings further suggest that a mostly organic diet for one week results in a dramatic reduction in OP pesticide exposure in Australian adults. Further research across geographical locations is now required to corroborate these findings and determine their clinical relevance. It is recommended that future research incorporates a wholistic approach to fully capture the potential of organic diets to positively impact health.

**Keywords**

health, wellness, organic diets, organic consumers, biomonitoring, organophosphate pesticides
Preface

I imagine, like most PhD candidates I began my journey wanting to answer the big questions. As time progressed I realised that my significant contribution to the field would not be to complete the whole jigsaw puzzle but rather to address some of the missing pieces so that in time the picture might become clearer.

To provide some context I should declare that I am a naturopath by trade. Naturopathy is a wholistic health practice and as a practitioner it is important to treat the patient as an individual, identifying and where possible addressing the individual causes that have compromised optimum wellness. Accepting that individuals respond and react differently to various triggers and treatments is a cornerstone of practice. Western medicine is inclined to ask ‘what is this disease?’ for which there may be a single answer. Naturopaths ask ‘why is this disease? for which the answer tends to be a great deal more complex. Embracing this complexity recognises the variability of individual responses and inter-relationships between causative factors. The aim of treatment is to restore balance so that the body may engage its natural healing processes and to optimise wellness at all levels.

As a naturopath specialising in and teaching about the use of food as medicine, it has always been my belief that ‘medicine’ should provide maximum benefit with minimum harm. For this reason I have been inclined to recommend organic foods. Patients often report additional health benefits when moving to a more organic diet... but were these simply anecdotes? Given the added expense and effort, is this something I should be recommending to all patients? So my big picture question was... ‘what are the health benefits of consuming an organic diet?’
It may seem strange that no one has yet answered this, but it turns out that it is not an answerable question. The issue is too complex and individual responses are so variable that science is not yet in a position to address such a wholistic question.

It was in the spirit of accepting the variability of individual responses, embracing complexity and maintaining clinical relevance that I entered my PhD program. Clearly I would prefer to avoid a reductionist approach; nevertheless I needed an answerable question to drive my thesis. This lead to planning a biomonitoring trial to fill in one of the more glaring gaps in the literature, the absence of any published studies in adults suggesting that an organic diet reduces pesticide exposure. This project remains integral to my thesis, but I recognised that even if fewer pesticides are found in consumers of organic food, this will not necessarily confirm health benefits.

Because there was so little research available, I thought it would be useful to find out more about the people who were already consuming organic food and explore their beliefs about the health effects of organic diets. What became obvious was that an understanding of organic consumers in Australia was limited or dated. More importantly, there is no clear definition of an organic diet. Maintaining a 100% organic diet in the real world is a challenge. While it may be possible to achieve this briefly in a controlled clinical trial, what would this really mean to a consumer? I decided early on that I didn’t wish to attempt this, I wanted a more natural experiment, one where people living in the real world could ascertain whether the effort and expense they invested in attempting to achieve the ‘most’ organic diet they could, would actually result in a measurable difference in their pesticide levels. As will be revealed, there are many reasons why this may not always be the case.
For this I needed some sort of food survey instrument and given that none was readily available I designed the ‘Organic Food Intake Survey’. To understand more about organic consumers and their general consumption patterns I conducted the ‘Organic Consumption Survey’. Along the way I also developed a ‘Chemical exposure and food behaviour’ survey to start to flesh out some of the factors that may confound results in biomonitoring trials.

By the end of the process I would know more about organic consumers; who they are, what they eat and why they opt for organic foods. I would have developed a way of measuring their intake of organic food. I would have a clearer idea of the sorts of health and wellness markers that might warrant future exploration and a better understanding of the many individual factors that may need to be considered when planning future research. While these pieces of the puzzle may not completely answer my initial question about the health benefits of organic diets, I hope they will at least provide increased clarity and direction for future work.

The thesis

I believe that a PhD provides the opportunity to delve deeply into a topic that is of interest to you but it is also about skill development. This includes writing skills. So I had to decide what type of writer I ultimately want to be. I looked at a number of theses and the ones that I found the most engaging were those that deviated from the traditional thesis structure and style. So please forgive me if I do the same. I want my thesis to have a voice so the language may be a little less formal than a traditional thesis. Don’t be surprised to see the occasional analogy or anecdote. You might have noticed that this preface has been written in an unusual font and a very informal tone, and I will revert to this font from time to time throughout the thesis
when I am being particularly informal. For the most part however I will return a somewhat more ‘scholarly voice’.

I will of course cover all the basics: background, methods, results, discussion, limitations, etc. But given the length of this document I don't expect that you will be reading it in a single sitting or will necessarily remember something that was mentioned a hundred pages earlier. In the project chapters the results and discussions (and sometimes limitations) will be covered together. However, in the final chapters I will revisit key issues in order to draw everything together. Footnotes will be used to identify the location of information that has already been covered or will be covered in more depth later. It is not necessary to follow all of the footnotes but they are there to assist you in more quickly locating the information should you wish to. This seemed a less clumsy approach than continually writing... ‘as was previously discussed in chapter X’.

I have published a number of articles throughout my candidacy, and my academic career, and I hope this will provide some evidence that I know how to write in an impersonal scholarly voice and follow the traditional guidelines... but for the purpose of this thesis I have chosen not to. I hope this will be a relief rather than an imposition.
Chapter 1. Introduction

1.1 Background
Providing a secure, nutritionally rich and safe food supply chain is a critical challenge for the future. Public concern for human health, environmental protection, social responsibility and animal welfare has raised debate over the relative advantages or disadvantages of organic compared to conventional food production systems (Lairon, 2010). While there is no consistent internationally accepted definition of the term ‘organic’, common definitions emphasise production practices which are guided by the underlying principles of ‘health, ecology, fairness and care’ (International Federation of Organic Movements [IFOAM], 2009).

As a wholistic health practitioner specialising in the use of food as medicine, recommending foods that on the one hand promote health (and wellness) and on the other contain substances that may potentially compromise it, concerns me. I have therefore been inclined to invoke the ‘precautionary principle’, recommending patients favour organic options when practical to do so. However, I am conflicted, as the additional expense and lack of clear evidence supporting the health benefits of organic diets is at odds with some of my core values as a practitioner. At the same time, I perceive that organic diets may offer additional advantages to the health and wellness of my patients because of their care for the soil, livestock and the environment. In addition, I believe that the mind is a powerful healing force, and that beliefs have an impact not only on behaviour, but also on the outcome of the therapeutic recommendations I prescribe.

My primary reason for recommending organic diets is the uncertain effects of exposure to agricultural inputs, especially pesticides, in conventional foods. These concerns are also echoed by my patients and I assume they are common amongst dedicated organic consumers.

Organic sales are on the increase with 65% of surveyed Australians claiming to have bought organic food in the past year (Monk, Mascitelli, Lobo, Chen & Bez, 2012). Attitudes, beliefs and personal values appear to be a stronger predictor for organic consumption than socio-demographic variables, and this includes the belief that organic

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1 Refer to Chapter 4. What Evidence is there that Organic Diets Improve Human Health and Wellness?
2 Refer to Chapter 6. The Pesticide Pathway
diets are healthier than conventional diets (Lea & Worsley, 2005). Health beliefs are important because they drive behaviour, especially if a threat is perceived (Rosenstock, 1982), but they can also affect outcomes as observed with the much maligned ‘placebo effect’. Beliefs about the health benefits of organic diets appear to be based, at least in part, on the assumption that it may mitigate the negative effects of pesticides (Lea & Worsley, 2005).

Pesticides are manufactured to be toxic to living organisms but are not necessarily specific to their target species (Aprea, Colosio, Mammone, Minoia & Maroni, 2002), so it is unsurprising that countless published studies attest to a link between pesticide exposure and health risks. These include neurological, reproductive, respiratory, metabolic and mental health effects, as well as cancer (Sanborn, Bassil, Vakil, Kerr & Ragan, 2012; Sanborn, et al., 2004). Whether dietary exposure, which is the primary route of non-occupational exposure for most pesticides (Lu, Barr, Pearson & Waller, 2008; Morgan, et al., 2005; Wilson, Chuang, Lyu, Menton & Morgan, 2003), represents a public health concern is less clear. However, studies are emerging that report exposure during critical periods of development may pose a risk, even at levels consistent with dietary exposure. For instance, recent reports have linked higher levels of urinary organophosphate (OP) pesticide metabolites with increased ADHD prevalence (Bouchard, Bellinger, Wright & Weisskopf, 2010) and poorer intellectual development (Bouchard, et al., 2011) in children.

Establishing dietary exposure as a cause of pesticide related disease, or organic diets as a preventative strategy, is complex. Low dose and non-monotonic dose responses, the cocktail effect of mixtures of different chemicals, individual variations in exposure and metabolism, and the effects of exposure during critical periods of development all hamper risk assessment. As a dose response might be anticipated a clear understanding of what constitutes an ‘organic diet’ is required and this should recognise that few consumers achieve a 100% organic diet and their organic choices may vary across food categories.

Australian researchers have demonstrated that ‘certified organic’ produce in Victoria has fewer pesticide residues than conventional food crops (McGowan, 2003), yet few studies have utilised biomonitoring to assess whether consuming these foods results in a reduction in personal pesticide exposure in people who consume organic produce.

3 Refer to 6.3 The Problem with Pesticides
4 Refer to 2.4.3 Organic Consumers – What do they Eat?; and 2.4.4 Organic Consumers – When do they Eat Organic?
Although biological reasoning would suggest that reducing the intake of pesticides (via an organic diet) would result in reduced exposure and therefore reduced health risks, humans are also exposed to non-dietary pesticides (Oates & Cohen, 2011). They may be inhaled from polluted air, absorbed through the skin or accidentally ingested. Studies in US children have confirmed that organic diets significantly reduce pesticide exposure (Curl, Fenske & Elgethun, 2003; Lu, Barr, Pearson, Walker & Bravo, 2009; Lu, et al., 2006), yet regional differences in exposure are likely to occur, and children are more highly exposed to pesticides because of their body weight and less efficient metabolism. Whilst interesting, these results cannot be extrapolated to an Australian population, nor to adult organic consumers.

Any health benefits from organic diets are likely to be the result of more than simply reducing pesticide exposure. For example, one study has demonstrated that children who exclusively consumed organic dairy products had a 36% lower risk of infantile eczema at 2 years of age, and the authors attributed the results to increased levels of omega-3 fatty acids and conjugated linoleic acid in organic compared to conventional milk (Kummeling, et al., 2008). However, few other studies have investigated health outcomes resulting from organic diets.

There has been a lot of publicity recently around the release of the Stanford University systematic review on organic food which claimed ‘the published literature lacks strong evidence that organic foods are significantly more nutritious than conventional foods’ (Smith-Spangler, et al., 2012). However, as with previous reviews, including a well publicised report from the Food Standards Authority in the U.K. (FSA) (Dangour, Dodhia, Hayter, Allen, et al., 2009), the focus was largely on product attributes, in particular the nutritional differences between organic and conventional foods. This approach to explaining the health effects of organic diets is fraught with difficulty, as nutrient levels are affected by a host of factors that extend beyond whether the production practices are organic or conventional.

While the ideology of ‘nutritionism’ assumes that it is the scientifically defined nutrients in foods that determine their value (Scrinis, 2012), it is the nutrient concentration achieved in target tissues, not the actual intake that will determine any health effects (Blumberg, et al., 2010). Foods are rarely eaten in isolation and each food may contain thousands of compounds with complex inter-relationships. There are also inter-individual variations in the bioavailability, bioactivity and metabolism of nutrients (M. Huber, Bakker, Dijk, Prins &
When the FSA attempted to review health effects of organic diets they found a dearth of research in the area (Dangour, et al., 2010). While studies of nutritional differences in foods are in their hundreds, the FSA could only locate eight *in vivo* human studies, of which only the infantile eczema study cited above was outcome based. Similarly the Stanford study identified 17 articles, all but three of which related to biomarkers rather than health outcomes. The lack of studies lead reviewers to report that there was a lack of evidence to support health effects from organic diets (Dangour, et al., 2010; Smith-Spangler, et al., 2012). However, it should be stressed that ‘a lack of evidence of effect’ is not the same as ‘evidence that there is no effect’. A more accurate conclusion would include the fact that there is insufficient evidence to be certain that eating organic food does not produce health benefits.

Such reviews tend to take a narrow view of ‘health’. For instance the FSA report interpreted relevant health outcomes as effects on defined diseases (Dangour, et al., 2010). In a recent study in the Netherlands respondents reported general health benefits after moving to an organic diet, which included improvements in energy, psychological wellbeing, and resistance to, or recovery from, illness (van de Vijver & van Vliet, 2012). Thus defining ‘health’ simply as the absence of disease, fails to capture outcomes that may be meaningful to consumers. These outcomes are of particular interest to the wellness movement which takes a broader view of health. The concept of wellness is multidimensional and recognises that the whole is more than the sum of its parts because factors that influence wellness are inter-related. Wellness also recognises that people want to flourish and be able to perform at their best and most vibrant, not simply escape disease. Thus some of the wider benefits of organic food production, including sensory qualities (Navarro, Perez-Lopez, Mercader, Carbonell-Barrachina & Gabaldon, 2011; Reganold, et al., 2010) and environmentally and socially responsible production practices (Baroni, Cenci, Tettamanti & Berati, 2007; Gomiero, Paoletti & Pimentel, 2008; Niggli, Schmid & Fliessbach, 2008), cannot be excluded from the wellness assessment.

### 1.2 Aims and Objectives

There are gaps in the literature that need to be filled before researchers can confirm (or deny) the belief that ‘organic food is healthier’. The exploration of this subject revealed

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5 This will be discussed in more detail in Chapter 5, The Nutritional Pathway.
more questions than answers and required contextualisation. Addressing the following aims will ensure that future research is better placed to provide answers that are meaningful to consumers.

- To explore the known health effects, and the biological rationale behind the key pathways that may explain any potential health effects from organic diets (literature review)
- To determine the characteristics of ‘dedicated Australian organic consumers’ including socio-demographic characteristics, behaviours, and beliefs
- To explore general consumption trends amongst current dedicated Australian organic consumers
- To develop a method of quantifying the amount of organic food consumed
- To explore differences in the uptake of organic foods from selected food categories
- To determine the health related beliefs that compel dedicated organic consumers to consume organic food
- To identify any health benefits dedicated organic consumers believe are derived from consuming an organic diet
- To determine whether consumption of a mostly organic diet for 7 days would reduce urinary DAP metabolites (markers of OP pesticide exposure) in Australian adults
- To determine whether commercially available tests are sufficiently sensitive to detect urinary DAP metabolites resulting from dietary exposure

While is not within the scope of this thesis to determine whether organic diets are ‘healthier’ the purpose is to build on the work of esteemed colleagues so that the field is better placed to explore the question in future research.

1.3 Hypotheses/ Research Questions

Hypothesis 1 – In Australia dedicated organic consumers believe that consuming an organic diet is beneficial for health.

Associated research questions:
- What are the socio-demographic characteristics, behaviours and beliefs of dedicated organic consumers in Australia?
- Do dedicated organic consumers in Australia believe organic diets are healthier? If so why?
• What percentage of food servings consumed by dedicated organic consumers in Australia is from organic produce?
• How does the intake of organic produce by dedicated organic consumers in Australia vary by food category?
• What are the specific health related beliefs and experiences of dedicated organic consumers in Australia?

Hypothesis 2 – Consuming a minimum of 80% of food servings from organic produce reduces urinary dialkylphosphate metabolites in Australian adults.

Associated research questions:
• Does a largely organic diet reduce OP pesticide exposure in Australian adults?
• Are commercially available testing methods sufficiently sensitive to detect dietary differences in OP pesticide exposure?

1.4 Significance to Health Practitioners and Consumers

Answering these questions is important to me as a health practitioner as it allows me to make a more informed decision about when and if to recommend organic diets to patients. At the same time it does not discount the importance of a patient’s personal beliefs and values. It is also important to my patients and the larger general community who have an interest in organic food, their health and the environment.

Having taught both naturopathic and medical students for many years it is apparent that there is a lack of clarity around the question of whether to recommend organic food. Much information about organic food is driven by myth and media, rather than evidence. Early in my candidacy I received a request from the Australasian Integrative Medicine Association (AIMA) to prepare a position statement on organic foods. So I believe the question is also of importance to other health practitioners. Moreover, it is important to their patients, and the broader population attempting to determine whether the added expense of organic food offers them something they value.

The results of this study are also significant for other researchers as it equips them with more information on which to base future research which can further explore the health benefits of organic food.

6 Australasian Integrative Medicine Association (AIMA) is an association of largely medical doctors who embrace an integrative and more wholistic approach to their practice. Refer to https://www.aima.net.au/wp-content/uploads/2012/02/aima_position_statement_on_organic_produce.pdf
1.5 The Projects

In order to test the hypotheses several terms needed to be more clearly defined: organic consumers; organic diets and health. Several projects were developed to augment what was discovered in the literature review.

The first project was an online survey of organic consumers, known as the Organic Consumption Survey (or OCS). The key purpose was to gain a better understanding of dedicated organic consumers in Australia. At the time there was some industry data and a few published studies on Australian organic consumers but some were becoming outdated. The focus of the research was often from a marketing perspective, so many studies targeted the wider population and the subset of dedicated organic consumers was quite small. They often defined an organic consumer as someone who had consumed any organic food in the previous 12 months.

The OCS provided more detailed and contemporary information about the socio-demographic characteristics of people who self-identify as organic consumers which helped me to better understand this population and ensure that my research would be relevant. The OCS targeted dedicated organic consumers and looked at socio-demographic characteristics and beliefs about organic food. Respondents were also questioned about how much organic food they were eating and what food categories they were favouring. These themes were revisited in the Organic Health and Wellness Survey (OHWS), the primary focus of which was to explore specific health related beliefs in more depth.

Incidental or occasional consumption of organic food is relevant for marketing based research but the bigger question driving this thesis was whether an organic diet has potential to modify human health. Considering there is likely to be a dose-response for any health benefits, determining the quantity of organic food consumed is important. Unlike a lacto-ovo vegetarian diet, for instance, which is quite clearly defined and readily achievable, this is not the case for an organic diet. A clearer understanding of what constitutes an organic diet and what is achievable is required in order to facilitate future research.

Exploring consumption behaviours amongst the larger group of dedicated organic consumers in the OCS provided a clearer picture of the broad consumption trends of self-reported Australian organic consumers. However as self-estimation of consumption can
be inaccurate, a method was required to more precisely quantify consumption. An extensive literature search was conducted but no standard method could be located so I developed an instrument known as the Organic Food Intake Survey (or OFIS). This was pre-tested over a 3-day period on a subset of respondents to the OCS. The OFIS allowed for a degree of quantification based on the percentage of food servings that were organic, and also explored differences in the level of organic consumption between food categories.

To identify potential areas for future research I conducted the OHWS. In part, this online survey investigated organic consumer’s perceptions of how their health had changed since moving to an organic diet. This created a list of possible health benefits that may warrant future research in controlled trials. It also explored specific beliefs regarding the ability of organic diets to prevent disease.

To determine whether organic diets could reduce pesticide exposure in adults I conducted a study entitled ‘Intrapersonal variation in pesticide residues in response to an organic diet: a biomonitoring trial’ (BMT). Using a cross-over design, and the OFIS as a supporting instrument, a small biomonitoring trial was conducted. The BMT assessed OP exposure in adults consuming a largely organic compared to a largely conventional diet for a 7-day period. This is not only the first Australian study of its kind but also the first study comparing pesticide levels in adults consuming organic or conventional food to be published anywhere in the world.

The main purpose of the data collected during these projects was to test the hypotheses and to explore the bigger question of whether organic diets have the potential to influence human health. In addition the findings have been used to support a call for a more wholistic approach to assessing the health effects of organic diets. However there may also be other applications for the findings including the development of industry marketing strategies.
1.6 Thesis Overview

Chapter 2

Chapter 2 describes what can be considered to be ‘organic’. It begins with a summary of the history and current position of the organic industry. It then describes the different ways the ‘term’ organic can be understood. Firstly the process and values of the organic movement are described, including key definitions and regulations. Next ‘organic’ is described based on its product attributes, how organic products may differ from conventional ones and what the potential implications of those differences may be for human health. Pesticides and nutrients are not included as they are discussed in detail in chapters 5 and 6. Lastly the organic person or ‘organic consumer’ is described, summarising the literature pertaining to the socio-demographic characteristic, consumption patterns, behaviours and beliefs of organic consumers. The chapter concludes with a discussion about the lack of a clear operational understanding of an ‘organic diet’.

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7 Appendix 1. Full page image.
Chapter 3

Chapter 3 defines the concepts of health and wellness that will be used in this thesis. It provides a brief history of the wellness movement and a discussion on the characteristics it has derived from traditional systems of medicine.

Chapter 4

Chapter 4 presents a summary of current evidence for the health effects of organic diets. It focuses on research which relates to specific health outcomes but also includes a review of studies that have investigated self-reported measures of health, measures that might be considered in the realm of wellness promotion rather than disease mitigation. It then goes on to present some key findings from studies that do not directly assess health outcomes as a result of consuming organic diets, but provide some preliminary evidence in support of potential effects. These include studies of farm workers, functional biomarkers and animal studies. The chapter concludes with a brief discussion about the difficulties associated with researching health outcomes resulting from organic diets.

Chapters 5 and 6

Chapters 5 and 6 discuss two key pathways that are used to explain the potential health effects of organic diets. The nutritional pathway which assumes that it is the scientifically defined nutrients in organic foods that explain any health benefits; and the pesticide pathway that assumes it is the absence of pesticides in organic foods that best explain perceived health benefits. Each chapter explores the differences between organic and conventional at a process, product and person level. Moreover the chapters highlight the many complexities that need to be considered when attempting to use these pathways to establish health effects.

Chapter 7

Chapter 7 summarises the key gaps in the literature. It ties together the gaps, the research questions and the projects in preparation for the following chapters, the projects.

Chapter 8, 9 and 10

Chapters 8, 9 and 10 present the project methods and results. Each chapter commences with an abstract to orientate the reader to the project to be discussed. The background revisits a few key issues that were raised in the early chapters before describing the aims and methodology used. Results, discussion and limitations are largely presented together with each chapter concluding with a summary of the key limitations, applications and conclusions.
Chapter 11

Chapter 11 summarises the key results and discussion points from chapters 8, 9 and 10 linking them to the research questions in order to explain how the body of work ties together and supports the hypotheses. It explores some of the more interesting issues to arise within the thesis, discussing; concerns raised regarding the consequences of price premiums paid for organic food, concomitant health-promoting dietary and lifestyle factors that may coexist with an organic diet, and psychological benefits derived from organic diets. It concludes with a discussion of how the scope of research may be broadened in order to better capture the potential health effects of organic diets.

Chapter 12

Chapter 12 concludes the thesis with an assessment of how the findings presented contribute to the existing body of knowledge and how they may be utilised to facilitate rigorous and meaningful research. It acknowledges that it is likely that the combined effect of multiple factors contribute to any health benefits rather than a single premise, and calls for a more wholistic approach to future research.
Chapter 2. What is ‘Organic?’

2.1 The Organic Industry

Some would say ‘organic’ is the way food is supposed to be and the way food had always been until the ‘Green Revolution’. In the period following World War II there was a rapid development in the modernisation and mechanisation of agriculture resulting in, amongst other things, the extensive use of chemical inputs, in particular synthetic pesticides and fertilisers. Reacting against these changes separate initiatives arose in different countries from pioneers of what would become known as the ‘organic’ movement. These included Lady Eve Balfour (UK), Rudolf Steiner (Austria) and Jerome Rodale (USA). Concerns, especially about the effects on the environment, were highlighted in Rachel Carson’s ‘Silent Spring’ published in 1962. Consumer activism during the period continued to drive interest in the movement and the International Federation of Organic Agriculture Movements (IFOAM) was founded in 1972. It was not until the mid 1990s though that the organic movement began to receive recognition in countries like Australia, when the first organic standards were finally approved (Pearson, Henryks & Jones, 2011).

The organic food industry went from strength to strength, and even now continues its global expansion despite the current global financial crisis. According to the most recently published data, there are currently 1.6 million organic producers, and 37 million hectares of land worldwide that are certified according to organic standards. Australia continues to account for the largest certified organic surface area globally, covering an area of 12 million hectares which is nearly 3% of Australia’s total agricultural land. However, despite having around a third of all organically managed land worldwide, 97% of this is extensive grazing land, and Australia accounts for only ~1% of producers (Willer & Kilcher, 2012).

The global market for organic products is currently estimated at over US$59 billion (2010 figures), over three times the value in 2000 (US$17.9 Billion) (Willer & Kilcher, 2012). The most recent Australian Organic Market Report (AOMR) valued the Australian industry at A$1.276 billion, up from A$946 million in 2010 (Monk, et al., 2012). Overall the report

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8 Although the term was first used in the late 1960’s, the ‘Green Revolution’ refers to the period from the 1940s when Norman Borlaug led initiatives which resulted in massive changes in the way food was produced. In addition to the use of chemical inputs, this included the development and distribution of high-yielding and hybridised seed varieties, expansion of irrigation systems and the rise of monoculture farming.
10 Refer to 2.2 The Process
shows the consolidation of a maturing organic industry with sustained growth above
global averages (2-11%). This is a surprise to many who still see the organic industry in
Australia as a niche-market. I refer to a recent communication with a significant figure in
the grocery industry who described the market for organic products as ‘pretty much
irrelevant’ (K. Henrick, personal communication, 27 September 2010). This was based on
his understanding that the ‘organic industry is worth around $80million a year, and less
than 0.1% of the Australian food and grocery market’. In fact 65% of Australians have
bought organic food in the past year and the industry commands around 1% of the total
value of the food and beverage market (Monk, et al., 2012).

What is organic?

Recently I was giving a presentation to a group of colleagues in the university’s
Environmental Science Research Group on the influence of organic diets on pesticide
exposure. At the end I dutifully asked for questions, at which point a highly esteemed
colleague asked… “what is organic?” My first thought was… “is that a rhetorical
question?” Clearly not, as he continued… “do you mean as opposed to junk food?” In
stunned disbelief I grasped for a description and responded… “it’s food produced
without chemicals”. This is perhaps the worst possible description because it fails to
capture the underlying values of the organic movement and is easily misunderstood. I
should know better having lived for many years with an industrial chemist who
would repeatedly remind me that “all food is organic!”

How could I, supposedly an upcoming authority in this field, make such a rookie
mistake? If someone else had offered this definition I would have retorted… “it’s so
much more than that!”

The focus of this thesis is on the health and wellness effects of organic diets. To
understand this we need to consider the chain of events of how organic process attributes
are reflected in the product, how this is realised in the person (the consumer), and how
this may ultimately affect health.
Currently there is no clear definition of what constitutes an ‘organic diet’ and a search of the published literature reveals no standard methods to quantify consumption of organic food. It might be assumed that an organic diet is one that contains only organic food but total organic consumption is rare and most consumers alternate between organic and conventional products (Henryks & Pearson, 2011). We might then propose that an organic diet is one that is eaten by someone who considers themselves to be an ‘organic consumer’ but this too requires elucidation.11

2.2 The Process

One of the key ways we understand the term ‘organic’ in a food context is by looking at the processes involved in producing it. Most people are familiar with the fact that organic production excludes the use of synthetic chemicals, but there’s a lot more to it. While there is no consistent internationally accepted definition of the term ‘organic’, the most common definitions emphasise the production practices (usually described in official ‘standards’) which are guided by underlying principles (or values).

There are numerous standards that define organic production practices. These may vary from region to region, and between the more than 500 certifying bodies worldwide (Willer & Kilcher, 2012), but they generally conform to the ‘Principles of Organic Agriculture’ laid out by IFOAM (2009):

The principle of health - Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
The principle of ecology - Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
The principle of fairness - Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities
The principle of care - Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

In Australia ‘The National Standard for Organic and Bio-Dynamic Produce’ (aka ‘The Standard’) (Australian Quarantine & Inspection Service [AQIS], 2009)12 defines what can

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11 Ultimately one of the aims of this project will be to better describe the term ‘organic diet’ and to develop tools to better quantify the level of consumption. Refer to 2.4 The Person - Organic Consumers; and 2.4.7 Defining Organic Diets
12 ‘The Standard’ was developed by the organic industry with the support of AQIS. It was first implemented in 1992 and updated most recently in July 2009. ‘The Standard’ details the minimum requirements for production, processing and labelling of organic produce for export.
be considered to be ‘organic’ for the export market, and ‘The Australian Standard for Organic and Biodynamic Products’ (AS 6000) (Standards Australia, 2009) defines the domestic market.

‘The Standard’ describes organic as:

“the application of practices that emphasise: the use of renewable resources; the conservation of energy, soil and water; recognition of livestock welfare needs; and environmental maintenance and enhancement; while producing optimum quantities of produce without the use of artificial fertiliser or synthetic chemicals.”

Australian standards, like most others, refer not only to avoiding the use of substances that are foreign to nature (such as pesticides and synthetic fertilisers) as well as transgenic technology (genetic modification), but also to applying practices that promote local, renewable resources; maintain diversity; and consider animal welfare (United Nations (CBTF), 2008).

The Australian Quarantine & Inspection Service (AQIS) oversees the certification of organic products bound for the export market and approves third party organisations, known as ‘organic certifying bodies’, to provide accreditation and verification services to organic operators (primary producers, food handlers, processors and retailers). Any permitted inputs must satisfy the principles of organic production and are permitted on the basis of necessity and evidence of environmental safety, and protection of human and animal welfare (AQIS, 2009).

‘Organic’ is fundamentally a labelling term that denotes products that have been produced in accordance with organic production standards and certified by a duly constituted certification body (Monk, et al., 2012). Other important terms include (AQIS, 2009):

- **Bio-dynamic**: an agricultural system that introduces specific additional requirements to an organic system. These are based on the application of preparations indicated by Rudolf Steiner and subsequent developments for management derived from practical application, experience and research based on these preparations.

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13 A list of Australian certifying bodies can be found at [http://www.daff.gov.au/aqis/about/contact/aco](http://www.daff.gov.au/aqis/about/contact/aco). The two major certifying bodies, ACO and NAASA, are not for profit organisations and between them they cover over 90% of the Australian market (Monk, et al., 2012).

14 Refer to 5.2.1 Process: Organic and Conventional Farming Practices; and 6.2.1 Process: Pesticide Use in Food Production, for further detail on how this affects the product attributes.
**In-conversion**: a production system, which has adhered to the Standard for at least one year and has been certified as such but which does not yet qualify as organic or bio-dynamic.

**Synthetic**: substances formulated or manufactured by a chemical process or by a process that chemically alters compounds extracted from naturally occurring plant, animal or mineral sources.

**Conventional**: is a definition of exclusion; that which does not adhere to the organic or biodynamic standard and may (or may not) use artificial fertiliser or synthetic chemicals (where permitted by law).

Food produced with adherence to the organic standards can generally be defined as an organic product under the proviso that adventitious contamination with prohibited chemicals does not exceed certain levels. Logically, it should follow that a person who consumes ‘organic food’ can be labelled an ‘organic consumer’; however the level of organic food consumption varies greatly between and within individuals.

### 2.3 The Product

Organic products may differ from their conventional counterparts by virtue of the different inputs and farming methods that are used. Two of the key differences are restrictions around fertiliser use, and differences in the way pests are managed. Because these factors can influence both the nutrient value of the foods produced and residues of potentially toxic compounds, they are of particular interest to consumer health. As differences in nutritional properties and pesticide residues are the most commonly identified factors contributing to the health effects of organic diets, they will be discussed at length in later chapters which explore the key rationales driving beliefs about the health effects of organic diets.\(^{15}\) However, it should be noted that there are a number of other differences between organic and conventional produce. Organic production excludes the use of synthetic fertilisers, veterinary medicines, hormones, genetically modified organisms (GMOs), food additives and irradiation which are practices commonly used in conventional production. Organic and conventional food may also differ in levels of pathogens, mycotoxins and heavy metals.\(^{16}\) I will cover these additional issues briefly below.

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\(^{15}\) Refer to [Chapter 5. The Nutritional Pathway](#) and [Chapter 6. The Pesticide Pathway](#)

\(^{16}\) Much of the following information was also included in a position paper I wrote for AIMA early in my candidacy. Refer to [https://www.aima.net.au/wp-content/uploads/2012/02/aima_position_statement_on_organic_produce.pdf](https://www.aima.net.au/wp-content/uploads/2012/02/aima_position_statement_on_organic_produce.pdf)
2.3.1 Synthetic Fertilisers and Nitrates

Organic farming practices fix nitrogen by utilising cover crops such as legumes. With organic fertilisers nitrogen is bound to organic material from which it is slowly released (Benbrook, Zhao, Yáñez, Davies & Andrews, 2008) resulting in less nitrates leaching into ground and surface water (Ho & Ching, 2008). Chemical fertilisers utilised in conventional farming are absorbed rapidly into the plant and increase nitrite and nitrate levels. Reviews suggest that organic vegetables contain around 50% less nitrates than their conventional counterparts (Lairon, 2010). Recent studies confirm that the application of organic based fertiliser reduces nitrate levels while increasing vitamin C, nitrogen and calcium content in the plant (Hassan, Mijin, Yusoff, Ding & Wahab, 2012).17

Nitrates have been associated with methylhaemoglobinaemia in infants and an increased risk of gastrointestinal cancers (Forman & Silverstein, 2012). However the case studies in the 1950s that attributed nitrate contaminated well water as the cause of methylhaemoglobinaemia and cyanosis in infants identified faecal bacteria as the cause of nitrate contamination. It has been suggested by some authors that the faecal bacteria produced nitric oxide in the guts of the infants and this may have been the real cause (Katan, 2009). It is believed that bacteria in the mouth and gut reduce nitrate to nitrite, which may then react with amines to form carcinogenic compounds known as nitrosamines, which have been associated with certain cancers in animal experiments. More research is required to elucidate these effects. Conversely, nitrates may also have beneficial effects due to their ability to dilate blood vessels and potentially reduce blood pressure (Katan, 2009).

2.3.2 Veterinary Medicines

The most controversial of the veterinary medicines used in conventional agricultural practice are antibiotics, due to concerns regarding the emergence of resistant bacteria (Forman & Silverstein, 2012). Although the widespread use of antibiotics in animal production ceased in Europe in 2006, it remains commonplace in Australia. On last count, approximately two-thirds of the antibiotics used in Australia were used in intensive animal production (The Joint Expert Technical Advisory Committee on Antibiotic Resistance [JETACAR], 1999).18 Antibiotic residues have been reported in animal tissue samples

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17 The reduction in nitrate and increased vitamin C has also been observed in organically produced grapefruit, which interestingly is also lower in furanocoumarins the compound in grapefruit responsible for drug interactions (Lester, Manthey & Buslig, 2007).

18 JETACAR was disbanded in 2002 and more recent data could not be located. Similarly high prevalence of use has been reported in the US (Shea, 2004).
collected as part of the National Residue Survey (NRS) as have ractopamine (a beta-agonist used as a growth promotant) and antiparasitics (anthelmintics, anticoccidials) (Department of Agriculture, Fisheries & Forestry [DAFF], 2012).

Sub-therapeutic doses of antibiotics are utilised on conventional farms for the control of infection, which is a particular concern in large-scale animal confinement operations, but they are also used as growth promotants (Dolliver, Kumar & Gupta, 2007). Antibiotics are routinely added to the food and water of healthy livestock and may be retained in animal products and therefore consumed by humans. Alternatively they may be excreted unaltered and then contaminate groundwater (Blackwell, Kay, Ashauer & Boxall, 2009) or soil used for growing human (or livestock) food, and accumulate up the food chain (Rosenblatt-Farrell, 2009). In addition, antibiotic residues may affect soil quality by inhibiting microbial and enzyme activities (Liu, et al., 2009). In organic farming veterinary drugs can only be used under veterinary direction to treat illness. After treatment, livestock cannot be sold as organic and may be quarantined for a period. Crops cannot be grown on the quarantined area for at least 12 months (AQIS, 2009).

A recent review of the differences between organic and conventional food performed by researchers at Stanford University, reported that there was a 33% greater risk of isolating bacteria that were resistant to three or more antibiotics among conventional chicken and pork samples than organic alternatives (Smith-Spangler, et al., 2012). However, potential issues include not only the development and spread of antibiotic resistant bacteria, but also the impact of chronic cumulative exposure to antibiotics, the risk of allergic reactions to antibiotics and the disruption of gut microbiota (Dolliver, et al., 2007). This last factor may provide an important rationale for the health benefits of organic foods as gut flora are involved in the metabolism and excretion of environmental toxins (including those believed to promote obesity and diabetes) (Snedeker & Hay, 2012) and are intricately involved in nutrient absorption and immune function.

2.3.3 Hormones and Growth Promotants

In Australian organic agriculture ‘The Standard’ does not permit the use of hormones, growth promoters or synthetic pesticides (AQIS, 2009), yet several hormonal growth

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19 The Stanford University review will be referred to repeatedly. It evaluated hundreds of studies comparing organic and conventional food but the vast majority were of nutritional differences. The study was widely publicised and interpreted by the media as conclusive evidence that organic foods are no healthier than conventional ones. The study itself has been widely criticised and this will be noted as we go along.

20 Addressing the health of the gut flora is a cornerstone of naturopathic treatment.
promotants (HGPs) are registered for conventional agricultural use in Australia. Endogenous hormone production can also be disrupted by the ingestion of so-called endocrine-disrupting chemicals (EDCs), which are chemicals with hormone like characteristics.

Bovine growth hormones are species-specific and are believed to be biologically inactive in humans with 90% being destroyed by pasteurisation (Vicini, et al., 2008). It has even been suggested that the use of growth hormone to increase milk production provides an environmental advantage as less cows are required for the same output, resulting in less inputs and excrement (Capper, Castaneda-Gutierrez, Cady & Bauman, 2008).

Sex steroids on the other hand are not species specific and synthetic sex steroids such as the HGP zearanol may be more metabolically active as they bind less readily to sex-hormone-binding-globulin (Forman & Silverstein, 2012). Zearanol is closely related to the naturally occurring substance zearalenone, a mycotoxin produced by the *Fusarium* species. This can make it difficult for residue surveys to attribute the source of hormones detected in residue surveys (DAFF, 2012).

Children are particularly susceptible to the effects of some sex hormones and currently no threshold has been established below which there are no hormonal effects (Forman & Silverstein, 2012). In addition some synthetic pesticides are known EDCs that mimic or affect endogenous hormone production (Vandenberg, et al., 2012).

Concerns around the use of hormones include early onset of puberty, hormone dependent cancers (Forman & Silverstein, 2012) and weight gain, but risks are difficult to attribute to food production methods because hormones are naturally present in humans and livestock. In the AOMR 82% of participants said that being hormone and antibiotic free was an important attribute of organic meat (Monk, et al., 2012).  

2.3.4 Genetically Modified Organisms (GMOs)

Methods of selective and cross-breeding have been used for centuries to alter the genetic make-up of foods, however, these methods only allow for the selective enhancement of characteristics that already exist within a species or compatible species. In recent years transgenic technology (genetic engineering) has developed methods that allow for the introduction of genetic material from unrelated species that would not be possible using

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21 In early 2011, Coles, one of the largest supermarket chains in Australia introduced a 'no hormones in beef' policy
It is beyond the scope of this thesis to do justice to this issue, suffice to say that in Australia GMOs are prohibited under ‘The Standard’ (AQIS, 2009):

3.3.1 The use of genetically modified organisms or their derivatives is prohibited. This includes but is not limited to, animals, seed and farm inputs such as fertilisers, soil conditioners, vaccines, crop production materials, food additives or processing aids.

In the most recent AOMR 75% of respondents said that the absence of GMOs was an important attribute of organic food (Monk, et al., 2012). As yet, the long-term safety implications of GMOs are unclear and most of the published studies have been conducted by biotechnology companies responsible for commercialising these products (Domingo & Gine Bordonaba, 2011). Concerns include the potential consequences of introducing genetic material into the food chain, the increased use of pesticides and herbicides with GMO crops, the contamination of non-GM crops with modified genes, the use of bacteria and viruses to introduce foreign material into cells, the use of terminator genes and patenting laws that prevent farmers from seed-saving (Pusztai, 2001).

2.3.5 Food Additives

Food additives include preservatives, artificial sweeteners, colourings, flavourings, and hydrogenated fats. There are over 500 food additives available for use in conventional food but only around 40 (mostly natural or traditional) are permitted in organic foods in Australia (Heaton, 2004). The prevalence of food additive intolerance in school-aged children is estimated to be around 1-2% (Fuglsang, Madsen, Saval & Osterballe, 1993). Reactions may occur to preservatives (atopic dermatitis, asthma, rhinitis), colouring agents (atopic dermatitis, asthma, urticaria, gastrointestinal symptoms) or other substances (Fuglsang, et al., 1994). Artificial colourings and preservatives have been associated with hyperactivity in some children, and a UK study reported that the proportion of hyperactive children halved when additives were removed from their diets (Bateman, et al., 2004). In addition, concerns have been expressed for a number of other additives permitted in conventional but banned in organic production, these include: tartrazine, phosphoric acid, aspartame, monosodium glutamate and sulphur dioxide (only permitted in organic wine) (Heaton, 2004). In the most recent AOMR 88% of respondents said that being additive free was an important attribute of organic food (Monk, et al., 2012).

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22 Some of this information comes from a chapter I wrote on ‘Food as Medicine’ (Oates & Cohen, 2010)
2.3.6 Irradiation

The use of ionising radiation during processing, storage or handling of organic produce is prohibited under ‘The Standard’ (AQIS, 2009), which describes irradiation as:

*The use of high energy emissions capable of altering a food’s molecular structure for the purpose of controlling microbial contaminants, pathogens, parasites and pests in food, preserving food or inhibiting physiological processes such as sprouting or ripening.*

The Food Standards Code in Australia allows for the irradiation of a select number of products including spices, herbs, herbal teas, and some tropical fruits (Food Standards Australia & New Zealand [FSANZ], 2012a). However, the practice is not common in Australia because it is expensive and the dose required to inactivate pathogens is often too high to be tolerated by the fresh produce without undesirable changes in nutrients and quality (Gomes, Moreira & Castell-Perez, 2011). The safety data from toxicologic analysis of irradiated food and animal feeding experiments, is relatively strong but the issue remains controversial due to concerns about nutrient impairment, effects on beneficial gut microbiota and the use of nuclear technology (Shea, 2000).

2.3.7 Pathogens

There are concerns that the application of manure, limited use of veterinary medicines and free ranging may increase the risk of bacterial and fungal contamination in organic farming systems. However, the overall body of evidence suggests these concerns are unfounded (Lairon, 2010; Magkos, Arvaniti & Zampelas, 2006). Bacterial contamination is common among both organic and conventional animal products and the Stanford University review did not identify statistically significant differences between organic and conventional produce (Smith-Spangler, et al., 2012). The review did identify a non-significant increase in the presence of some pathogens in organic poultry or pork, which are foods that generally have high levels of pathogens. A possible increase in the incidence of *Campylobacter jejuni* infection is reported after consumption of organic meat in winter in the UK (Gillespie, et al., 2003). Routine recommendations for the safe storage and thorough cooking of poultry and pork should reduce pathogens in both conventional and organic produce (Department of Health (Victoria) [DPH], 2013).

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23 Refer to 4.5 *Campylobacter Infection*
2.3.8 Mycotoxins

Mycotoxins (fungal toxins) are produced by microfungi (e.g. *Fusarium*, *Aspergillus*, *Penicillium* etc) and may cause acute toxicity or chronic health effects including cancer, kidney or liver toxicity and immune suppression (Bennett & Klich, 2003; Lairon, 2010). An example is zearalenone, a metabolite of *Fusarium spp.* with potent oestrogenic activity that may occur naturally or be added to crops as the synthetic HGP known as zeranol (banned by the European Union since 1989). Some reports suggest that mycotoxins are detected 50% more often and at levels twice as high in conventional compared to organic food and this may be the result of the use of nitrogen based fertilisers and synthetic fungicides in conventional agriculture (Benbrook, 2005).

2.3.9 Heavy metals

Concerns have been raised because heavy metals can be present as impurities in both conventional and organic fertilisers. Residue surveys in Australia that test for heavy metals do not differentiate between organic and conventional produce but cadmium and lead have been detected in animal tissue samples (DAFF, 2012). Although the Stanford University review reported that overall there were no significant differences in heavy metal contamination between organic and conventional produce, there were a number of individual comparisons where statistically significant differences were identified. For lead, nine out of 49 comparisons reported lower levels in organic compared to seven reporting lower levels in conventional produce; none of the arsenic and mercury comparisons reported differences; however, for cadmium 21 out of 77 comparisons reported lower levels in organic with only one reporting lower levels in conventional produce (Smith-Spangler, et al., 2012). As with nutritional elements there are a number of factors that may influence heavy metal contamination of foods including the species genotype (Hussain, Larsson, Kuktaite & Johansson, 2012). Despite some evidence from Poland suggesting reduced heavy metals in organically reared animals (Tomza-Marciniak, Pilarczyk, Bakowska, Pilarczyk & Wojcik, 2011), at present there is insufficient Australian data to determine whether organic practices consistently result in reduced heavy metal contaminants.
2.4 The Person - Organic Consumers

2.4.1 The Who, What, When, Where, How and Why?

As will be discussed in a later section much of the current research into the health effects of organic food focuses on product attributes, in particular nutrient differences between organic and conventional foods. Yet while organic consumers appreciate both the process and product qualities of organic food (M. Huber, et al., 2012) these differences are only really of importance if they produce noticeable and relevant differences in consumers of the food. One of my concerns with the practice of relying on product attributes to demonstrate health effects, is that it doesn’t adequately consider the end user. In fact there is not a great deal of consensus about who that end-user might be.

In naturopathic medicine there is an important adage ‘treat the person, not the disease’. This means that we need to understand this person in all their complexities and in the context of their overall lives and how they operate. It can be useful to consider this in terms of the who, what, when, where, how and why? I believe this is also important for understanding populations in research.

Although consumers consistently cite health reasons as a major determinant for choosing to consume organic food (Pearson, et al., 2011), very few studies have demonstrated any direct health effects of organic diets (Dangour, et al., 2010; Smith-Spangler, et al., 2012). Because research in the area is still in its infancy there are few formal intervention studies and most studies focus on observing natural populations in order to determine how behaviours are reflected in outcomes such as allergic conditions (Alfvén, et al., 2006; Kummeling, et al., 2008).

To clearly evaluate any health effects from organic food, organic consumers need to be clearly differentiated from conventional consumers. It would also be useful to establish the amount of organic food consumed as a percentage of the overall diet. This is to help identify whether a dose response effect occurs, whereby as the proportion of the diet that is organic increases, so too does the likelihood of any health benefit.

Previous studies have attempted to define the characteristics of organic consumers using socio-demographic and attitudinal descriptions and some of the key results from

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24 Refer to Chapter 5. The Nutritional Pathway
25 This will be explored in more depth in Chapter 4. What Evidence is there that Organic Diets Improve Human Health and Wellness?
Australian studies are reported below. However, there is still no consensus regarding the characteristics and behaviours of organic consumers in Australia and results have frequently been contradictory, especially with regard to socio-demographic characteristics (Pearson, et al., 2011). This may in part be due to difficulties with study design and to the varying and changing nature of the organic industry and organic consumers. Despite a rapid global increase in organic sales, large-scale surveys are uncommon (Adamsen, Lyons, Winzar & Rundle-Thiele, 2007). Many surveys investigate organic consumers as a subset of the general population so the number of dedicated organic consumers may be quite low even in larger scale studies.

If we are to explore the potential health effects of organic diets, I believe we need to know more about dedicated organic consumers. Who are they? How are they similar or different to the general population? What are they eating… when, where and how? … and importantly… why?

2.4.2 Organic Consumers – Who are They?

A commonly held belief is that organic consumers are primarily ‘yuppies, greenies and health nuts’ (Lockie, Lyons, Lawrence & Mummery, 2002) and that the industry is driven by high income earners attracted both to the perceived health and food safety attributes, and to the high status of niche-market organic foods. This is based on the assumption that organic foods are prohibitively expensive so only ‘the wealthy or the radically health or environment conscious could afford them’ (Lockie, et al., 2002).

Australian data, collected from focus groups and surveys (Lea & Worsley, 2005; Lockie, et al., 2002; Meldrum, 2005a, 2005b; Newspoll, 2008), reveals a complex picture and a clear profile remains elusive (Pearson, et al., 2011). Organic consumers are found in all socio-economic and demographic segments but trends include: female gender, younger age (<40yo), higher levels of education and the presence of young children in the household (Lea & Worsley, 2005; Pearson, et al., 2011).

While it is widely assumed that income plays a major role in the decision to purchase organic foods this has not been clearly established. Lockie (Lockie, et al., 2002) observed a slight increase in organic food consumption with increasing income but the effect appeared to level out at around AU$35,000 per annum (based on 2002 figures) with around a third of people with an annual income of less than AU$20,000 reporting some organic food consumption. As a higher education qualification, especially science
education, is also a positive predictor for organic consumption (Lockie, et al., 2002) organic consumers might be expected to have higher than average income levels.

Overall it appears that personal values related to ‘nature, environment and equality’ are more predictive of organic consumption than socio-demographic factors (Lea & Worsley, 2005) suggesting that it is values that best define this population.

2.4.3 Organic Consumers – What do they Eat?

When we consider the term ‘organic diet’, it is useful to consider what we mean and exactly what organic consumers are eating. The choice to consume organic food may not be consistent across all food categories. These choices may be impacted by financial restraints, availability or specific beliefs about organic food that may vary between different food categories or specific foods. Most consumers alternate between purchasing organic and conventional products and have hence been labelled ‘switchers’ by Henryks and Pearson (2011).

In the most recent AOMR (which surveys general consumers, not specifically self-reported organic consumers) non-alcoholic beverages were reported to be the most common organic items to be purchased on a monthly basis (49%). This presumably includes organic juices and was closely followed by fresh fruit and vegetables which were purchased monthly by 47%, and by 60% during the course of the previous year (Monk, et al., 2012). Fresh fruit and vegetables have a relatively high market share, well above the average of all organic products, accounting for about a third of organic sales. They are considered an entry point for many new organic consumers (Pearson, et al., 2011). The uptake of organic fruit and vegetables rose to 92% amongst the ‘Leader’ group in the AOMR. This is compared with 72% of the ‘Leaders’ who had purchased organic red meat in the same period (Monk, et al., 2012). The increased uptake of organic fruit and vegetables might be because consumers are more sensitive to price increases in absolute terms rather than relative terms and more tolerant of paying higher premiums for lower priced foods such as fruit and vegetables (Pearson & Henryks, 2008).

Other organic products that were commonly bought in the 12 months prior to the conduct of the AOMR were cooking ingredients (45%), canned goods (39%), bread (39%), red

26 “Leader” is a term used in LOHAS (Lifestyles of Health & Sustainability) profiling to describe people who are considered to have a high level of participation in activities with ‘healthier and more sustainable’ attributes. The ‘Leaders’ are considered to be the primary participants in the organic market at present.
meat (35%) and dairy products (34%); and products that were purchased at least monthly included dairy products (44%), eggs (43%), and bakery items (42%) (Monk, et al., 2012).

The consumption of organic pork is likely to be quite low due to limited availability. Pork accounts for only 0.14% of all organic sales in Australia and this is largely due to the very small number of producers.\textsuperscript{27} The majority of organic pork sales are in New South Wales, which has the most certified land dedicated to pig production, and many sales occur via direct marketing to consumers (e.g. farmers’ markets) (Monk, et al., 2012). Thus a consumer’s location and shopping practices may determine whether they have access to organic pork products. Interestingly 21% of participants in the AOMR claimed to have bought organic pork products in the previous year and this may be a reflection of consumer misunderstanding about the difference between ‘organic’ and ‘free range’ labelling.

Similarly, organic fish and seafood sales are limited in Australia, to the extent that they were not included as a category in the AOMR. Because it is the process that is certified not the product, such sources would necessarily be ‘farmed’, and organic consumers may have objections to aquaculture regardless of the organic status.

2.4.4 Organic Consumers – When do they Eat Organic?

By ‘when’ I refer to the frequency with which consumers eat organic food. Much of the research targets the wider population and often classifies ‘organic consumers’ as anyone who has reported consuming organic food in the previous 12 months. As a proportion of the general population these surveys indicate that there are only a small percentage of organic consumers who purchase organic food exclusively (Pearson, Henryks & Moffitt, 2007).

According to the 2012 AOMR, 65% of households claimed to have purchased some organic food in the previous 12 months. However, most households (58%) who currently purchase organic food estimate that this constitutes less than 10% of the cost of their food purchases, with 71% indicating organic food is less than 20%. Only 14% said they spent more than 50% of their house-hold food-spend on organic options (Monk, et al., 2012). This recent finding confirms previous reports, both in Australia and abroad, that organic food is purchased in significant quantities by a minority of ‘dedicated organic consumers’.

\textsuperscript{27} This is likely due to the challenges of rearing organic pork.
while the rest is purchased in small quantities by ‘occasional organic consumers’ (Lockie, Lyons, Lawrence & Grice, 2004; Pearson, et al., 2011).

In a 2002 Australian survey of around 1200 participants, less than 7% of respondents who reported eating organic food claimed to consume ‘most’ or ‘all’ of their diet as organic (Lockie, et al., 2002). In a 2008 Newspoll survey (Newspoll, 2008) of 966 Australian grocery buyers aged 18 years or older, 13% reported purchasing organic at least once a week and 35% at least once a month. In a more recent survey which included both organic and non-organic consumers (n=163); only 2% of respondents said they ‘always’ purchased organic, 15% ‘frequently’, 36% ‘sometimes’, 34% ‘rarely’; while 13% reported ‘never’ purchasing organic produce (Pearson, 2012). The discrepancy in these figures may reflect an increase in the availability of organic food via supermarkets and other outlets in the years that separated these surveys.

While the ‘Leaders’ in the 2012 AOMR remained the primary participants in the organic market in terms of the amount and regularity with which they purchase organic food, there was also an increase in the number of ‘Laggards’ who report occasionally purchasing organic foods (up from 15% in 2010 to 24% in 2012) (Monk, et al., 2012). This suggests that consumer purchasing behaviour is changing.

The reliability of the figures above is uncertain as both under and over-reporting may occur when gathering such dietary data. For instance, a lack of public awareness of the various organic certifying logos and the true meaning of the term ‘organic’ may lead to over-reporting. It is also possible that over-reporting may occur due to ‘socially desirable responding’ (SDR). SDR is a phenomenon where respondents answer questions in ways that make them look good according to current cultural trends, and this may be particularly prevalent when Likert scales are used, which is common in these types of consumer surveys (Adamsen, et al., 2007).

Conversely under-reporting may also occur, as it is difficult to ascertain the level of intake of non-certified organic food from home gardens or purchased from farmer’s markets and local food initiatives where non-certified organic food is traded on a ‘trust’ basis (Lockie, et al., 2004). In addition consumers may be purchasing surplus organic food which has been

28 ‘Laggard’ is a term used in LOHAS (Lifestyles of Health & Sustainability) profiling to describe people who are considered to have a generally low level of participation in activities with ‘healthier and more sustainable’ attributes.
sold into the conventional market or food that has been grown with adherence to organic standards that has not been certified and for which no organic claims have been made.

2.4.5 Organic Consumers – Where do they Get their Food?

The 2012 AOMR reported that supermarkets were the main outlet for people purchasing organic products with approximately three quarters of respondents using this option for at least some products. The availability of organic foods in supermarkets has been facilitated by the larger supermarket chains stocking over 500 organic lines including their own private labels (organic home brands). The AOMR Leaders were less inclined to use supermarkets favouring other outlets such as grocers, wholefood stores, markets and online alternatives. Approximately 5% of organic shopping was done either online or via direct methods such as home delivery (Monk, et al., 2012). Overtime dedicated organic consumers can become expert in knowing where to purchase their favourite foods.

In previous Australian surveys when organic consumers were asked where they purchased the majority (half or more) of their organic produce the results were as follows (Lockie, et al., 2002): supermarkets (42%); greengrocers (28.9%); direct sales from farmers (farmers markets or farm gate sales) (15.5%); butchers (5.6%); home delivery (2.1%); and restaurants/cafes (1.8%). The Australian Organic Consumer Report 2005 (Meldrum, 2005b) produced somewhat different results: organic food stores (42%); large supermarkets (20%); farmers markets (10%) and online (~6%) (Meldrum, 2005b). For the 41% of respondents who purchased less than 25% of their weekly spend on organics, supermarkets were generally the preferred choice. Consumers purchasing >26% were more likely to shop at organic food stores or farmer’s markets (Meldrum, 2005b).

To a certain extent the nature of the product (and availability) can influence the purchasing behaviours and the AOMR reported multi-channel purchasing by many consumers (Monk, et al., 2012). For instance, a consumer may purchase their fresh fruit and vegetables from a local organic grocer but once a month frequent a farmers’ market in their local area. They may refuse to purchase pre-packaged organic fruit and vegetables from a supermarket but be willing to purchase other staples such as organic dairy foods, canned and dry goods, especially when they are on sale. They may frequent an organic butcher but supplement their organic meats from the small array available in

29 In recent years Australia’s largest organic retailer was bought out by one of the largest supermarket chains, Woolworths.
some supermarkets. They may also grow a few herbs or vegetables using what they believe to be organic techniques.\textsuperscript{30}

2.4.6 Organic Consumers - How to they Prepare their Food?

The two key mechanisms believed to be responsible for any health benefits of organic foods are increased nutrients and reduced pesticides exposure. How a consumer prepares their food may have an influence on both of these factors and thus affect the likelihood of health effects being experienced.

Different cooking techniques can alter nutrient levels and availability. For example, microwaving broccoli is reported to cause a 97% loss in the flavonoid content (Vallejo, Tomas-Barberan & Garcia-Viguera, 2003), and cooking tomatoes can increase the total phenolic concentration and anti-oxidant capacity (Gahler, Otto & Bohm, 2003). If tomatoes are cooked with oil the bioavailability of lycopene also increases, however there is some loss of vitamin C (Dewanto, Wu, Adom & Liu, 2002).

Consumers often believe that washing, peeling and cooking will eliminate pesticide residues in food; however the effects of these behaviours vary depending on the properties of the pesticides (Keikotlhaile, Spanoghe & Steurbaut, 2010; Krol, Arsenault, Pylypiw & Incorvia Mattina, 2000; Rasmusssen, Poulsen & Hansen, 2003).\textsuperscript{31} Peeling and cooking may also result in a loss of nutrients not just pesticides.

2.4.7 Organic Consumers – Why do they Consume Organic Food?

The choice to consume organic foods is psychologically viewed as being a conscious life strategy for well-being and vitality, and reflects a personal set of values in relation to ethical standards (Von Essen & Englander, 2013). Food choices are embedded in the context of a person’s sense of identity and shaped by life experiences (Bisogni, Connors, Devine & Sobal, 2002). Attitudes, beliefs and personal values appear to be a stronger predictor for organic consumption than socio-demographic variables although the predictive power of these values is fairly weak (Adamsen, et al., 2007; Lea & Worsley, 2005). Attitudes and beliefs appear to have remained stable over time, as well as being consistent internationally, and several clear trends emerge as major motivators for

\textsuperscript{30} It is contentious whether such home grown foods could be considered organic. In the absence of soil testing some backyard soils may be unknowingly contaminated due to historical use of pesticides or rubble buried on the property. Foods grown in such soils may not only fail to meet organic standards but may pose safety concerns due to heavy metal contamination in particular.

\textsuperscript{31} The actual effects will be discussed a little later under \textit{6.3.3 Food Preparation Effects on Pesticide Exposure}
organic purchasing (Pearson, et al., 2011). These trends range from self-interest (personal health and sensory qualities), to altruism (environment, animal welfare, health of others) (Henryks & Pearson, 2011).

Although the order of importance may vary between studies, the three key domains that are regularly reported are (Pearson, 2002; Pearson, et al., 2011):

- **Health benefits** (i.e. minimal artificial chemical residues in the product and higher nutritional value)
- **Environmental/social benefits** (i.e. preference for a product that has been produced and processed in an environmentally friendly and socially responsible manner) and
- **Product quality** - such as taste

For instance, respondents to the 2012 AOMR believed that the benefits of organic food were due to it being: chemical free (79%), additive free (77%), hormone/antibiotic free (64%), GMO free (62%), more nutritious (47%) and tastier (42%) (Monk, et al., 2012). In an earlier survey conducted on a randomly selected population from Victoria (N=223) the majority of participants believed organic food to be healthier, tastier and better for the environment than conventional food (Lea & Worsley, 2005). More than half of the respondents agreed with the statements ‘Organic food is healthier than conventionally grown food because it has no pesticide residues’ (74%); ‘Organic foods are better for the environment than conventionally grown foods’ (70%); ‘Organic food tastes better than conventionally grown food’ (61%); and ‘Organic foods have more vitamins and minerals than conventional foods’ (51%).

In a separate survey that targeted organic consumers, participants said they bought organic food/products because they are ‘better for health’ (93%), ‘free from pesticides/herbicides/residues’ (93%), ‘free from growth hormones/antibiotics’ (87%), ‘free from artificial additives/preservatives’ (85%), ‘better for the environment’ (77%), and ‘contain more nutrients/vitamins’ (71%) (Meldrum, 2005b).

The relative importance of health, environment benefits and quality, may vary between individuals so there is unlikely to be one specific set of characteristics that reflect all organic consumers. Pearson, Henryks and Moffit (2007) identified five distinctly different groups with regard to reasons for organic purchases:
• Passionate organic (60%): who gave the highest rating for all three attributes. This percentage rose to 88% for participants who were recruited from an organic food co-operative.
• Health and quality conscious (24%): who gave the highest rating for only health and quality.
• Moderately concerned (10%): for whom all three attributes were of moderate importance.
• Quality connoisseur (5%): for whom only quality was given the highest rating.
• Environmentally concerned (1%): for whom only environment was given the highest rating.

Regardless of the ranking, there appears to be a general perception that organic produce has more ‘desirable characteristics’ than conventionally farmed alternatives (Yiridoe, Bonti-Ankomah & Martin, 2005) and that consumers perceive that by purchasing organic food they are also purchasing these ‘characteristics’. For instance, the consumer may believe that by purchasing organic products that they perceive to possess reduced contaminants and superior nutritional value, they are purchasing ‘good health’, a quality that they value (Grossman, 1972). Similarly by purchasing produce that they perceive to have a reduced negative environmental impact, they are investing in the long term future and health of the planet and its inhabitants. In alignment with these values, self-reported organic buyers are also more likely to engage in a variety of other health-promoting and environmentally friendly behaviours than conventional buyers (Williams & Hammitt, 2000).

Barriers to organic food purchase

The major barriers to organic consumption reported in most surveys are cost, convenience, lack of trust in ‘organic’ labels and lack of knowledge about the certification of organic foods (Meldrum, 2005a). In the 2012 AOMR the key barriers to purchasing organic products were ‘price/value’ (80%) and ‘knowing you can trust it is organic’ (48%) (Monk, et al., 2012).

Cost

The price premium has been identified as a key barrier to organic consumption with 71% of Australian respondents claiming that they would buy more organic products if prices were lower (Meldrum, 2005a). While consumers value the perceived benefits of organic produce they are often not willing to pay the premium attached to these products (Donaghy, Rolfe & Bennet, 2003). A number of studies nominate tolerable price premiums
at below 20% with consumers believing that it is the responsibility of governments, retailers and food processors to absorb additional costs (Lockie, et al., 2004; Meldrum, 2005a).

It appears to be generally accepted, especially amongst more educated people that the additional care and costs involved in organic production and certification processes warrants a price premium (Paull, 2007). In fact both organic and conventional consumers report similar views on the fairness of paying premiums to farmers for farming in an environmentally sustainable manner (Lockie & Donaghy, 2004).

Surveys in Australia suggest that actual income level is not a major determinant of organic consumption (Lockie, et al., 2002), yet cost may be prohibitive for some consumers. The proportion of consumers willing to pay a price premium for organic produce decreases as the premium increases, although demand tends to depend more on the price differential with respect to conventionally grown alternatives, than on the actual price (Yiridoe, et al., 2005). Consumers may be more willing to pay a proportionately more substantial premium for less expensive than more expensive products (Donaghy, et al., 2003).

**Convenience**

In 2005 respondents in the Australian Organic Consumer Report claimed that they would purchase more organic products if stores were more conveniently located (55%), there was a wider variety/ range of products available (54%), if they could buy more in supermarkets (41%) and if supermarkets had more ‘home brands’ (10%) (Meldrum, 2005a). In recent times the variety and year round availability of organic products has become more reliable due to improvements in organic supply chains (Pearson & Henryks, 2008). Potential consumers have an increasing opportunity to purchase organic foods through a variety of permanent, temporary and online retail outlets. These include an increasing variety of ‘home-brand’ organics available through major supermarket chains, and the increasing popularity of week-end farmer’s markets and home-delivery services (Pearson & Henryks, 2008).

However, the entry of large and multinational players into the organic industry has led to debate over the extent to which organic principles may be compromised. The increase in large-scale and industrialised (albeit chemical free) production methods, the development of highly processed (nutritionally depleted) organic foods, and the environmental expense
of transporting organic produce to export markets are all contentious issues (Lockie, et al., 2002).

**Trust**

Media reports of mislabelling and misrepresentation, lack of uniform regulation standards; and a dearth of quality research to support organic claims may also instil scepticism and distrust (Yiridoe, et al., 2005). Trust in labelling has been significantly eroded in recent times due to the proliferation of ‘green-washing’, a marketing practice that promotes ill-defined terms such as ‘natural’ and ‘sustainable’. In a US study by TerraChoice 22% of products making environmental claims included a certification-like label without any apparent meaning. Media reports have also questioned the purity of the United States Department of Agriculture (USDA) certification logo, ‘USDA organic’, with reports of lobbying by interested manufacturers and a growing list of non-organic ingredients approved by the advisory board (Kindy & Layton, 2009).

In a survey conducted in Victoria, 47% of participants did not believe that all foods labelled as ‘organic’ were really organic (Lea & Worsley, 2005). The Australian Organic Consumer Report 2005 also reported that 32% of consumers who purchased organic products at least once a week did not trust product labels and a further 34% were unsure (Meldrum, 2005a).

In focus groups, criticisms of organic methods often mirror those disseminated by proponents of chemical use and genetic engineering via the mass media. Suspicion about the potential health implications of using animal manures for fertiliser reveals a lack of understanding of the procedures required of organic growers when using such inputs (Lockie, et al., 2002).

**The importance of beliefs**

Both positive beliefs and barriers are important because they drive behaviour but the extent of these factors is not always obvious. On the whole organic consumers are as price sensitive and averse to risk as conventional consumers. They share many values with regard to their food choices but there is often a discrepancy between attitudes and behaviour, with people expressing positive beliefs about organic foods, but not necessarily purchasing them (Shepherd, Magnusson & Sjoden, 2005).
The Transtheoretical Model of Behaviour Change (Prochaska, DiClemente & Norcross, 1992)\(^{32}\) is often used to evaluate readiness for change in health care settings. Positive values and beliefs about the health benefits of organic food can occur at the pre-contemplation and contemplation stages so they do not necessarily result in a change in consumption behaviour (i.e. action). In the preparation stage a decision is made, and something is then required to tip them over the edge to prepare for action. Even people who do not consume organic food seem to agree that there are benefits of organics, yet organic consumers appear to have stronger beliefs. What distinguishes regular organic consumers from the general population is not that they have positive beliefs but that they have made a decision to act on those beliefs. Having said that, without the beliefs, the decision to act is unlikely to occur. At this point barriers can prevent the person from taking action but if the determination is strong these barriers will generally be overcome.

### 2.4.7 Defining Organic Diets

In order to evaluate health outcomes, whether they be benefits or harms, or result from harm minimisation, a clear distinction must be made between organic and conventional (non-organic) consumers. The occasional consumption of organic foods (deliberate or incidental) may have little or no health effects compared to a diet made up of a majority of organic produce. Ideally, some sort of quantification of the percentage of organic food in the diet should be established in order to determine whether a dose-dependent effect occurs (Oates, Cohen & Braun, 2012).

A number of methods have been applied to record organic food consumption. In the KOALA birth cohort study parents reported on their infant’s diet in their second year of life. The food categories reported were meat, eggs, vegetables, fruit, dairy, bread and/or dry products (including pasta, rice, beans, wheat). Three consumption categories were used based on the percentage of the occasions that the food was eaten as organic; conventional was defined as <50% organic; moderate organic as 50-90% organic; and strictly organic >90% organic (Kummeling, et al., 2008).

In a Polish survey comparing self-assessed health in 100 female conventional consumers and 100 female organic consumers, respondents were allocated to the ‘organic group’ if they had consumed a minimum of 25% of their diet from organic sources for at least 6 months. The cut off was set quite low due to concerns that it would be difficult to recruit

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\(^{32}\) This is sometimes referred to as the Prochaska DiClemente model. It identifies five key stages in behavioural change: pre-contemplation, contemplation, preparation, action and maintenance. http://en.wikipedia.org/wiki/Transtheoretical_model
adequate numbers who adhered to a strictly organic diet. Nevertheless, in the final cohort only 5% of the organic consumers had consumed organic for only 6 months whereas 50% had been organic consumers for over 4 years (Rembialkowska, Kazimierczak, Srednicka, Bienko & Bielska, 2008). The 25% cut-off may also have been unnecessarily low and this highlights the need for a more accurate picture of what organic consumers are eating in order to establish criteria for future studies.

In studies measuring urinary pesticide metabolites in children, different approaches have been used. One observational study asked parents to complete a food diary noting the organic status of the food. This was used to assess the consumption of organic fresh fruit, vegetables and juice, with a minimum of 75% organic servings required for inclusion in the organic group (Curl, et al., 2003). In another study that involved an active dietary intervention, organic fruits and vegetables, wheat and corn-based food items were substituted for most of children’s conventional diet during the organic phase (Lu, et al., 2006).

Some of these studies have only considered specific food categories and none have attempted to assess a 100% organic diet. In reality it is very difficult for people to consume a 100% organic diet so it may not be clinically meaningful to assess such a rigorous practice.

Most countries have standards to describe what can be labelled as organic produce, but there are no standards to describe an organic consumer and a search of the published literature did not reveal any standard method to quantify organic consumption. So while there is no clear picture of what constitutes an ‘organic diet’ a profile of organic consumers is emerging.

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33 The results from these studies will be reported later in Chapter 4, What Evidence is there that Organic Diets Improve Human Health and Wellness?
34 The results from these studies will be reported later in 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
Chapter 3. Health and Wellness Defined

3.1 Health and Wellness

The title of this thesis is ‘Health, Wellness and Organic Diets’. Having determined that more work needs to be done to get a better understanding of what is meant by ‘organic diets’, the next question is… what do I mean when I use the terms ‘health’ and ‘wellness’?

There are four terms that are used more or less interchangeably: health, quality of life, wellbeing and wellness. While health is often understood simplistically as the absence of overt disease, quality of life focuses on subjective, functional health and may include cognitive, psychological and emotional status, as well as ability to adapt to disease (Gupta & Kant, 2009). Thus, a person may experience disease but still enjoy good quality of life.

Wellbeing goes a step further incorporating pleasure and happiness (the hedonic perspective); as well as meaning and self-realisation (the eudemonic perspective) (Ryan & Deci, 2001). The concept of wellness is still evolving but it is acknowledged as being wholistic and multidimensional involving all aspects of life, not just health; and applies not only to individuals but also to communities, organisations and the planet as a whole (Cohen, 2010). Wellness is a conscious dynamic process, not a static destination; it privileges ‘becoming’ over ‘being’. Hettler (1980) describes it as ‘an active process through which the individual becomes aware of and makes choices toward a more successful existence’ (p. 77).

3.1.1 Definitions of Health

The etymology of the word ‘health’ dates back to the Old English word ‘hælþ’ meaning “wholeness, a being whole, sound or well,” and is derived from the same word root (‘hal’) as whole or holy.

In 1913 Webster’s Dictionary defined health as (Hyperdictionary (online), 2009):

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35 The narrow working definition often used for research purposes
36 Wholism is the belief that natural systems (biological, chemical, social, economic etc.), and their properties, function as wholes and that their functioning cannot be fully understood as a collections of their individual component parts i.e. the whole is more than the sum of its parts. "Wholism" is from the Greek word holos for "whole," and was first used by Jan Christian Smuts (1870-1950) in his political treatise "Wholism and Evolution" to define an evolutionary drive for progressively more complete wholes. The terms wholism and holism are interchangeable, as are wholistic and holistic (Sobel, 2010).
The state of being hale, sound, or whole, in body, mind, or soul; especially, the state of being free from physical disease or pain.

A commonly cited definition of health is the one produced by the World Health Organisation (WHO) in 1948. Although it has been criticised for its lack of operationalisation, largely due to the unfortunate inclusion of the word ‘complete’, it was extremely ahead of its time and has not been amended since 1948:

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. (WHO, 1948)

In many ways the WHO definition comes closer to what we now refer to as wellness than the dominant medical model’s more narrow working definition of health. It blazed a path to a broader understanding of positive health which was picked up and expanded by the wellness movement. And yet, despite this groundbreaking move by the WHO, the general populace understanding of the term ‘health’ continued to remain in the domain of the physical, as reflected in The 1959 Chamber’s Twentieth Century Dictionary definition: ‘sound bodily condition’ (Geddie, 1959).

More recent medical dictionaries and popular internet reference sources do not appear to have progressed beyond the 1948 WHO definition. Mosby’s Dictionary of Medicine, Nursing & Health Professions defines is as (Harris, Nagy & Vardaxis, 2006):

a condition of physical, mental and social wellbeing and the absence of disease or other abnormal condition;

and Wikipedia (2013) as:

the general condition of a person’s mind and body, usually meaning to be free from illness, injury or pain.

Even some of the more enlightened definitions maintain focus at a primarily individual level, for instance ‘health as the ability to adapt and self-manage’ (M. Huber, Knottnerus, et al., 2011, p. 3). The term ‘health’ may be more closely associated with the dominant Western medical model which is fundamentally a reactive treatment paradigm, aiming to move individuals from a state of ill-health to no ill-health (a neutral state). The term ‘wellness’ is more closely aligned with wholistic forms of healthcare and involves a more proactive approach aiming not only to rid the individual of disease (or dis-ease) but to

37 There remains a sense within this definition that these individual aspects of health exist in isolation, so a doctor treats physical health; a psychologist addresses mental health; and social health is the domain of government decision making bodies.
invoke positive health. Thus a person may already be healthy by normal standards but may work towards being healthier.

3.1.2 Definitions of Wellness

World Health Organisation (Smith, Tang & Nutbeam, 2006):

*The optimal state of health of individuals and groups. There are two focal concerns: the realisation of the fullest potential of an individual physically, psychologically, socially, spiritually and economically, and the fulfilment of one’s role expectations in the family, community, place of worship, workplace and other settings.*

Mosby’s Dictionary of Medicine, Nursing & Health Professions (Harris, et al., 2006)

*A dynamic state of health in which an individual progresses toward a higher level of functioning, achieving an optimum balance between internal and external environments.*

Prof Marc Cohen, Program Leader, Master of Wellness program, RMIT University (Cohen, 2010)

*Wellness is a wholistic and multidisciplinary concept that represents a state of maximal resilience and enjoyment… The concept of wellness is still evolving and applies not only to individuals but also to communities, businesses, economies and the planet as a whole. Being wholistic and multidimensional, wellness includes physiological, psychological, social, demographic and ecological dimensions and thus involves all aspects of life, including occupational, recreational and spiritual pursuits, as well as social, financial and educational resources. The notion of wellness can therefore be expanded beyond health to include environmental sustainability, corporate social responsibility, social justice, human security and conscious consumption (p. 5).*

Interestingly, if you search for ‘wellness’ in Wikipedia you get separate entries for Wellness (alternative medicine) and Wellness (medicine), the latter redirects you to the ‘health’ page.

3.2 A (Very) Brief History of ‘Health’ and ‘Wellness’

In modern times the way we conceptualise and measure ‘health’ has focused on a disease paradigm, yet historically this is a fairly recent development. From ancient times
the ‘humoral theory’ was popular, which posited that ill health was the result of an imbalance in the ‘humors’ (blood, yellow bile, black bile, phlegm). This theory is usually credited to Hippocrates (c. 460 BC – c. 370 BC) the ancient Greek physician who coined the phrase ‘let food be your medicine and medicine be your food’. It retained its popularity through the writings of the second century Roman physiologist Claudius Galen (131–201 AD) another prominent figure in the history of medicine. Galen believed that different foods had the potential to produce different humors. Later in the Islamic Golden Age, Avicenna (980–1037), who wrote the ‘Canon of Medicine’, further reinforced the humoral theory. Ultimately the theory was displaced by the rise of cellular pathology in the late 19th century through the work of Rudolf Virchow (1821-1902). The strength of the humoral theory lay not in the humors themselves but in the notion of balance.

During the scientific revolution reductionism and mechanism were introduced together and have remained intertwined as the dominant approaches to health research, underpinned by a narrow working definition of health. The focus on the presence or absence of pathology, likely arose from a preoccupation with the treatment of infectious diseases that previously dominated as the major human health concerns, and was useful for the progression of the medical sciences in the late 19th and early 20th centuries. However, as the 20th century progressed the decline in infectious disease, was matched with the rise of chronic lifestyle-related disease, and an increased interest in ‘positive health’ developed (Breslow, 1972).

One of the first known references to the term ‘wellness’ was in 1654 when the Scotsman, Lord Archibald Johnston wrote in his diary: “I ... blessed God ... for my daughter’s wealnesse”. Wellness as an antonym to illness was the most common understanding until the middle of the 20th century. While many notable figures played a role in the development of wellness as a concept it was Dr. Halbert Louis Dunn who was instrumental in the term wellness being applied to these concepts. Dunn defined ‘high-level wellness’ as:

“an integrated method of functioning which is oriented toward maximizing the potential of which the individual is capable. It requires that the individual maintain

38 I think we can safely say food in this era was organic
39 The notion of balance will be explored further shortly as it is fundamental to all traditional systems of medicine and the wellness movement.
40 Chronic diseases existed previously but usually resulted in early death, now life expectancy for those with chronic disease was increasing, resulting in less mortality but more morbidity.
41 In the 1970s Aaron Antonovsky would coin the term salutogenesis (in contrast to pathogenesis) focusing on factors that support human health, especially the relationship between health, stress, and coping; rather than on factors that cause disease.
Dunn’s death in 1975 coincided with the founding of the Wellness Resource Center, in California, by Dr. John Travis. One of Travis’ most notable contributions is his focus on empowering individuals to take responsibility for their own wellness. Travis developed a wellness inventory to assess an individual’s state of wellness on a total of 12 dimensions, a Lifestyle Assessment Questionnaire, and the illness-wellness continuum (Miller, 2005) (Figure 3.1).

According to the continuum, overt disease (resulting in premature death) is at one end and high level wellness is at the other. What is commonly understood to be health is really the neutral point in the middle. In reality a person can experience both overt disease and high level wellness or be completely free from disease yet not at all well.

The National Wellness Institute was founded in 1977 and defines wellness as (NWI, n.d.):

- an active process through which people become aware of, and make choices toward, a more successful existence.
- Wellness is a conscious, self-directed and evolving process of achieving full potential
- Wellness is multi-dimensional and wholistic, encompassing lifestyle, mental and spiritual well-being, and the environment
- Wellness is positive and affirming

Wellness programs gained popularity at US universities in the 1970s and later moved into schools and the corporate arena (Miller, 2005). Employer-sponsored wellness programs are now common and result in improved economic outcomes (e.g. reduced health care costs, absenteeism and workers’ compensation claims; and improved productivity) as well as decreased health risks (Kaspin, Gorman & Miller, 2013).

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Figure 3.1. The illness-wellness continuum. (Reproduced with permission)

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For more information visit <http://www.wellpeople.com/What_Is_Wellness.aspx>
3.2.1 Lessons from Traditional Systems of Medicine

Much of the way we understand wellness has been derived from traditional systems of medicine, these are sometimes referred to under the banner of Complementary and Alternative Medicine (CAM). These systems recognise the importance of balance and living in harmony with nature. They recognise the inter-relatedness of all things and are thus wholistic in nature.

The key to understanding balance is the recognition that it is not a perfect or static state, it is a process. This notion is also at the heart of ‘wellness’.

Take a moment to experience balance at a most basic level. Stand on one foot for a minute (in tree pose if you are experienced in the yoga asanas and you feel the urge). Become aware of what is happening in your foot. Even when you feel completely balanced there is a gentle oscillation around the focal point, or what Aristotle would have called the ‘mean’.

Another central notion in these more traditional medical systems is the concept of inter-relatedness and the idea that the whole is more than the sum of its parts (a concept that would much later become known as wholism). Traditional medicine takes a cosmological view that sees the microcosm reflected in the macrocosm with fundamental cosmological principles applying at all levels (Cohen, 2010).

Healers sought to work with natural cycles and observed the universe for patterns that provided clues for this. Again, this is reflected in the way that we understand that individual wellness is interdependent with our environment at every level and that we cannot understand health simply by looking at each element in isolation.

The wellness movement has borrowed heavily from these systems to make what are fundamental concepts about health more palatable to a Western middle class society, and perhaps this is necessary for these principles that were widely accepted for millennia to regain recognition.

43 In the Western medical model the closest interpretations are ‘allostasis’, the ability to achieve stability through change; and homeostasis, the ability to achieve stability through constancy (M. Huber, et al., 2012).
Note: For the sake of simplicity I will often use the term ‘health’ throughout this thesis when what I am generally referring to is ‘wellness’ or at least the broader meaning of ‘health’. But asking if organic consumers feel ‘weller’ doesn’t have the same ring.
Chapter 4. What Evidence is there that Organic Diets Improve Human Health and Wellness?

4.1 Search Strategy and Results

Clearly many people hold beliefs in the affirmative but do organic diets really improve human health and wellness? If you read media reports you might be inclined to think that this question has already been answered, in the negative. However, there are very few published studies that even attempt to investigate real health outcomes.

As part of this project a review of the scientific literature was initially conducted in April 2008 and repeated in November 2012. Search strategies were developed in PubMed using Medical Subject Headings terms (MeSH terms) and title/abstract terms to identify studies which evaluated human health and/or wellness outcomes from organic diets.

Following the initial search of PubMed the search terms were repeated in CSA Illumina and an alert was set up to identify any subsequent releases. Prior to finalisation of this thesis the search strategy was rerun in PubMed to ensure that no additional studies had been published in the interim. The final results current to the end of January 2013 are included below.

The most recent search revealed 453 potential articles which included four reviews in English (Crinnion, 2010; Dangour, et al., 2010; Forman & Silverstein, 2012; Smith-Spangler, et al., 2012) and one in Portuguese (Sousa, Azevedo, Lima & Silva, 2012). A further review was also located after searching for key authors in the field (M. Huber, Rembialkowska, Srednicka, Bugel & van de Vijver, 2011). Reference lists from the English language review articles were also hand searched for additional studies.

Several observational studies were revealed which investigated allergic conditions (Alfvén, et al., 2006; Kummeling, et al., 2008), self-reported health (K. Huber, Henning, Dlugodsch & Fuchs, 2005; Rembialkowska, et al., 2008; van de Vijver & van Vliet, 2012) or incidence of Campylobacter infection (Gillespie, et al., 2003). Only one poorly

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44 Available at http://www.ncbi.nlm.nih.gov/pubmed/
45 ((((((((((health[Title/Abstract]) OR wellness[Title/Abstract]) OR wellbeing[Title/Abstract]) OR well-being[Title/Abstract]) AND organic food*[MeSH Terms]) OR organic diet*[Title/Abstract]) OR organic consum*[Title/Abstract]) OR organic agriculture[MeSH Terms]) OR organic farming[MeSH Terms]) OR organically grown[Title/Abstract]) OR organic produce[MeSH Terms]) OR organic production[Title/Abstract]). Filters (human).
described intervention study that specifically investigated a health outcome (lean body mass) as a result of consuming an organic diet was identified (De Lorenzo, et al., 2010), other intervention studies only explored biomarkers.

There were two further studies in farm workers for whom any differences may be due to occupational pesticide exposure rather than dietary differences (Cross, Edwards, Hounsome & Edwards-Jones, 2008; Smit, et al., 2007); as well as a number of studies that investigated functional biomarkers and semen quality in humans (Abell, Ernst & Bonde, 1994; Di Renzo, et al., 2007; Jensen, Giwercman, Carlsen, Scheike & Skakkebaek, 1996; Juhler, et al., 1999; Larsen, Spano, Giwercman & Bonde, 1999; Olsson, Andersson, Oredsson, Berglund & Gustavsson, 2006; Ren, Endo & Hayashi, 2001). Three studies measuring urinary pesticide residues were identified which will be discussed in a later chapter as they are not direct health outcomes. A number of dietary intervention studies were also identified which measured specific nutrients and these will also be discussed in a later chapter. In addition there were a number of feeding trials conducted in animals which may provide insight for future research (Baranska, et al., 2008; Finamore, et al., 2004; Holmboe-Ottesen, 2004; M. Huber, Rembialkowska, et al., 2011; M. Huber, et al., 2010; Lauridsen, et al., 2008; Millet, Cox, Buyse, Goddeeris & Janssens, 2005; Velimirov, et al., 2010). Out of interest these will be discussed briefly at the end of this chapter even though they do not directly investigate human health as a result of consuming an organic diet.

### 4.2 Reduction in Infantile Eczema

The most compelling research to date was conducted as part of the KOALA birth cohort study in the Netherlands (N=2,764). This study found no association between the development of eczema, wheeze or atopic sensitisation and the consumption of organic meat, fruit, vegetables or eggs, or the total proportion of organic products in the diet. However, sub-group analysis revealed that the consumption of organic dairy products was associated with a 36% lower risk of infantile eczema in children who exclusively consumed organic dairy products (>90% organic; weaned on organic milk, cheese and yoghurts and who were breastfed by mothers eating organic dairy products); the dairy consumption was within the context of a general organic diet. The authors attributed the results to increased levels of omega-3 fatty acids and conjugated linoleic acid in organic foods.

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46 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods

47 Refer to 5.2.3 Person: Improved Nutritional Status
compared to conventional milk, but the potential impact of agricultural chemical residues was not explored (Kummeling, et al., 2008).

### 4.3 Other Allergic Conditions

In a large cross-sectional study of 14,893 children (aged 5-13 years) across five European countries, the prevalence of allergic symptoms and sensitisation was lower among Steiner school children compared to reference children. The Steiner children represented an anthroposophic lifestyle which includes the consumption of organic and biodynamic food. Overall, there was a statistically significant reduced risk for rhinoconjunctivitis, atopic eczema, and atopic sensitisation (based on allergen-specific IgE). However, there was some heterogeneity between the countries and the difference was less pronounced than the effects of growing up on a farm (Alfvén, et al., 2006; Floistrup, et al., 2006).

### 4.4 Fat Mass

A prospective crossover study in 100 healthy males and 50 males with chronic kidney disease (CKD, stage 2 and 3 of Chronic Renal Failure) investigated the Mediterranean Diet, either organic or conventional. After 14 days there were significant differences in fat mass in the organic group. An improvement in lean body mass was observed in CDK patients ($p=0.004$) (De Lorenzo, et al., 2010).

### 4.5 Campylobacter Infection

An exploratory case-control study (3,489 cases) has identified the consumption of organic meat in winter as a risk factor for *Campylobacter jejuni* infection in the household (OR 6.86 [95%CI 1.49, 31.69]). However, the prevalence of organic meat consumption was low and the consumption of organic meat in general was not a statistically significant risk factor (Gillespie, et al., 2003). In addition the wide confidence intervals draw these results into question.

### 4.6 Self-reported Health

Some of the more interesting research findings to date come from surveys of self-reported health measures as these tend to include assessment of indicators that are ‘wellness’ rather than pathology oriented. For instance, in a survey of 566 organic consumers in The Netherlands in 2009, the majority of respondents reported perceived health benefits after moving to an organic diet. These effects included feeling more energetic and having
better resistance to illness (70%), a positive effect on mental wellbeing (30%), improved gastrointestinal function (24%), improved condition of skin, hair and/or nails (19%), fewer allergic complaints (14%) and improved satiety (14%). It was also noted that the move to organic food coincided with other health-promoting activities such as the consumption of more fresh produce (van de Vijver & van Vliet, 2012).

A Polish survey comparing 100 female conventional consumers and 100 female organic consumers who consumed a minimum of 25% of their diet from organic produce for at least 6 months found that those in the organic group assessed their health significantly higher than the conventional consumers (Rembialkowska, et al., 2008). Organic consumers reported more rarely contracting infectious diseases or experiencing headache; fewer problems with the digestive, circulatory and integumentary (skin) systems; fewer hospitalisations and cancers. They also reported exercising more and choosing better ways to manage stress. Their nutritional patterns were more in line with the recommendations of nutritionists, for instance: eating more regular meals (including breakfast) and generally eating more frequently, less fast food, drinking more fluids and paying more attention to the presence and quantity of synthetic substances in the diet. They also evaluated their living environments more positively although there was no difference between the groups in the degree of contact with nature.

The above report also referred to a German study, presented at a scientific conference (K. Huber, 2005, cited in Rembialkowska, et al., 2008) that reported on the self-assessed health of 17 German nuns (59-80 years) consuming biodynamic or conventional products for four weeks. After the biodynamic (organic) phase, the nuns reported better health, including: improved concentration, fewer headaches and migraines, lower blood pressure; improved appetite, sleep, stress resistance and immunity (fewer T-helper cells, more natural killer cells). Another secondary source (K. Huber, 2005, cited in Meier-Ploeger, 2005) reported that the nuns recorded significantly higher on the parameter of ‘well feeling’ after the biodynamic phase. Based on food diaries completed by the participants, the overall nutrient levels and fat intake were similar during each phase, daily energy intake was lower in the biodynamic phase, as was protein intake from animal produce but not from plant products and there was a higher intake of dietary fibre.

Although these studies do not lead to any definitive conclusions about the effects of organic diets, they are useful for hypothesis development, especially where similar

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48 Unfortunately I was unable to locate an English translation of this report and have had to rely on secondary interpretations by colleagues (Meier-Ploeger, 2005; Rembialkowska, et al., 2008)
findings are reported in the different cohorts. For instance, all three studies indicate an effect on the incidence and severity of infectious diseases, and this may warrant future investigation given that animal experiments have also explored possible mechanisms that may explain this. These studies also draw attention to concomitant dietary and lifestyle changes that may contribute to an improved perception of wellness.

4.7 Studies in Farm Workers

Several studies have compared health outcomes in organic and conventional farm workers. In one study, 1,205 conventional and 593 organic farmers were surveyed with regard to respiratory symptoms. Overall the organic farmers reported less wheezing with shortness of breath, but slightly more hay fever than conventional farmers. However, when adjusted for farming practices and potential confounders, such as growing up on a farm, organic farming was not an independent determinant of hay fever (Smit, et al., 2007).

In a study investigating the self-reported health and wellbeing status of farm workers in the UK, there were no significant differences between those working on conventional or organic farms for the Short Form 36, EuroQol EQ-5D and the Visual Analogue Scale. However, organic farm workers were happier than their counterparts, based on the Short Depression Happiness Scale (SDHS). Multiple regression analysis suggested that the difference was primarily associated with an increase in the variety of tasks performed by this group. The majority (93%) of those sampled were migrant workers and their health overall was shown to be poorer than national norms. The study did not assess dietary or other exposure to pesticides or other agricultural chemicals (Cross, et al., 2008). Thus, while it is likely that organic farming coincides with increased organic food consumption, the influence of occupational exposure in the matched conventional groups must be considered.

4.8 Functional Biomarkers in Humans

There is also some data from studies which have investigated functional biomarkers in humans consuming organic food. In a study of ten adult males, plasma antioxidant capacity was significantly increased by 21% after 14 days on an organic Mediterranean diet. This reflected the higher antioxidant content in most of the organic compared to conventional foods consumed (Di Renzo, et al., 2007). However, other studies have produced variable results, which may be due to differences in the bioavailability of

49 Refer to 4.9 Animal Studies
antioxidant nutrients (especially secondary metabolites)\textsuperscript{50} between different individuals; or a lack of sensitivity of testing instruments (Briviba, et al., 2007; Grinder-Pedersen, et al., 2003).

Biomarkers which indicate potential benefits for reducing the incidence or progression of cancer have also been compared between organic and conventional produce. For instance, in one study extracts from organic strawberries exhibited higher antiproliferative activity against colon and breast cancer cells than conventional ones, suggesting a higher content of secondary metabolites with anticarcinogenic properties (Olsson, et al., 2006). Another study reported antimutagenic\textsuperscript{51} activity in organic compared to conventional green vegetables juice (Ren, et al., 2001).

Several studies have investigated semen quality in men consuming organic compared to conventional food or who are organic farmers (Abell, et al., 1994; Jensen, et al., 1996; Juhler, et al., 1999; Larsen, et al., 1999). In one study, sperm concentration was 43\% ($p<.05$) higher amongst organic consumers, however a clear dose-response was not evident suggesting other factors may also have contributed to the effects (Jensen, et al., 1996). Another study that looked at semen quality in 171 conventional and 85 organic farmers; consuming no, medium or high intakes of organic fruit and vegetables, found the proportion of normal spermatozoa morphology was higher in those consuming organic food but other markers were not significantly different (Juhler, et al., 1999); this study was interested in occupational pesticide exposure rather than dietary exposure. In a related study the organic farmers had slightly higher inhibin B concentration and testosterone/sex hormone binding globulin ratio. While the conventional farmers again had a significantly lower proportion of normal spermatozoa, this result was not confirmed in a second sample (Larsen, et al., 1999).

\section*{4.9 Animal Studies}

Recent reviews which report on animal feeding trials have highlighted differences in reproductive performance, developmental rate and immune responses for animals consuming organic compared to conventional feed (M. Huber, Rembialkowska, et al., 2011; Velimirov, et al., 2010).

\textsuperscript{50} Refer to 5.2.1 Process: Organic and Conventional Farming Practices: Secondary metabolites

\textsuperscript{51} Suppresses the rate of spontaneous mutations or protects cells from mutagenic substances
Of particular interest are several recent studies investigating the effects of organic feed on immune parameters. For instance studies have shown that chickens fed organic food exhibited enhanced immune reactivity and a stronger reaction to immune challenge, with slightly stronger ‘catch-up growth’ after the challenge (M. Huber, et al., 2010). Feeding studies also report improved health-related biomarkers in rats fed fertiliser and pesticide free diets (e.g. higher serum IgG concentrations; 14% less adipose tissue; less daytime activity suggestive of more uninterrupted sleep; and shorter half-oxidation time indicative of better hepatic metabolic activity) (Lauridsen, et al., 2008). Increased proliferation of splenocytes have also been observed in rats consuming organic feed (Baranska, et al., 2008). Furthermore, an increase in immunotoxicity (higher risk to lymphocyte function) from the consumption of conventional wheat has been observed in rats (Finamore, et al., 2004). In pigs, while immune responses were similar, stress resistance at slaughter was improved in organically fed animals (Millet, et al., 2005).

While results from animal models may not be directly applied to human consumers of organic food they are designed to test certain assumptions and may provide useful information for hypothesis development. For instance, whether the immune effects reported in animal studies might help to explain self-reports of improved resistance to infection amongst organic consumers.52

4.10 Difficulties associated with Investigating Health Outcomes of Organic Diets

As was highlighted in a review published by the American Academy of Paediatrics, well-powered human studies which directly demonstrate health benefits or disease protection as a result of consuming an organic diet are lacking. The authors called for additional research to identify relationships between diet, pesticide exposure and health outcomes; but noted that such studies are difficult to perform and require large prospective cohort populations, or the random assignment of participants to organic or conventional food (Forman & Silverstein, 2012).

Designing high quality trials to investigate whether organic diets improve health and wellness outcomes are difficult. Intervention studies are extremely expensive and as a result examine only a limited number of health outcomes over short periods. On the other hand identifying natural populations of organic consumers for long term observational research can be challenging. While the PARSIFAL study (Alfvén, et al., 2006) has

52 Refer to 4.6 Self-reported Health
identified Steiner school children with an anthroposophic lifestyle as being useful candidates, there will be considerable variation in the level of adherence to an organic diet. Quantifying the level of organic intake to determine whether effects are dose dependent is difficult. In addition other aspects of an individual’s diet can make conducting research or drawing reliable conclusions difficult. For instance participants with very nutritionally replete diets may not derive additional benefits from additional nutrients. Furthermore, just because a chemical is artificial doesn’t automatically mean that it is dangerous to human health, and just because a chemical is natural and allowed in organic agriculture doesn’t necessarily mean that it isn’t (Pearson, et al., 2011). 53

When research is unavailable, or impractical, reasoning can be applied to develop logical rationales. The most common rationales used to explain why organic diets might provide benefits for health and wellness are explored in the following chapters.

53 The distinction between artificial and natural chemicals is a somewhat subjective one. While the understanding of ‘organic’ is often understood by consumers to be based around the absence of artificial or synthetic chemicals in food production; most standards focus on a list of positive traits and practices. Substances are not allowed based on ‘naturalness’ alone. Any permitted inputs must satisfy the principles of organic production and are permitted on the basis of necessity and evidence of environmental safety, and protection of human and animal welfare (AQIS, 2009).
Chapter 5. The Nutritional Pathway

5.1 Why Might Organic Diets Improve Health and Wellness?

In the previous section I discussed the lack of outcome based research available to suggest that organic diets are beneficial to health and wellness. In the absence of research directly investigating health outcomes biological reasoning may be applied for hypothesis development. This is the act of making inferences (reasoning) based on known biological phenomena and requires that there is a plausible explanation (based on existing biological and medical knowledge) for a causal association.

In terms of the ability of organic diets to impact health and wellness, we can again look at process, product or person. There are two major pathways (Figure 5.1) that are commonly used to explain the perceived health benefits of organic diets. These fall under the broader categories of health promotion and risk aversion. In other words organic diets may be beneficial because they provide something that the body needs to enable it to function at optimal capacity, or because they avoid some factor that may be detrimental to its function thereby mitigating any associated harm.

![Figure 5.1. Biological rationale for why organic diets might improve health and wellness.](image)

In terms of health promotion the issue that receives the most attention is whether the focus on building healthy soils in organic agriculture may result in higher nutrients in the food and therefore better nutritional status in those consuming organic food. As nutrients provide the building blocks for physiological function and structure it is inferred that more nutrients will therefore result in improved health.

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54 Appendix 1. Full page image
The other approach is harm mitigation. While there are a number of differences in the inputs used to produce conventional compared to organic food, pesticides receive the most attention in terms of their potential to cause harm to human health. If exposure to pesticides at levels found in the diet can cause harm then it might be expected that reducing the level of exposure reduces any associated risks.

Given that diet is considered the primary source of pesticide exposure for the majority of the population, and that organic food is relatively free from pesticides, biological reasoning suggests that reducing the intake of pesticides (by consuming an organic diet) mitigates any expected harm. But there are other factors that need to be considered. Humans are exposed to pesticides from sources other than food and there are additional factors that may influence whether exposure to pesticides might result in harm.

At the very least, for the rationale to be plausible, two basic premises need to be confirmed a) that exposure to pesticides at levels found in the diet can cause harm; and b) that the consumption of an organic diet significantly reduces pesticide exposure. This would not necessarily prove that organic diets are better for health but it at least strengthens the plausibility of the biological rationale.

There may also be a secondary pathway whereby reduced pesticide exposure results in improved nutritional status because there is less demand on the nutrients involved in metabolising pesticides. Thus, dietary intake of pesticides may result in harm by causing nutritional insufficiencies, which in turn compound any toxic effects.

In the following section I will follow these two hypothetical pathways, nutritional superiority and pesticide risk aversion, and explore how much evidence is available to support the various premises. However, it is important to remember that there may be additional factors that play a role in whether organic diets improve health and wellness. Some of these are also intrinsic product attributes such as differences in the use of veterinary medicines and artificial food additives, others are more extrinsic such as psychological benefits and concomitant behaviours that may indirectly result from organic diets.

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55 Refer to 2.2 The Process  
56 Refer to 6.3 The Problem with Pesticides  
57 Refer to 2.3 The Product  
58 This may be described as the ‘warm fuzzy’ effect derived from doing something that makes you feel good about yourself
consumption. These will be explored further in the final discussion at the end of this thesis.

5.2 Nutritional Pathway

Farming techniques that build soil health and organic matter can be expected to increase levels of at least some nutrients in certain foods grown in these soils. As a result, humans (or livestock) consuming these foods might also have better nutritional status which may confer health benefits. But what is the evidence for this?

5.2.1 Process: Organic and Conventional Farming Practices

Generalisations about the nutritional content of food based on the farming system alone are prone to be imprecise. The nutritional composition of a food depends upon a wide range of genetic and environmental factors, regardless of the production system used. These factors include: seed and breed variety, soil characteristics, watering methods, length of growing season, maturity at harvest, animal feeding and care practices, climate, location, transport conditions, storage and processing (Brandt, Leifert, Sanderson & Seal, 2011; Dangour, Dodhia, Hayter, Aikenhead, et al., 2009).

In relation to the effects on crops, this is largely determined by soil quality. Two key differences between organic and conventional production systems are the use of synthetic pesticides, and the type and intensity of fertilisation. The restriction on fertilisers directly results in less nitrogen availability to plants but this can have indirect effects on the amount of some vitamins and secondary metabolites, due to the effect of nitrogen on plant metabolism and physiology (Brandt, et al., 2011).

Organic farmers strive to build healthy soil to provide the best environment for plant growth. A healthy soil is primarily defined by its fertility, which depends upon the interactions of its physical, chemical, and biological properties. Farmers may utilise manures, composts, legume crops and some commercial inputs such as lime, plant and animal by-products; in order to ‘feed the soil, not the plant’ (Baldwin, 2006).

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59 These issues will be discussed at length in the Major discussion at the end of this thesis. Refer to 11.4.2 Other Factors that may Contribute to Health Benefits for Organic Consumers and 11.4.3 Psychological Benefits Associated with Organic Diets.

60 Organic practices would not be expected to increase all nutrients, and any increases may be relevant only to certain foods. Conversely there may also be nutrients that are decreased as a result of these practices.
Generally organic systems have large amounts of organic matter added to the soil leading to an increase in soil biodiversity with a consequent increase in biological activity. Organic farms therefore tend to have higher soil organic matter (SOM) content (Tuomisto, Hodge, Riordan & Macdonald, 2012). This improves soil fertility (Leifeld & Fuhrer, 2010) with organically managed soils having higher carbon and similar nitrogen content to conventional soils (Romanya, Arco, Sola-Morales, Armengot & Sans, 2012), and increases in the accumulation of SOM over time have been correlated with increased flavonoid levels in organic tomatoes (A. E. Mitchell, et al., 2007).

Organic farmers may select seed varietals that are more resistant to pests and these may naturally produce more nutrients, including secondary metabolites. In addition differences in the nutritional properties of organic and conventional produce may also arise from differences in organic farming practices including mulching and crop rotation (Brandt, et al., 2011).

In Australia some organic standards require periodic soil analysis to monitor SOM, nutrient levels and other important factors. This allows organic farmers to detect and correct undesirable trends early on (Department of Primary Industries (Victoria) [DPI], 2011a). However the SOM content of Australian organic farms may differ to elsewhere. In Australia the vast majority of organically managed land is broadacre and organic materials are not always available in bulk (Lawerence & Vadakattu, 2009). Few studies have been conducted comparing Australian organic and conventional soils, although the Commonwealth Scientific and Industrial Research Organisation (CSIRO) reported findings from a small group of analyses in 2009. The study confirmed that the genetic and catabolic diversities of soil bacterial and fungal communities differ significantly between organic and neighbouring conventional farms. Organic farm soils contained higher levels of the microbial biomass carbon and nitrogen, organic carbon, and microbial activity; although this may have been due to crop rotation and cultivation techniques. Populations of micro-organisms that produce nitrogen in a form usable by plants were higher in organic soil but the activity of enzymes involved in the release of plant available phosphorus was lower, and there were higher levels of soil-borne pathogens in organic farm soils (Lawerence & Vadakattu, 2009).

In livestock, differences in the choice of breeds; feeds including pasture (grass) feeding; and other organic farming practices such as free ranging are likely to impact on the nutritional content of animal products (Brandt, et al., 2011; Forman & Silverstein, 2012). For instance, nutritional differences in dairy products are likely to be related to different
feeds used in organic agriculture. Organic dairy is higher in beneficial fatty acids with a better omega 3 to omega 6 ratio (Palupi, Jayanegara, Ploeger & Kahl, 2012). However, both certified organic and low-input conventional milk has higher levels of omega 3, conjugated linoleic acid and fat soluble antioxidants (Forman & Silverstein, 2012).

Ultimately many organic farming practices may also be adopted by conventional farmers so the point of differentiation may be lost.

**Secondary metabolites**

Secondary metabolites (unlike vitamins, minerals, proteins etc) are not directly involved in normal functioning (e.g. growth, development or reproduction) but may exert a physiological function. To date around 50,000 secondary metabolites have been elucidated in plants, yet the final number is likely to exceed 200,000. They are sometimes referred to as phytonutrients or phytochemicals and often possess antioxidant, antimicrobial, anticarcinogenic and other beneficial properties (Hounsome, Hounsome, Tomos & Edwards-Jones, 2008). An example is salicylic acid, a phenolic compound that acts as a signalling molecule when a plant is under attack. It is also the active compound in aspirin which exerts anti-inflammatory and antiplatelet effects, and has been shown to be higher in organic food (Baxter, Graham, Lawrence, Wiles & Paterson, 2001). These substances explain the therapeutic properties of medicinal foods and herbs and are therefore of great interest to health practitioners.

Secondary metabolites are also believed to contribute to taste, colour and aroma in plants (Hounsome, et al., 2008). A study that reported higher phenolic content in organic compared to conventional strawberries, also reported that sensory panels judged the organic strawberries to be sweeter and have better flavour (Reganold, et al., 2010). Organic mandarins have also been shown to have higher levels of secondary metabolites such as carotenoids, and better colour and aroma than conventional varieties (Navarro, et al., 2011).

Organically produced food may have higher levels of secondary metabolites as when plants are under stress they produce chemicals to defend themselves against infection or predation (Brandt, et al., 2011). For instance, when mechanical damage occurs from insects, birds etc, there is an elevation in secondary metabolites that act as precursors for

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61 Interestingly one study demonstrated that respondents whose environmental concerns were deemed to be low, perceived that organic foods were more healthy but would be less tasty than conventional foods (Schuldt & Hannahan, 2013).
natural toxins. It is therefore believed that in the absence of synthetic pesticides organic farming practices encourage these endogenous plant defence mechanisms and may therefore result in an increase in secondary metabolites. Whether these substances exert positive or negative health effects is unclear and concerns have been raised that some may act as ‘natural toxins’ in humans (Magkos, et al., 2006).

Fertilisers are also thought to affect levels of secondary metabolites by increasing plant available nitrogen in conventional crops. This reduces the accumulation of defence-related secondary metabolites and vitamin C, while those not involved in defence such as some of the carotenoids may increase in some cases (Brandt, et al., 2011). Nitrogen favours vegetative growth so conventional foods may be higher in carbohydrates, but may also be high in nitrates (Lairon, 2010).

5.2.2 Product: Nutritional Differences between Organic and Conventional Produce

One fairly consistent finding amongst reviews is the presence of higher levels of secondary metabolites especially antioxidants and phenols in organic compared to conventional produce (Benbrook, et al., 2008; Brandt, et al., 2011; Lairon, 2010; Rembialkowska, 2007; Smith-Spangler, et al., 2012).

The recent Stanford review on organic food (Smith-Spangler, et al., 2012), which included 223 comparisons of nutrient levels between organic and conventional food, identified several examples of nutritional superiority for organic produce (total phenols and phosphorous), chicken (omega 3) and milk (omega 3); however, the overall conclusion was that the published literature lacked strong evidence that organic foods are significantly more nutritious than conventional foods.

Previous reviews, which examined a largely similar body of evidence, had also identified nutritional benefits for organic foods, including increased levels of secondary metabolites; more vitamin C and a trend towards increased iron and magnesium in some vegetables; and less overall fat but more polyunsaturated fat (especially omega 3) in animal products. However, regarding the clinical implications of these differences, there have been conflicting conclusions amongst reviewers, both positive (Benbrook, et al., 2008; Brandt,

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62 Refer to **2.3.1 Synthetic Fertilisers and Nitrates**
et al., 2011; Lairon, 2010; Rembialkowska, 2007) and negative (Dangour, Dodhia, Hayter, Aikenhead, et al., 2009; Smith-Spangler, et al., 2012).

Like the reviews that went before it, the Stanford University review identified significant heterogeneity in the reported studies (Smith-Spangler, et al., 2012). This is not surprising considering the studies investigate different nutrients, in different foods, over different growing seasons, in different regions, and using different standards to confirm organic status. While there are reasons to believe that some nutrients might be enhanced by organic farming methods that may not be the case for all nutrients in all foods under all conditions. Generalisations may be of little value to the consumer who is likely to be more interested in whether nutrients of specific interest to them are higher in the foods they eat at the places they procure their food.

Relevance for health

There are a lot of factors in the journey from paddock to plate to person that influences a foods nutritional value (Kahl, et al., 2012). While nutrient levels in food are used as a proxy for nutritional status and thus health, it is questionable how valid this is. Studies of nutrient levels in foods are often done shortly after the produce has been harvested but this may not be reflective of the typical nutrient content at the time of consumption which will be affected by post-harvest factors, including storage time and conditions, and food preparation techniques which can result in degradation of nutrients.

For instance we may speculate that consumers may be more likely to peel conventional fruit and vegetables in an attempt to remove unwanted pesticides; or that conventional produce may be more likely to be purchased from a supermarket and have been stored for a longer period compared to organic produce procured from an organic grocer or farmer's market. Without accounting for such factors we cannot really predict how any differences in the nutritional content may be realised in the actual person.

The review by the Food Standards Agency in the U.K. concluded that (Dangour, Dodhia, Hayter, Aikenhead, et al., 2009):

There is no good evidence that increased dietary intake, of the nutrients identified in this review to be present in larger amounts in organically than in conventionally produced crops and livestock products, would be of benefit to individuals

63 The study conducted for the FSA in the UK did not include most of the studies from well controlled field trials (M. Huber, Rembialkowska, et al., 2011). The strict inclusion criteria resulted in only 55 studies being assessed.

64 This will be explored further in 5.3 The Problem with Nutritionism
consuming a normal varied diet, and it is therefore unlikely that these differences in nutrient content are relevant to consumer health. (p. 2)

So it would appear that even when findings do suggest nutritional superiority it is often argued, just as it is with multivitamin supplements, that if a person is receiving their recommended daily intake (RDI) of various nutrients there is no health benefit to be derived from any additional nutrients. The RDI is a somewhat arbitrary level indicating the intake required to prevent overt deficiency disease. Yet nutritional status is a continuum and optimal function may be impaired well before signs of overt deficiency arise. Furthermore, meeting the RDI for one nutrient doesn’t infer that others will be met and while RDIs are set for individual nutrients, they are not generally available for secondary metabolites.

Many people’s nutritional needs are not met, certainly not optimally; although this may be less true for organic consumers whose nutritional intake tends to be closer to nutritionists’ recommendations (Rembialkowska, et al., 2008).

5.2.3 Person: Improved Nutritional Status

The Stanford review identified 14 studies in adults which investigated biomarker and nutrient levels in serum, urine, breast milk, and semen but did not identify any clinically meaningful differences (Smith-Spangler, et al., 2012). The term ‘clinically meaningful’ is not defined and is actually very difficult to assess. Most of the studies were short term, had small sample sizes and few evaluated a predominantly organic diet.

Some studies investigated nutritional markers for single foods but it is important to remember that consumers don’t generally eat foods in isolation they eat combinations. The organic-conventional comparisons included: plasma vitamin C\textsuperscript{66} and lycopene following the consumption of 96 g/day of tomato puree for 3 weeks (Caris-Veyrat, et al., 2004); polyphenol concentrations in plasma and urine following 500g apples per day for 4 weeks (Stracke, et al., 2010);\textsuperscript{67} carotenoids\textsuperscript{68} following carrot consumption (Soltoft, et al., 2011); and plasma carotenoid concentrations following 200g of blanched carrots per day.

\textsuperscript{65} Some of these studies related to functional biomarkers rather than specific nutritional biomarkers and were discussed previously. Refer to 4.8 Functional Biomarkers in Humans.
\textsuperscript{66} The value of testing vitamin C is highly questionable except in overt deficiency states.
\textsuperscript{67} In this study there was no increase in polyphenols regardless of whether participants consumed conventional or organic apples, or no apples at all.
\textsuperscript{68} It has already been established that some carotenoids would not necessarily be expected to be increased in organic systems. Refer to 5.2.1 Process: Organic and Conventional Farming Practices.


for 2 weeks (Stracke, et al., 2009)\textsuperscript{69}. These studies were unable to detect significant differences between organic and conventional consumption but most would have been insufficiently powered to do so. Those who also tested a control group who did not consume the food at all often had similar results. This suggests there was a failure of the tests, or of the original expectation that consumption of the food would result in changes in the test results.

In a study of 312 breast milk samples there was a dose dependent increase in rumenic acid (the main conjugated linoleic acid) and trans-vaccenic acid (a beneficial, naturally occurring trans-fat) depending on the proportion of meat and dairy consumed that was organic (Rist, et al., 2007)\textsuperscript{70}. In a related study the ratio of trans-fatty acids differed between those consuming in excess of 90% organic, compared to conventional meat and dairy products (Mueller, et al., 2010).

In a crossover study 16 participants received an organic or conventional diet for 22 days each before having urinary polyphenol excretion and serum antioxidant activity measured. The investigations produced few statistically significant results in favour of the organic diet. The exception was the excretion of quercetin and kaemferol but there was a large inter-individual difference in flavonoid excretion generally. As the diets were the same this suggests individual differences in bioavailability (Grinder-Pedersen, et al., 2003).

Nutrients rarely work in isolation but rather in teams. Nevertheless a deficiency or insufficiency of a specific nutrient may be a rate limiting factor in the body’s ability to perform an important activity so both individual and overall nutrient status are relevant to health. However, overall markers are not available and because tissue levels of nutrients are most important, less-invasive biological samples such as blood, serum and urine may not always adequately assess nutritional status.

\textit{Outcome: nutritionally related health benefits}

As previously discussed few studies have assessed health outcomes in organic consumers. One of the few that has was the KOALA Birth Cohort study which demonstrated that consumption of organic dairy products was associated with a 36\% lower risk of infantile eczema at 2 years of age, in children who exclusively consumed

\textsuperscript{69} Plasma antioxidant status, endogenous DNA strand breaks and parameters of the immune system were also tested but there was no difference between carrot and non-carrot eaters

\textsuperscript{70} These samples were from participants in the KOALA Birth Cohort study discussed in \textcolor{red}{4.2 Reduction in Infantile Eczema}; and in the next section \textcolor{red}{Outcome: nutritionally related health benefits}
organic dairy products. The authors attributed the results to increased levels of omega-3 fatty acids and conjugated linoleic acid in organic compared to conventional milk (Kummeling, et al., 2008). The potential role of other factors in the organic diet such as pesticide residues was not discussed.

5.3 The Problem with Nutritionism

Nutritional status cannot be adequately assessed by measuring individual nutrients in individual foods. While poor nutritional status will certainly impair physiological structure and function, nutritional sufficiency will not necessarily guarantee health. Thus, nutritional differences between organic and conventional food may be of interest to individuals lacking in these nutrients, but may not be relevant to the bulk of organic consumers. Kahl, Baars and others (2012) have previously questioned the validity of defining organic food quality only according to single food constituents, whether positive (nutrients) or negative (chemical residues such as pesticides), as there are many factors along the food chain that affect food quality.

While the ideology of ‘nutritionism’ assumes that it is the scientifically defined nutrients in foods that determine their value (Scrinis, 2008), in the end, food, not nutrients are the basic units of nutrition (Jacobs & Tapsell, 2007). Furthermore consumers eat diets not individual foods and the nutrients contained within the diets can compete with each other for availability or work together to exert beneficial effects. It is estimated that an individual plant can contain in the realm of 7,500 to 10,000 different compounds (M. Huber, Rembialkowska, et al., 2011) many of which science has yet to identify or name let alone fully investigate for their effects and inter-relationships. How then is it even perceivable that we could begin to evaluate the possible combined effects of these substances (which may be additive, synergistic or antagonistic with each other), even within a single plant, let alone in a diet which will contain a continually changing combination of foods? Try then to factor in variations within actual plants due to soil conditions, weather, maturity at harvest etc; and variations within the individuals that consume them.

The effects of diets are not just the sum of their nutritional parts. Intake is not the only determinant of nutritional status. The old adage, ‘you are what you eat’ doesn’t account for individual differences in absorption and demand for nutrients. There are inter-individual variations in the bioavailability, bioactivity and metabolism of nutrients so it is the nutrient

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72 Refer to 5.2.1 Process: Organic and Conventional Farming Practices
concentration achieved in target tissues not the actual intake that will determine any health effects (Blumberg, et al., 2010; M. Huber, et al., 2012). It may be more correct to say ‘you are what you absorb in relation to your individual demands’.

For instance differences in flavonoid bioavailability may result from variations in gut physiology and flora (Grinder-Pedersen, et al., 2003). Demand for nutrients may also vary both between and within individuals depending on their circumstances. For instance additional nutrients may be required to support the body during times of stress, infection, blood loss etc. Demand may also be increased to support the metabolism of environmental toxins including pesticides.

According to the Organic Food Quality and Health ([FQH], 2008) Research Agenda, various study designs are required to “build a strong ‘body of evidence’ about the effect of good quality food on good human (and animal) health”. However much of the current research favours a reductionist nutritionism approach, and this may have more to do with a lack of funding and the methodological difficulties involved in assessing actual health outcomes than the ability of this approach to answer the question.

Exploring nutritional differences in organic and conventional food may be of interest to some, but I am not convinced that this approach is of interest to the bulk of consumers as studies have not determined that a belief in the nutritional superiority of organic foods is a major driver for organic consumption. In a 2005 Australian survey only 51% of 223 participants (general public) agreed that ‘organic foods have more vitamins and minerals’ while 74% agreed with the statement ‘Organic food is healthier than conventionally grown food because it has no pesticide residues’ (Lea & Worsley, 2005). Furthermore, despite heavy media attention around the reviews discussed above that suggest little nutritional difference between organic and conventional food (Dangour, Dodhia, Hayter, Allen, et al., 2009; Smith-Spangler, et al., 2012), organic consumption in Australia continues to rise (Monk, et al., 2012).

In practice consumers are more likely to make decisions based on risk aversion (Dickson-Spillmann, Siegrist & Keller, 2011; Lockie, et al., 2004), so this is the line of enquiry I will pursue next.
Chapter 6. The Pesticide Pathway

6.1 Why Might Pesticides be Perceived as a Threat?

The health beliefs model proposes that a belief in a personal threat, and the strength of that perception, together with a belief that a proposed behaviour will be effective in reducing that threat will predict the likelihood of the behaviour being exhibited (Rosenstock, 1982). In order to understand why organic consumers may perceive a threat from pesticides in conventional food and therefore choose to consume organic foods in order to avoid those risks, it is useful to understand the biological pathway via which dietary exposure to pesticides used in conventional farming might cause harm (Figure 6.1).

Before I begin exploring the biological rationale for the pesticide pathway there are two important questions that need to be answered. Firstly what are pesticides; and secondly what are the health concerns associated with pesticide exposure? Having explored this I will go on to discuss the current evidence that supports the biological rationale, comparing what we know about pesticides in conventional versus organic systems (process, product and person); and then discuss confounding factors.

6.1.1 Pesticides: What are They?

Pesticides (including insecticides, herbicides, fungicides etc) are substances or mixtures of substances used to destroy, suppress or alter the life cycle of a ‘pest’. They do this by physically, chemically or biologically interfering with their metabolism or normal behaviour. Some are topical in action (contact pesticides), others are systemic and can be moved (translocated) from the site of application to another site within the plant or animal where they become effective. A pesticide can be synthetically produced but may also be naturally derived (The Environment Protection Authority [EPA(NSW)], 2012). Some

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73 Appendix 1. Full page image
74 In reality this is a more complex issue which involves multiple exposure pathways. This will be explored further in 5.3 The Problem with Pesticides (Figure 6.2)
‘natural’ pesticides are permitted for use in organic agriculture under ‘The Standard’ (AQIS, 2009).75

While some agricultural pesticides are utilised to prevent invasive species from spreading and resulting in crop losses, others are used for cosmetic purposes to maintain the preferred appearance of produce.

6.1.2 What are the Health Concerns for Pesticide Exposure?

Surveys indicate that most people, whether they consume organic or not, believe that organic food is healthier because it has no pesticide residues (Lea & Worsley, 2005).76 But when consumers say that they purchase organic food for health reasons, they aren’t necessarily just talking about their own health. They may also be interested in animal welfare; or the health of the environment, of agricultural communities or the people who produce their food (Lea & Worsley, 2005; Lockie, et al., 2002).

Currently most of the research on the toxic effects of pesticides is based on animal data, studies of occupational exposure or reports of acute poisoning.77 So it is unclear how much of an impact pesticides in the food chain may have. The lack of adequate evidence reflects the limited number of studies conducted on specific exposure-outcome relationships and methodological limitations. Major sources of uncertainty include small sample sizes; difficulty in quantifying exposure; limited knowledge and control of potential confounders; difficulty accounting for the effect of multiple exposures; difficulty identifying potential epigenetic effects and specific time windows when developmental processes may be most vulnerable; long latency periods between exposure and development; and the complexities associated with investigating rare health outcomes (Wigle, et al., 2008; Wigle, et al., 2007).

Nevertheless, given that the intended purpose of pesticides is to damage or kill living organisms, it is not surprising that there are many published studies attesting to a link between pesticide exposure and health risks. In a systematic review conducted for the Ontario College of General Physicians in 2004 (Sanborn, et al., 2004) a positive relationship was identified between exposure to pesticides and the development of many cancers (Bassil, et al., 2007); as well as the risk of genotoxic, immunotoxic, neurotoxic

75 Refer to 6.2.1 Process: Pesticide Use in Food Production
76 Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?
77 For a more complete discussion of the difficulties associated with assessing the health risks of pesticides, refer to the article published in the Journal of Organic Systems early in my candidacy (Oates & Cohen, 2009) (Appendix 6)
and reproductive effects; and an increased incidence of psychiatric and dermatological conditions (Sanborn, 2007). The review was updated in 2012 and included a total of 142 studies, with a focus on reproductive, neurodevelopmental, behavioural and respiratory health outcomes (Sanborn, et al., 2012). The review highlighted specific concerns for elevated risk of preterm birth as well as birth defects, including hypospadias, neural tube defects, and diaphragmatic hernia; and called for measures to reduce exposure of pregnant women to pesticides. It also found that prenatal pesticide exposure is consistently associated with measurable deficits in child neurodevelopment from impaired mental development in newborns, to attention deficit hyperactivity disorder (ADHD) and reduced IQ in older children. The review further highlighted multiple studies reporting associations between pesticide exposure and asthma, chronic obstructive lung diseases and reduced lung function. Other recent reviews have presented similar results (American Academy of Pediatrics [AAP], 2012; Forman & Silverstein, 2012).

Consistent research on the risks to children have led to calls to limit children’s exposures to pesticides as much as possible (Roberts & Karr, 2012). A report for the American Academy of Pediatrics expressed concern about the subclinical effects of long-term, low-dose exposure and recommended ongoing research describing toxicologic vulnerabilities and exposure factors across the life span to inform regulation and allow for appropriate interventions (AAP, 2012).

Much of the current research on the toxic effects of pesticides in humans focuses on both the acute and chronic effects of occupational exposure. In occupationally exposed populations evidence of acute poisoning is not uncommon and may result in alterations of the digestive, neurological, respiratory, circulatory, integumentary, renal, and reproductive systems with signs of DNA damage and lipid peroxidation (Payan-Renteria, et al., 2012). Although higher in occupationally exposed individuals, acute poisoning can also occur in residents of agricultural regions as a result of exposures such as aerial spray-drift and soil fumigation (S. J. Lee, et al., 2011). Conservative global estimates suggest 3 million accidental or intentional pesticide poisonings occur every year with over 260,000 deaths (Gunnell, Eddleston, Phillips & Konradsen, 2007). Due to a lack of reporting these figures are widely assumed to be underestimates and they do not take account of chronic or cumulative health effects or the effects of exposure during critical periods of development (London, 2009).

78 With particular reference to the ability of organophosphate pesticides to stimulate uterine contractions
In the United States’ a large prospective cohort study known as the Agricultural Health Study has followed pesticide applicators and their spouses and identified links between various pesticides and prostate, lung, colorectal and other cancers (Alavanja & Bonner, 2012; Alavanja, et al., 2004; Alavanja, et al., 2003; W. J. Lee, et al., 2007; Weichenthal, Moase & Chan, 2010). Occupational pesticide exposure has also been linked to respiratory disorders, Parkinson’s disease, diabetes, depression and other health conditions (Bassil, et al., 2007; Richardson, et al., 2009; Ritz, et al., 2009; Sanborn, et al., 2004; Thiruchelvam, Richfield, Goodman, Baggs & Cory-Slechta, 2002; Weichenthal, et al., 2010).

Long-term exposure to low levels of OPs in occupational settings has been shown to impair neurobehavioral function including psychomotor speed, executive function, visuospatial ability, working and visual memory (Ross, McManus, Harrison & Mason, 2013). In addition, European studies show that, despite special measures to protect pregnant farm workers, their sons are born with significantly shorter penis length, a tendency to reduced testicle size and lower testosterone levels. This indicates that current measures are insufficient to protect the developing foetus from the hormone disrupting agents in pesticides (Andersen, et al., 2008).

Risk to consumers
The effects of dietary exposure to pesticides are less clear than with occupational exposure, partly because of the difficulties associated with attributing exposure when most people are unaware of what pesticides they have ingested and in what amounts.

As many insecticides exert their effects on the nervous system concerns have been raised for both occupationally and non-occupationally exposed populations (London, et al., 2012) and studies have reported poor mental development and pervasive developmental problems (Eskenazi, et al., 2008), reduced cognitive ability, stamina, coordination, memory, creativity and more aggressive behaviour in exposed children (Guillette, Meza, Aquilar, Soto & Garcia, 1998). There have also been recent reports linking higher levels of urinary OP pesticide metabolites with increased ADHD prevalence (Bouchard, et al., 2010) and poorer intellectual development (Bouchard, et al., 2011) in children. This has been noted at levels occurring in the general population for whom diet is the major source of exposure.

Refer to EDC discussion in 6.3.7 Dose Response is Not Always Predictable
Concerns have also been raised regarding immunological effects that may contribute to hypersensitivity reactions, certain autoimmune diseases and cancers (Corsini, Sokooti, Galli, Moretto & Colosio, 2012) with animal feeding experiments confirming differences in immune function after the consumption of organic and conventional feed (Finamore, et al., 2004; M. Huber, et al., 2010). Studies in animals and pesticide workers have also demonstrated effects on weight control mechanisms and neurotransmitters (Baillie-Hamilton, 2002; Lim, et al., 2009).

6.2 Pesticide Pathway

6.2.1 Process: Pesticide Use in Food Production

There are thousands of pesticide products currently registered by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for use in conventional food production (EPA(NSW), 2012). Dozens of these are not registered or have been de-registered elsewhere due to concerns for carcinogenicity, endocrine disruption or environmental impact. Unlike countries in the European Union, Australian regulatory authorities are not required to report pesticide usage so the prevalence of use is unclear.

An Auditor General’s report conducted on APVMA in 2006-07 expressed concerns for the time taken to conduct reviews of chemicals identified as being of potential risk (Australian National Audit Office [ANAO], 2006). The report also revealed that 90% of the records required to be held by registrants to prove the quality of the active ingredients used in pesticides were missing, incomplete or contained errors when reviewed by APVMA.


3.1.6 The use of pesticides produced from synthetic chemicals is prohibited.

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Refer to 4.9 Animal Studies
This will be discussed later in 9.6.6 Health and Wellness Effects Reported by Respondents: Weight management
As an example, in the UK in 2011 over 16 million kg of pesticides were applied to edible crops (Food and Environmental Research Agency, Chemical Research Division [CRD], 2012)(CRD, 2012).
At the time of the report 142 chemicals of concern had been identified, 34 reviews had been completed resulting in 50% of these chemicals (and their associated products) being removed from the Australian market. The average time taken to complete a review was five years eight months and one (carbaryl) was still under review after 14 years, it was finalised in August 2012.
However substances derived from plant, animal, microbial or mineral origin are permissible under ‘The Standard’. For this reason microbial derived substances such as *Saccharopolyspora spinosa* (spinosad) and *Bacillus thuringiensis* (Bt) are permitted as are plant derived pesticides including pyrethrum (extracted from *Chrysanthemum cinerariaefolium*) and rotenone (extracted from *Derris elliptica*).

Auditing is conducted by organic certifying bodies annually to ensure that producers and retailers comply with ‘The Standard’. In turn the certifying bodies are audited annually by AQIS. Soil testing is conducted during the certification process but may also be repeated as part of the annual auditing process especially if an area is identified as high risk e.g. adjacent to a neighbouring conventional farm.

It should be stressed that just because a farm isn’t ‘certified organic’ doesn’t mean that it will use pesticides. Some conventional farmers may not require or may minimise chemical use for financial, environmental or other reasons. Others, while not certified as organic, may employ organic or integrated pest management techniques that avoid the need for synthetic pesticides.85

### 6.2.2 Product: Pesticide Residues in Foods

In Australia, produce is subjected to pesticide residue testing through industry-driven programs, government programs and private testing through food retailers, processors and organic certifying bodies, yet most of the data generated isn’t available to the public. It should be noted however that the detection of pesticides in foods is generally a reflection of growers failing to adhere to good agricultural practice (GAP) and does not necessarily imply that the residues are a food safety issue. In reality determining food safety is extremely complex.86

Government testing programs would be expected to have the broadest scope, yet the purpose of many of these programs is to demonstrate compliance with GAP for the maintenance of export markets so the data produced isn’t necessarily intended to be used to identify public health concerns. Only the Australian Total Diet Survey (ATDS) has this specific focus.

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85 Anecdotally, an example of this are wine growers who may prefer to avoid pesticides due to concerns that they may taint the taste of the wine but want to maintain the option should an outbreak occur. They do not always perceive that consumer attitudes to organic wine are positive or that the premiums sufficiently cover the expense of certification.

86 Refer to [6.3 The Problem with Pesticides](#)
According to the website of Food Standards Australia New Zealand (FSANZ, 2012b):

‘The Australian Total Diet Study, formerly known as the Australian Market Basket Survey, is Australia’s most comprehensive assessment of consumers’ dietary exposure (intake) to pesticide residues, contaminants and other substances. The survey is conducted approximately every two years’

The 23rd ATDS was released in November 2011. Pesticides were tested for the first time since the 20th ATDS which was conducted in 2001 and published in early 2003 (FSANZ, 2003). The survey examined dietary exposure to 214 agricultural and veterinary chemicals in 92 foods and beverages. This represented a wider range than the 88 pesticides and 65 foods previously surveyed. A total of 46 agricultural chemicals were detected in this study. Seven had dietary exposures exceeding 10% of the Acceptable Daily Intake (ADI) and estimated dietary exposures tended to be highest in 2-5 year olds (FSANZ, 2011).

Since 1987, the Department of Primary Industries (DPI) in Victoria has been conducting a residue testing program for chemicals and other contaminants in fresh, Victorian grown produce. The Victorian Produce Monitoring Program (VPMP) aims to ensure that the application of agricultural chemicals meets national food safety standards. In the past, the DPI conducted its own tests but in the last report for 2008-09, they obtained pesticide residue data from FreshTest, an industry based chemical residue testing program run by the Australian Chamber of Fruit and Vegetable Industries. The samples used comprised 160 vegetables, 197 fruits, 13 nuts and 8 herbs that were grown in Victoria. Pesticides were detected in 36% of the 378 samples tested, including 55% of the fruit samples, but mostly in small amounts. However, 5% of the samples had unacceptable residues, either because they exceeded maximum residue limits (MRLs) or were being used in foods without an MRL (off-label use) (DPI, 2011b).

The most recent NRS (2010-2011) conducted by the Department of Agriculture Fisheries and Forestry (DAFF) tested twelve different red meat products (including wild boar, horse, ostrich, emu and camel) but only five products from horticulture (almond, apple, macadamia, onion and pear), along with 21 grain, legume and oilseed products (DAFF, 2012). The actual number of detections from this testing are not reported, and the data
released is minimal. The NRS is largely funded by industry and tends to focus on compliance with relevant Australian Standards.\(^{87}\)

**Why regulatory bodies struggle to predict the effects of pesticides on human health.**

In comparison to many other developed nations Australia’s pesticide monitoring programs tend to lack scope, regularity and in some cases transparency.\(^{88}\)

Given the many uncertainties and complexities, the task of determining the safety of pesticides is an onerous one. Regulatory bodies are required to make decisions with limited data and often rely on something akin to an honour system with manufacturers. They assess complex mixtures of chemicals but often have data only on the active compounds.\(^{89}\) Chemicals behave differently in varying climatic and working conditions making risk assessment and management very complicated (Colosio, et al., 2011). They must also account for differences in individual exposure to, as well as responses to pesticides, despite a lack of extensive human data.\(^{90}\)

The 2008-09 President’s Cancer Panel Report described the current regulatory environment in the US as being ‘reactionary’ rather than ‘precautionary’ (Reuben, 2010) and this is also the case in Australia. The burden of proof is on the public to demonstrate hazard rather than on industry to demonstrate safety. The report criticised current testing methods as being insufficient and claimed that they failed to accurately assess human exposure.

It is unsurprising then that organic consumers are sceptical about the ability of regulatory bodies or industry to adequately manage the potential risks posed by pesticides. Thus choosing organic foods may be a rational decision for those (Lockie, et al., 2004) subscribing to the precautionary principle.\(^{91}\)

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\(^{87}\) I once attempted to obtain more detailed information and was referred to the following: NRS Administration Act 1992. 11 Release of information (5) A person to whom information is released under paragraph (2)(b) commits an offence if the information is used otherwise than for a purpose specified in the approval. Penalty: Imprisonment for 12 months.

\(^{88}\) For example the U.K. http://www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/PRIF and the USA http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateC&navID=PesticideDataProgram&rightNav1=PesticideDataProgram&topNav=&leftNav=ScienceandLaboratories&page=PesticideDataProgram&resultType=

\(^{89}\) Refer to 6.3.6 Interaction with other Chemicals: The Effect of Mixtures

\(^{90}\) Refer to 6.3.5 Individual Differences in Absorption, Metabolism and Excretion of Pesticides

\(^{91}\) … or what my mother would refer to as ‘better safe than sorry’


**Pesticide residues in organic food**

So, what about organic food? Can consumers be confident that organic produce contains little or no pesticide residues?

Certification bodies conduct routine testing as part of the certification process, yet a 2008 Australian survey (Newspoll, 2008) reported that only 48% of regular organic food buyers were aware that independent testing was conducted by these organisations, and there is limited Australian data comparing pesticide levels of organic and conventional produce, and no data comparing pesticide residues in organic and conventional animal products.\(^{92}\)

The one study that was conducted by the DPI in 2003 reported that 99.4% of organic samples contained no detectable residues for any of the 45 pesticides assessed and none exceed the MRLs (McGowan, 2003). These results were consistent with the recent Stanford University review (Smith-Spangler, et al., 2012)\(^ {93}\) and international studies which consistently report higher levels of pesticides in conventional compared to organic plant produce (Baker, Benbrook, Groth & Lutz Benbrook, 2002; Lairon, 2010; Tasiopoulou, Chiodini, Vellere & Visentin, 2007; USDA, 2012a). Thus, while ‘certified organic’ produce may still contain traces of residues, these are likely to be very low or non-existent, and comparatively lower than their conventional counterparts.

Recognising that it is virtually impossible to guarantee product claims ‘The Standard’ acknowledges that non-allowed residues may occur as a result of adventitious contamination.\(^ {94}\) Certified produce must therefore register below 10% of the MRLs set by FSANZ and listed in the Food Standards Code (AQIS, 2009). Most certifying bodies set their own acceptable levels which are commonly 5 or 10% of the MRL and undertake their own testing to verify that these standards are met by their operators (McGowan, 2003).\(^ {95}\)

Where breaches occur a trace-back is conducted and the organisation works with the operator to address the issue and prevent reoccurrence. If the detection exceeds 10% of the MRL, AQIS will be notified and the product will be recalled, although it is very rare that this is required.

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\(^{92}\) Internationally there is a lack of comparisons of animal products (Magkos, et al., 2006; Smith-Spangler, et al., 2012)

\(^{93}\) The way in which these results were reported using frequency of detection and risk difference was questionable, but the overall result that organic contains lower pesticide residues than conventional produce stands

\(^{94}\) Refer to [6.3.1 Accidental Contamination of Produce with Pesticides](#)

\(^{95}\) The results remain the property of the relevant certifying organisation and/or the grower, and are not required to be made publicly available. However Australia’s largest certifying body ACO, is currently developing plans to communicate results from testing on a yearly or twice yearly basis (A. Monk, personal communication, 19 January, 2013).
6.2.3 Person: Pesticide Residues in Human Tissue

While data from pesticide residue surveys in food give us some indication of exposure there are many factors that will influence whether these pesticides will make it into the human body. The direct measurement of pesticide residues in humans is the aim of biomonitoring (aka biological monitoring) studies, which measure the amount of a pesticide (or its metabolites) in body tissues. Assessing the relevance of these studies to risk assessment however, remains complex, for while these studies help to account for poorly understood processes such as bioaccumulation, excretion and metabolism (Smolders, et al., 2009); demonstrating pesticide exposure at a specific time point does not provide information about the lifetime risk of chronic exposure, or the increased risk of exposure during critical periods of development. Applying the results from biomonitoring studies is further complicated by differences between individuals and population groups. Nevertheless, despite its limitations, biomonitoring remains the most reliable surrogate measure of pesticide exposure currently available (Angerer, Ewers & Wilhelm, 2007). The more significant biomonitoring studies related to this topic are discussed briefly below but more detailed results will be compared with those obtained from the BMT in a later chapter.

The majority of consumers eat a conventional diet, and while biomonitoring studies conducted on the general population do not distinguish between conventional and organic consumers, they do give a useful indication of exposure to pesticides from conventional foods. Large scale biomonitoring studies have not been conducted in Australian adults but a study was recently published in which 340 South Australian (SA) children aged 3-6 years had their urine analysed for a range of pesticide residues (Babina, Dollard, Pilotto & Edwards, 2012). The study identified widespread chronic exposure to OP and synthetic pyrethroid (PYR) pesticides in children living in urban, periurban and rural areas. Exposure to multiple chemicals was common and the levels were higher than those reported in US (National Centre for Environmental Health, Department of Health and Human Services, Centers for Disease Control and Prevention [NCEH], 2009) and German (Heudorf, Angerer & Drexler, 2004) children.

96 The strengths and limitations of biomonitoring studies were discussed in an article I wrote earlier in my candidacy (Oates & Cohen, 2011) (Appendix 6). Also refer to 6.4 Biomonitoring for Pesticide Exposure: Considerations
97 Refer to 10.6.7 Comparison with the General Population
The only Australian study of non-occupationally exposed adults included 48 participants from Sydney and reported on six urinary metabolites of OPs (Globline, et al., 2001). All samples contained at least one metabolite and one of the samples contained all six.

Large scale population studies conducted overseas report a high frequency of pesticide detections (Bouvier, Seta, Vigouroux-Villard, Blanchard & Monas, 2005; Center for Disease Control [CDC], 2009; Health Canada, 2011). For example, biomonitoring in the general population has been conducted as part of the National Health and Nutrition Examination Survey (NHANES) in the USA (Barr, et al., 2004). Each of the six OP metabolites tested were detected in more than 50% of samples. Children had higher concentrations than adults and there were also slight differences depending on racial/ethnic group.

**Comparisons between consumers of organic and conventional foods**

To date only a few studies have attempted to utilise biomonitoring to compare pesticide exposure between consumers of organic and conventional foods.98

In 2003 Curl, Fenske and Elgethun (Curl, et al., 2003) published the first work in this area in the prestigious journal *Environmental Health Perspectives* (Curl, et al., 2003). This study, which will be referred to herewith as the ‘Curl study’, targeted pre-school children (2-5 years) and included 18 children who consumed organic diets (fruits, vegetables and juice) and 21 who consumed conventional diets, confirmed by food diaries completed by the parents. The children provided a 24-hour urine sample which was analysed for five dialkylphosphate (DAP) metabolites: Dimethylphosphate (DMP), Diethylphosphate (DEP), Dimethylthiophosphate (DMTP), Diethylthiophosphate (DETP), and Dimethyldithiophosphate (DMDTP); a sixth DAP metabolite, Diethylidithiophosphate (DEDTP) was not tested due to analytical concerns. These non-selective metabolites are common to around 70-80% of pesticides in the organophosphate class. The mean total dimethyl metabolite concentration99 was approximately nine times lower in children consuming organic produce than those consuming conventional produce. This study was significant because dose estimation allowed the investigators to conclude that the consumption of organic fruits, vegetables and juice reduced the children's OP exposure.

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98 These following studies will be referred to in more depth when comparing the results from the biomonitoring trial. Refer to 10.6.3 Differences in DAPs between the Conventional and Organic Phases

99 The dimethyl metabolites are those with a dimethyl rather that a diethyl group i.e. DMP, DMTP and DMDTP
levels from a range of uncertain risk to a range of negligible risk, based on the U.S. Environmental Protection Agency’s guidelines.

Again from the United States, the Children’s Pesticide Exposure Study (CPES) reported on selective urinary metabolites of OP and non-selective metabolites of PYR insecticides in 23 children (3–11 years) (Lu, et al., 2008; Lu, et al., 2006). Urine samples were collected over a 15-consecutive-day sampling period; using both first morning voids and last void before bedtime. Children who normally consumed a conventional diet maintained their usual diet for 3 days before an organic intervention phase of 5 consecutive days, then returned to their usual conventional diet until the end of the study period. During the organic phase organic food items (fruit, vegetables, juice, wheat and corn products) were substituted for most of the children’s conventional diet. The organic intervention resulted in a significant reduction in selective OP metabolites of malathion and chlorpyrifos to non-detectable or close to non-detectable levels. However this was not the case for metabolites of diazanon, methyl-primiphos and coumaphos which was likely due to less frequent use of these pesticides in agriculture, resulting in low levels and detection frequencies of metabolites in both conventional and organic phases. The OP pesticide residues dropped immediately after introduction of the organic diet and rose again after resuming a conventional diet. In a separate article the CPES reported that switching the children’s diets to mostly organic food items was not sufficient on its own to lower their PYR insecticide exposure to non-detectable levels although there was an approximately 50% reduction (Lu, et al., 2009).

A further study in children has recently been announced by a group of researchers associated with Environmental Defence in Canada but results have yet to be published.

These studies, which begin to explore the role of organic diets in reducing pesticide exposure, are limited to children and it is unclear if the results can be extrapolated to adults. ‘Children are not little adults’ (Landrigan, 1993) as their exposure to, and ability to metabolise pesticides is different.

To my knowledge only one study has been conducted in an adult population. This study, conducted by a group of Slovenian researchers, examined 63 university students who were provided with organic or conventional food for a 3- day period, at the end of which 75% of the conventional consumers but only 16% of the organic consumers had

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100 Coumaphos for instance is only registered for use in livestock in the US.
101 For updates go to www.http://environmentaldefence.ca/
detectable DAP metabolites (DMP, DEP, DETP, DMDTP and DEDTP) in their urine. In the ‘Slovenian study’ only the frequency of detection was reported with no explanation for the absence of the sixth DAP metabolite, DMTP. The most frequently detected metabolite following the intervention was DMP in 28 of the 63 participants, 23 from the conventional group and 5 from the organic group. Both DMDTP and DEDTP were not detected or were below 5µg/L. The results of this study were presented in a poster at the 2011 Food Quality and Health Conference in Prague, but have not been published in an English-speaking journal (Bavec, et al., 2011).102

The above studies suggest that replacing some conventional with organic food does indeed reduce exposure to many pesticides. Yet, while biological reasoning suggests that reducing the intake of pesticides (via an organic diet) would result in reduced exposure, other factors need to be considered. A lot of things can happen in the journey from paddock to plate to person and it is interesting to note that PYRs were only halved in the CPES study and some of the organic Slovenian students still had detectable OP residues in their urine. This suggests there are sources of pesticide exposure other than diet and/or exposure can result from organic food or the consumption of even small amounts of conventional food.

An important consideration is the extent to which an organic diet is employed in these studies.103 The Curl study only assessed the consumption of fresh fruit, vegetables and juice, with a minimum of 75% organic servings to be included in the organic group (Curl, et al., 2003). In the CPES, organic fruits and vegetables, wheat- or corn-based food items were substituted for most of children’s conventional diet on days 4 through 8 of the 15-consecutive day sampling period (Lu, et al., 2006). In the Slovenian study, discussion with the primary researcher revealed that the oil used in the intervention was not organic (M. Bavec, personal communication, 19 May, 2011). Table 6.1 presents a brief summary of the key elements of each of these studies.

Apart from the lack of published data in adults, there is significant heterogeneity between the few available studies in children which limits the possibility of drawing any general conclusions. Moreover pesticide use varies between countries (and even regions) so the results are not likely to be meaningful to adult organic consumers in Australia. A great deal more research is required.

102 Although it is as yet unpublished the abstract for this study did undergo a competitive peer-review process prior to selection for inclusion as a conference poster
103 Refer to 2.4.7 Defining Organic Diets
### Table 6.1. *Comparison of Studies Investigating the Effects of Organic Diets on Pesticide Exposure*

<table>
<thead>
<tr>
<th>Study Citation</th>
<th>Participants</th>
<th>Analytes and (LODs* µg/ L)</th>
<th>Key findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curl Study (Curl, et al., 2003)</td>
<td>39 children 2-5yrs (18 organic, 21 conventional)</td>
<td>Non-selective OP metabolites: DMP (1.2), DEP (1.3), DMTP (1.3), DETP (1.3), DMDTP (1.3)</td>
<td>dimethyl metabolite concentration was approximately nine times lower in children consuming organic produce than those consuming conventional produce</td>
<td>Minimum 75% organic fresh fruit, vegetables and juice</td>
</tr>
<tr>
<td>CPES (Lu, et al., 2006)</td>
<td>23 children 3–11 years</td>
<td>Selective OP metabolites: MDA (0.3), TCPY (0.2), IMPy (0.7), DEAMPY (0.2), CMHC (0.2)</td>
<td>significant reduction in selective OP metabolites of malathion and chlorpyrifos to non-detectable or close to non-detectable levels during the organic phase.</td>
<td>Organic fruit, vegetable corn and wheat products provided on days 4-8 of the 15-day testing period</td>
</tr>
<tr>
<td>CPES (Lu, et al., 2009)</td>
<td>23 children 3–11 years</td>
<td>Non-selective PYR metabolites: PBA (0.1), FPBA (0.2), cis-DCCA (0.2), trans-DCCA (0.4), DBCA (0.1)</td>
<td>50% reduction PYR exposure during organic intervention</td>
<td>Intervention as above Residential use appears to have a marked impact</td>
</tr>
<tr>
<td>Slovenian study (Bavec, et al., 2011)</td>
<td>63 university students</td>
<td>Non-selective OP metabolites: DMP (5)</td>
<td>25% of the conventional consumers and 84% of the organic consumers had no detectable OP metabolites in their urine. DMP most</td>
<td>DMTP not included LODs higher than Curl study Only frequency reported Organic or conventional</td>
</tr>
</tbody>
</table>
6.3 The Problem with Pesticides

Whether exposure to pesticides presents a real health hazard is difficult to determine, as is whether an organic diet is sufficient to mitigate such harm.

There is currently insufficient data from epidemiological studies to confidently predict the levels of pesticides (either the parent compounds, metabolites, degradation products or adjuvants) that might be associated with human health risks. Risk assessment involves long-term animal studies exposing test animals to a range of pesticide doses to establish the No Observed Adverse Effect Level (NOAEL) or No Observed Effect Level (NOEL) (Damalas & Eleftherohorinos, 2011). This is then used to determine the ADI for humans, which accounts for the amount of the chemical that can be consumed every day without harm; and the much higher Acute Reference Dose (ARfD) which accounts for the amount of the chemical that can be consumed in a single event without harm. Even though a 100-fold uncertainty factor is used when establishing safe daily intakes for humans, this may not completely account for individual variability in exposure and metabolism.

The levels that may cause harm are likely to vary between individuals, as well as with the timing and combination of exposure. Demonstrating clear harm as a result of dietary pesticide exposure is therefore difficult and there are significant hurdles to conducting human research. Consequently, it is difficult to investigate whether organic diets mitigate any harmful effects of pesticides.

*LOD – Limits of detection

Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
While organic food consumption may reduce exposure to pesticides present in conventional food, there are many other factors that influence exposure in both conventional and organic consumers (Figure 6.2). Furthermore, most of us don’t know what we’ve been exposed to or at what dose, whether it be from the diet or other sources of pesticide exposure. Even if we did, the effects may not always be dose dependent. The cocktail effect of mixtures of different chemicals can cause unpredictable effects, and the timing of exposure may be important, especially during critical periods of development. There may also be differences in the way various individuals absorb, metabolise and excrete chemicals and this will differ not only between individuals but also over time within the same individual. These are some of the key issues that will be explored in the coming section.106

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**Pre-market testing and post-market surveillance: a comparison with pharmaceuticals**

As previously discussed risk assessment is a complex issue and there are many factors along the journey from paddock to plate to person that can increase or decrease that risk. I would like to provide a comparison with pharmaceutical drugs here. It is a slightly crude analogy but I believe that it highlights some of the limitations of the pesticide risk assessment process and will provide some perspective for the following section.

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105 Appendix 1. Full page image
106 These issues have also been covered in articles published during my candidacy (Oates & Cohen, 2009, 2011) (Appendix 6)
Both pesticides and pharmaceuticals undergo testing prior to market. However pharmaceutical companies are required to undertake large scale human trials before a product can be registered. This is not the case with pesticides where computer modelling and animal testing is more common, in fact human testing is often considered unethical (National Resources Defense Council [NRDC], 2011).

With pharmaceutical drugs it is well recognised that the risk of adverse effects varies considerably between individuals. It is understood that these risks increase with the number of medications being taken, and not just additively, because each medication can affect the body’s ability to absorb, metabolise or excrete other medications. For this reason labels or leaflets may recommend that the medication is not taken by children, pregnant or lactating women; those with impaired liver or kidney function; those taking certain other medications etc. We know these ‘contraindications’ because these chemicals have been tested on human subjects before they’re released onto the market, and yet despite this things can still go awry. There are no such labelling requirements for pesticides in food.

Despite large scale human trials pharmaceutical products may later be removed from the market if post-market surveillance reveals an unacceptable risk to human health. This also occurs with pesticides, but the risks tend to be more readily identified with pharmaceutical drugs because for the most part people know what they are taking and in what dose, and may also be under the care of a medical practitioner trained to identify ill effects. While those exposed occupationally to pesticides may be aware of what and how much pesticide they have been exposed to this is unlikely to be the case for the majority of the population whose primary exposure is through diet. You
don’t pick up an apple and see a little label outlining all of the chemicals it may contain, in what doses and who they may not be suitable for.

6.3.1 Accidental Contamination of Produce with Pesticides

Adventitious contamination of organic food can occur during production, transport and storage. Even with the best of intentions it is impossible to guarantee that organic produce is free of pesticide residues. Some of the older classes of pesticides have very long half-lives and it is not feasible to test every square metre of a property, so isolated pockets of contamination may persist if chemicals were previously used on the land. Adventitious contamination may also occur in production due to current use on neighbouring farms resulting in contamination of soil, groundwater or irrigation water; spray drift; percolation through soil on sloping fields; or unauthorised use (Oates & Cohen, 2009). Other sources include accidental contact with conventional food or storage vessels during transportation or storage, or spray drift during pest control management in stores, distribution centres and warehouses. In recognition of this, accidental contamination is tolerated under ‘The Standard’ if it does not exceed 10% of the MRL (AQIS, 2009).

For example, in the aforementioned Victorian survey of pesticides in organic produce two samples did have detectable residues (McGowan, 2003). Dieldrin was reported in a sample of organic rockmelon at ~50% of the MRL. This would have excluded it as being able to be sold as ‘organic’ under ‘The Standard’. Its presence was most likely due to historical use in an old orchard on the property. In addition iprodione was detected in a sample of apples (<2% of the MRL) and this was probably due to contamination of a wooden crate that had previously stored conventional produce. Under ‘The Standard’ this would still have qualified as ‘organic’.

A recent USDA report identified that only 57% of the 571 organic samples tested had no detectable residues with a further 39% that were below 5% of the MRL so the remaining 4% were in violation of the USDA organic regulations (USDA, 2012a). Some of the foods selected for testing are also known to be problematic in conventional agriculture.107

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107 Of the products tested, apples, bell peppers, strawberries and potatoes appear on the EWG Dirty Dozen list <http://www.ewg.org/foodnews/summary/>. Tomatoes and broccoli were also tested.
6.3.2 Food Choice Affects Pesticide Exposure

Although diet is a major source of pesticide exposure in all age groups, certain foods are known to have a greater impact (Riederer, Bartell, Barr & Ryan, 2008). Levels of urinary OP metabolites have been shown to increase in children in line with the increased number of fruit and vegetable servings per day (Bradman, et al., 2011). Whether pesticide residues are present and/or remain on produce at the point of consumption will depend upon a number of factors including: the nature and persistence of the pesticide product; the amount, how often and how close to harvest it was applied; the addition of post-harvest treatments (e.g. fungicides); and whether the part consumed received direct application (e.g. leafy greens) (Oates & Cohen, 2009).

To a certain extent pesticide residue surveys provide information about the foods that are likely to be most problematic. However, there are significant gaps in the data especially in a country such as Australia where testing is limited, very little detail is released to the public, and many food-pesticide combinations are not tested at all or the sample sizes are very small. Whether pesticides can be detected will also depend upon the sensitivity and selectivity of the tests used. In some cases the ‘limits of detection’ (LOD) and ‘limits of reporting’ used in Australian residue surveys have been higher than the MRLs set by international regulatory bodies and thus the use of pesticides in food production does not always result in ‘detectable’ residues.

One of the criticisms levelled against current food safety assessment methods is that they do not adequately account for individual variation in food choices. To use parsley as an example, the most recent VPMP (DPI, 2011b) tested only three parsley samples. Two of the samples were found to contain unacceptable levels of pesticides. One contained levels of dimethoate, a commonly used OP insecticide, which exceeded the MRL by nearly 50%. Parsley was not one of the 92 foods tested in the most recent ATDS conducted by FSANZ (FSANZ, 2011) so this could not be compared. Since this time APVMA has suspended the use of dimethoate in a broad range of food crops including parsley. This action was triggered following the release of the 2011 Dimethoate Residues and Dietary Risk Assessment Report (APVMA, 2011). The report found that the widespread use of dimethoate could result in the ARfD being exceeded.

108 In the US, data from such surveys is used by the Environmental Working Group to publish a list of the dirty dozen and the clean 15 food items http://www.ewg.org/foodnews/summary/. However, pesticide residue results are likely to be regionally specific and compiling a similar list for Australia is limited by the lack of available data.
In order to work out how much of a particular pesticide people might actually be consuming from all combined sources dietary modelling is often used. But this can be misleading when people’s dietary habits are so different and change over time. Until very recently the data used to calculate overall dietary exposure to a particular pesticide was derived from the 1995 National Nutrition Survey. While there are differences between individuals in their food choices, differences also occur within the same individual overtime. At a population level it is unlikely that such dated information is reflective of current consumption trends. Again, taking parsley as an example, consumption for one individual may constitute a sprinkle of parsley used as a garnish where for another it may be a main ingredient used in a large bowl of tabouli. This makes overall exposure highly variable and food selection may be a much greater issue for some foods and pesticides than others.

### 6.3.3 Food Preparation Effects on Pesticide Exposure

It is often assumed that food preparation techniques such as washing, peeling and cooking will eliminate pesticide residues in food however the effects can be variable (Keikothaile, et al., 2010; Krol, et al., 2000; S. H. Mitchell, Devlin & Gault, 2008; Rasmusssen, et al., 2003). Some pesticides with a systemic mode of action can be distributed throughout fruits and vegetables so surface methods such as washing and peeling may not be sufficient to remove all unwanted pesticides (S. H. Mitchell, et al., 2008). For instance residues of vinclozolin, bifenthrin, and chlorpyrifos are not reduced by rinsing and the rinsability of a pesticide is not correlated with its water solubility (Krol, et al., 2000). Storage reduces some pesticide residues but increases others (Rasmusssen, et al., 2003) and this effect has also been noted for baking, boiling, canning and juicing (Keikothaile, et al., 2010).

### 6.3.4 Non-dietary Sources of Pesticide Exposure

Although dietary ingestion is considered to be the primary route of non-occupational exposure for most pesticides (Lu, et al., 2008; Morgan, et al., 2005; Wilson, et al., 2003), all humans are exposed to non-dietary pesticides whether they be inhaled from polluted air, absorbed through the skin or accidentally ingested.

Examples of non-dietary pesticide sources include residential insect sprays, garden pesticides, personal insect repellents, and some pet treatments. Tap water may also be an unexpected source of pesticides (McKay & Moeller, 2001; Schafer, et al., 2011).
Inhalation can be a significant source of exposure especially where pesticides have been applied recently in the environment (home, day-care centre, parks, playgrounds etc) (Wilson, et al., 2003). Pesticides can also be absorbed through the skin following contact with contaminated surfaces or topical applications (Akland, et al., 2000; Wilson, et al., 2003) and accidental ingestion can occur when pesticides are transferred from surfaces to food, or from surfaces to hands to food. Children are at higher risk because they display more hand to mouth behaviour and may come into contact with pesticides from contaminated dust or soil from play areas or close contact with treated animals (Eskenazi, Bradman & Castorina, 1999).

Additional exposure also occurs in agricultural areas through off-target pesticide drift (S. J. Lee, et al., 2011) and tracking into homes by pesticide workers’ vehicles and contaminated clothing (Curl, et al., 2002). In agricultural regions higher levels of OP pesticides have been reported for indoor air samples, house dust, children's hands and their toys (Lu, Kedan, Fisker-Andersen, Kissel & Fenske, 2004), and children of pesticide applicators are reported to have particularly high levels of urinary OP metabolites during periods of crop spraying (Fenske, Lu, Curl, Shirai & Kissel, 2005).

6.3.5 Individual Differences in Absorption, Metabolism and Excretion of Pesticides

When attempting to determine whether exposure to pesticides may result in harm consideration needs to be given not only to the nature, dose, timing and combination of exposure but also the individual’s ability to metabolise, detoxify and excrete particular pesticides. This may vary between individuals due to genetic differences but may also vary over the lifespan of the individual as a result of developmental, physiological, nutritional and environmental factors.109

The interaction between environmental chemicals and genetics is complex. Tens of thousands of single nucleotide polymorphisms have been identified, some occurring in between 5- 50% of the population (Blumberg, et al., 2010). Genetic variations in phase I and phase II detoxification enzymes may activate some chemicals resulting in a more toxic metabolite, and lead to detoxification and excretion of others. Further, it is known that conjugation and detoxification enzymes such as sulfotransferases (SULTs) and uridine diphosphate glucuronosyltransferases (UGTs), which are involved in metabolism and excretion of toxins, are found to have influential polymorphisms that are of sufficient

109 For more detail refer to the article published in The International Journal of Environmental Research and Public Health (Oates & Cohen, 2011) (Appendix 6)
frequency in the population to create a large degree of variability in enzyme activity (Ginsberg, et al., 2010).

There are also age-related differences in the activity of enzymes responsible for pesticide detoxification such as carboxylesterase. In adults enzyme activity is four times higher than children and 10 times higher that foetal enzyme activity (Yang, et al., 2009). It is also known that in childhood there can be reduced activity of paraoxonase-1 (PON-1), an enzyme which plays an important role in the detoxification of pesticides, however, the extent of this effect appears to vary depending on the genotype (Huen, et al., 2009). Serum PON-1 levels and activity also vary widely between different ethnic populations due to polymorphisms (Mohamed Ali & Chia, 2008). During pregnancy enzyme expression may be down regulated (Fortin, Aleksunes & Richardson, 2012), and smoking and medication use may also affect the metabolism of pesticides (Riederer, et al., 2008).

Inter-individual differences in detoxification capacity or entero-hepatic recirculation may allow toxicants such as pesticides to remain or be reabsorbed into the body (Jandacek & Tso, 2007). This may be influenced in part by variations in gut microbiota (gut flora) which may affect chemical metabolism by directly activating chemicals, depleting metabolites needed for metabolism, or altering enzyme activity. In addition the gut flora can affect absorption by influencing gut motility and barrier function, or by altering the bioavailability of environmental chemicals. It may also influence entero-hepatic circulation impairing the body’s ability to excrete metabolites (Snedeker & Hay, 2012).

6.3.6 Interaction with other Chemicals: The Effect of Mixtures

While regulations are set for individual chemicals, humans are exposed to numerous chemicals via multiple routes. This cocktail may include pesticides and other chemicals acquired through ingestion, inhalation or dermal absorption. Studies that analyse exposure to multiple rather than single pesticides report a dose-response relationship (Bassil, et al., 2007) suggesting that it is not the isolated acute exposure to individual chemicals that is of greatest concern but rather the combined and cumulative effect of multiple chemicals. Single chemicals with low toxicity can combine to act additively (or even synergistically) with others (Laetz, et al., 2009).

This can occur not only as a result of exposure to a number of products but even single products can contain a mixture of chemicals. For instance many pesticides are in themselves mixtures of chemicals, but generally only the active ingredient, not the actual
registered product, is tested for long term safety. These mixtures may contain so-called ‘inert’ ingredients that may be directly responsible for toxic effects or may increase the toxicity of the active ingredient (Cox & Surgan, 2006). In addition chemical breakdown products are generally not tested.

For instance some glyphosate formulations contain an adjuvant known as polyethyloxylated tallowamine (POEA), a supposedly inert surfactant; and microbial degradation of glyphosate produces aminomethyl phosphonic acid (AMPA), the major environmental breakdown product of glyphosate (Benachour & Seralini, 2009; Kolpin, et al., 2006; Mañas, et al., 2009). In vitro studies in human cell lines have demonstrated significant genotoxic effects (DNA damage and clastogenicity i.e. disruption or breakages of chromosomes) for AMPA (Mañas, et al., 2009) as well as genotoxicity, cytotoxicity and endocrine disruption from sub-agricultural doses of various glyphosate formulations (Gasnier, et al., 2009). The adverse effects appear to be more dependent on the formulation tested than on the glyphosate concentration (Benachour & Seralini, 2009; Gasnier, et al., 2009) highlighting concerns regarding toxicity testing of individual chemicals rather than whole formulations (including adjuvants and breakdown products). Both AMPA and POEA separately and synergistically damage cell membranes and these mixtures are generally even more harmful in the presence of glyphosate. Adjuvants like POEA change human cell permeability and may amplify glyphosate toxicity, through apoptosis and necrosis (Benachour & Seralini, 2009). Another example is piperonyl butoxide a synergist combined with pyrethrum for the very reason that it is known to increase the toxicity of the active product. Prenatal exposure to this airborne chemical has been associated with impaired mental development in three year olds (Horton, et al., 2011).

In addition to exposure to pesticides which are in themselves mixtures of chemicals, it is also likely that we will be exposed to a number of different pesticides. This has been confirmed by residue surveys which report the presence of multiple residues in foods (Baker, et al., 2002; PRIF, 2012). Some of these pesticides have similar and potentially synergistic mechanisms of action, for example, OPs and carbamates which interfere with cholinergic neurotransmission in both animals and humans by inhibiting the acetylcholinesterase enzyme (AChE) (Laetz, et al., 2009). Such effects are demonstrated in a study of juvenile salmon exposed to sublethal concentrations of OPs and carbamates. With some combinations this resulted in overt signs of AChE intoxication and

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110 Refer to 6.2.2 Product: Pesticide Residues in Foods
death which would not be predicted from dose addition alone. Some of the earlier signs included loss of equilibrium, altered startle response, and increased mucus production (Laetz, et al., 2009). These are signs that are commonly seen in humans yet they would rarely be attributed to pesticides.

Exposure to multiple chemicals via multiple routes may contribute to harmful effects by affecting the body’s ability to metabolise certain chemicals. Synergistic (and even antagonistic) effects can occur because mixtures of chemicals may interact via toxicokinetic (absorption, distribution, metabolism and excretion) or toxicodynamic (binding, interaction and induction of toxicity) processes (Borgert, Quill, McCarty & Mason, 2004). For this reason chemicals do not require the same mechanism of action for an interaction to occur. This is a phenomenon well recognised with pharmaceutical drugs, but not fully considered with pesticides.

Current safety assessment methods do not assess the synergistic toxicity of mixtures of chemicals and cannot predict effects that may occur within individuals unavoidably exposed to some of the 84,000 synthetic chemicals currently listed by the US Environmental Protection Agency under the Toxic Substances Control Act of chemicals in commerce. This list does not include chemical substances subject to other U.S. statutes, such as food additives, pesticides, pharmaceuticals, cosmetics, tobacco, etc (Environmental Protection Agency [EPA], 2012). The number of possible combinations is astronomical.

Multiple Chemical Sensitivity (MCS) is becoming a well recognised disease state which can involve a diverse and sometimes debilitating array of symptoms, and is attributed to exposure to extremely low levels of multiple environmental chemicals (National Industrial Chemicals Notification and Assessment Scheme [NICNAS], 2010).

6.3.7 Dose Response is Not Always Predictable

“Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy.” Philipus Aureolus Paracelsus (1496-1541)

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111 Dose addition assumes that the cumulative toxicity of a mixture of chemicals can be predicted from the sum of the toxic potential of each individual chemical. However, this is not always the case, sometimes the effect is synergistic, in other words, sometimes 1+1=2, but in a synergistic interaction it may be more like 1+1=22.
Nearly 500 years ago Paracelsus, the father of toxicology and pharmacology, told us that everything was a poison it just depended on the dose.\textsuperscript{112} Despite its antiquity, ‘the dose makes the poison’ remains an adage in modern toxicology and risk assessment that is used to describe a predictable monotonic linear relationship between dose and toxicity. This adage however, does not take into account non-monotonic dose responses and low-dose effects (Vandenberg, et al., 2012). These effects have recently been found to be remarkably common in studies of EDCs and this has led a pre-eminent group of authors to call for fundamental changes in the way chemicals are researched, assessed for safety, regulated and monitored.

An example of an EDC exhibiting low dose effects is the herbicide atrazine, which causes an increase in the conversion of testosterone to oestrogen and decreases androgen synthesis and activity. Studies have shown gonadal malformations in frogs from doses as low as 0.01 µg/L (Hayes, et al., 2011; Hayes, et al., 2002). Atrazine is known to contaminate Australian ground and drinking water (Amis, 2012; Kookana, et al., 2010; McKay & Moeller, 2001) but the safe drinking water guideline in Australia (20 µg/L) is 200 times higher than the equivalent European standard (Amis, 2012) and around seven times higher than US standards (Vandenberg, et al., 2012).

\textbf{6.3.8 Effects of the Timing of Pesticide Exposure}

The effects of pesticides may be immediate or latent, or only evident during certain developmental stages. Furthermore, exposure to chemicals that may interact does not necessarily need to be concurrent in order to produce additive or synergistic effects (Thiruchelvam, et al., 2002). Persistent chemicals may be active long after exposure, repeated exposure may result in cumulative effects and some chemicals will bioaccumulate in human tissue. For example, in experimental studies, mice exposed prenatally to paraquat (herbicide) and maneb (fungicide), alone or in combination, displayed only minimal neurotoxic changes in motor activity and dopamine levels. However when the same mice were rechallenged in adulthood with these pesticides there were significant decreases, especially after exposure to the combination, which resulted in a 70% reduction in motor activity and a 62% reduction in dopamine levels with a similar pattern of dopaminergic cell loss. Prenatal exposure to either pesticide produced a silent state of toxicity which enhanced adult susceptibility to the neurotoxic effects of the pesticides later in life (Thiruchelvam, et al., 2002).

\textsuperscript{112} Incidentally, at this time chemistry was not distinguished from alchemy; arsenic, mercury and lead were used as pesticides; and the first chemical discovery of an element (phosphorous) was still more than a century away.
The unpredictable effects of chemicals (a hairy tale)

Let me illustrate with a personal example. All of my adult life I have had long wavy hair. However, I prefer to wear it straight but this can be time consuming. This has led me to undergo chemical straightening treatments. In 2011 I underwent three straightening treatments between April and November. In July 2012, approximately 8 months after the last treatment, I underwent another straightening treatment, this time using a different chemical. Although the effects of the previous straightening treatment had long worn off, residues remained in my hair. Shortly after the application of the new chemical changes began to occur. The structure of the hair began to disintegrate as the combination of the hair and the chemical treatment formed a jelly-like consistency and fell to the floor. What remained looked something like a brillo-pad.

Clearly this was more than a simple additive effect. Despite the lag in time between the two applications an interaction had occurred. You would expect that a manufacturer of a chemical straightening treatment would have tested it in combination with other similar treatments knowing that it would be likely that consumers may over time use both? But there are so many potential variables it would be difficult to account for all of these. The situation is the same for pesticides, it is not really possible to test all of the potential variables.

Would this effect occur in everyone who had previously had the first chemical treatment? Hard to say. It is possible that there were individual factors about my particular hair that influenced the outcome. Perhaps it was also the type of hair colour I use or a residue from exhaust fumes or something that is just specific the physical make-up of my hair or the fact that it had been 8 months and the initial
chemical on my hair had broken down into a different chemical. The reality is that it is not possible to test all of these factors prior to market. As a result safety assessments can never truly confirm safety they can at best identify obvious and immediate risk.

6.3.9 Individual Susceptibility to Pesticides: Population Groups at Increased Risk

Just as there are age-related differences in the activity of enzymes that metabolise pesticides and other chemicals\(^{113}\) there may also be increased susceptibility to the damaging effects of pesticides depending on the life-stage and other factors.

Prenatal exposure to pesticides has been associated with preterm birth, decreased gestational age, lower birth-weight, birth defects and impaired neurological development in offspring (Rauch, et al., 2012; Sanborn, et al., 2012).\(^{114}\) The preconception, pregnancy and lactating periods require specific consideration to protect the developing child as there may be an increased risk of adverse health effects during these developmental windows, which may include childhood cancers, thyroid dysfunction and impaired mental development (Eskenazi, et al., 2008; Garry, 2004; Sanborn, et al., 2012).

During critical periods of development chemicals (such as pesticides) can interact with genes turning them off or on at inappropriate times. The effect of these epigenetic changes may not be evident for decades or generations (Hileman, 2009). For example, in male rats an ancestral genetic modification (resulting from a single exposure to a common-use fungicide three generations prior) was carried transgenerationally resulting in alterations in the physiology, behaviour, metabolic activity, and transcriptome in discrete brain nuclei of the descendant males, causing them to perceive and respond differently to chronic stress (Crews, et al., 2012).

Children may be at particular risk of adverse effects from pesticide exposure with reviews suggesting neurobehavioral toxicity, childhood cancer, endocrine disruption and adverse reproductive outcomes are more likely to occur in children (Garry, 2004). This may be partly due to differences in metabolism\(^{115}\) but exposure is also likely to be higher in children who eat and drink more per kilogram of bodyweight than adults (Committee on

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\(^{113}\) Refer to 6.3.5 Individual Differences in Absorption, Metabolism and Excretion of Pesticides

\(^{114}\) Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?

\(^{115}\) Refer to 6.3.5 Individual Differences in Absorption, Metabolism and Excretion of Pesticides
Pesticides in the Diets of Infants and Children, National Research Council [NRC], 1993), have more permeable skin (Valcke & Bouchard, 2009), spend more time near the ground and exhibit more hand-to-mouth behaviour (Eskenazi, et al., 1999). As a result the Committee on Pesticides in the Diets of Infants and Children, have stated that 'in the absence of data to the contrary, there should be a presumption of greater toxicity to infants and children' (NRC, 1993).

6.3.10 Other Factors that may Increase or Decrease Risk from Pesticides

In addition to pesticide and other chemical exposure, there are other dietary and lifestyle factors that influence the onset of disease and many disease states are multifactorial. Poor dietary choices may result in nutrient insufficiencies leaving the body less able to metabolise chemicals and more vulnerable to tissue damage. Physiological factors such as body fat may increase the body's capacity to accumulate lipophilic contaminants (Schildkraut, et al., 1999) while weight loss diets may mobilise stored toxicants allowing them to re-enter the circulation and cause damage to target tissues (Jandacek, et al., 2004).

6.4 Biomonitoring for Pesticide Exposure: Considerations

As a result of many of the above factors, data from pesticide residue surveys can only provide limited information regarding pesticide exposure. Biomonitoring, which measures the amount of a pesticide (or its metabolites) in body tissues, can help to account for poorly understood processes such as bioaccumulation, excretion and metabolism (Smolders, et al., 2009). However, assessing the relevance of these studies to risk assessment remains complex, as demonstrating pesticide exposure at a specific time point does not provide information about the lifetime risk of chronic exposure, or the increased risk of exposure during critical periods of development. Applying the results from biomonitoring studies is further complicated by differences between individuals and population groups. Nevertheless, despite its limitations, biomonitoring remains the most reliable surrogate measure of pesticide exposure currently available (Angerer, et al., 2007).

The more significant biomonitoring studies related to this topic were discussed previously\textsuperscript{116} and a biomonitoring study was planned as part of this project to address the lack of biomonitoring studies in adults. In the planning of this study I considered the

\textsuperscript{116} Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
characteristics of the population of interest;\textsuperscript{117} the need to establish the amount of organic food consumed\textsuperscript{118} and some of the potential confounders that may influence biomonitoring results.\textsuperscript{119} It was also necessary to consider priorities for testing and the most appropriate methods.

\textbf{6.4.1 Choice of Pesticides}

Organophosphates have been widely investigated for potential toxicity,\textsuperscript{120} and have been associated with negative effects on human health even at low doses (Bouchard, et al., 2010; Bouchard, et al., 2011; Ross, et al., 2013). They are widely used in Australian agriculture (Radcliffe, 2002), and residues are commonly found in Australian produce (FSANZ, 2011).\textsuperscript{121} In large scale population studies detection rates are high (Babina, et al., 2012; Barr, et al., 2004; Bouvier, et al., 2005). As excretion is usually quite rapid (80-90\% within 48 hours) (Aprea, et al., 2002) this suggests widespread and frequent exposure making them useful candidates for comparing organic and conventional diets.

\textbf{6.4.2 Choice of Analytes}

Urinalysis of six DAPs (DMP, DEP, DMTP, DETP, DMDTP, DEDTP) was chosen based on an assessment of possible analytes previously conducted and published in the \textit{International Journal of Environmental Research and Public Health} (Oates & Cohen, 2011).\textsuperscript{122}

\textit{Analytes used in previous studies}

To date a number of studies have demonstrated reduced pesticide metabolite residues in the urine of children eating mostly organic diets but no studies have been published on adults or in Australian populations.\textsuperscript{123} The majority of these targeted metabolites of OP pesticides.

In 2003 the Curl study measured five urinary DAPs in pre-school children and reported that those consuming organic fruit, vegetables and juice had significantly lower levels of these OP residues in their urine (Curl, et al., 2003). The CPES went on to demonstrate that substituting organic foods for conventional foods for 5 consecutive days in school-

\textsuperscript{117} This was conducted as part of the OCS and OHWS surveys
\textsuperscript{118} The OFIS was piloted as a method of achieving this
\textsuperscript{119} Refer to 6.3 The Problem with Pesticides
\textsuperscript{120} Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
\textsuperscript{121} Refer to 6.2.2 Product: Pesticide Residues in Foods
\textsuperscript{122} Appendix 6.
\textsuperscript{123} Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
aged children resulted in a decrease in urinary levels of selective OP metabolites of malathion and chlorpyrifos to non-detectable or close to non-detectable levels (Lu, et al., 2006).

Published data in adults is currently lacking however an unpublished study conducted by a group of Slovenian researchers, examined 63 university students who were provided with organic or conventional food for a 3-day period, at the end of which 75% of the conventional consumers but only 16% of the organic consumers had detectable DAP metabolites in their urine (Bavec, et al., 2011).

Although specific markers for various OP pesticides are available, DAP metabolites may be more useful in untargeted exposure situations. DAPs are non-selective metabolites of a variety of organophosphate pesticides, and whilst DAPs don’t identify individual pesticides, they are common to more than 70-80% of the available compounds in the organophosphates class (Bouvier, et al., 2005; Johnstone, Capra & Newman, 2007) so are reflective of more general exposure. Their use in previous studies (Bavec, et al., 2011; Curl, et al., 2003), allows for comparison with the BMT results.

### 6.4.3 Choice of Quantification Limits

Commercially available DAP tests are used to identify unacceptable sources of occupational exposure to OPs but the LODs required to determine dietary exposure levels are much lower. The LOD represents the concentration of the OP metabolites that can be ‘seen’ with the detection method used; however quantification may not be reliable at such low levels. The limit of quantification (LOQ) is the concentration in urine that can be reliably quantified with some statistical certainty (Taskova, 2012). The lower the LODs and LOQs the greater the chance that metabolites will be detected, whereas higher quantification limits will fail to capture sufficient data to enable a thorough comparison of results. This can result in erroneous conclusions.

The only commercial laboratory in Australia able to conduct DAP urinalysis is Workcover NSW. Given the high detection limits the laboratory offered to undertake tests at 20% of their usual LODs. However, even at these levels, their tests are significantly higher than those used in other biomonitoring studies. AsureQuality Limited (New Zealand) was able to provide lower LODs. Table 6.2 provides a comparison of the LODs offered by the laboratories.

Table 6.2. Comparison of the Limits of Detection (µg/ L)
### 6.4.4 Analytical Concerns with DAPs

While DAP tests are commercially available and include some of the more established pesticide biomonitoring techniques (Oates & Cohen, 2011), some analytical concerns have been raised. In the Curl study (Curl, et al., 2003) DEDTP was not targeted due to ‘analytical difficulties’. All six DAP analytes were investigated in a South Australian study which assessed 3-6 year olds in urban, periurban and rural areas but DEDTP and DMP were not reported due to ‘analytical method limitations’ (Babina, et al., 2012). In an Australian study of non-occupationally exposed adults the frequency of detection for DEDTP was comparatively low amongst the six DAPs (Oglobline, et al., 2001) and this has also been reported in other studies (Aprea, et al., 1996; Hardt & Angerer, 2000). The Slovenian study did not include DMTP, however no rationale was provided in the limited data available from the conference poster and abstract (Bavec, et al., 2011).

The *in vivo* metabolism of OPs yields different DAPs, depending upon whether they undergo bioactivation or detoxification. They are non-selective and do not provide specificity with respect to the OP from which they were derived. In addition a dose-response relationship has not yet been established between DAPs as biomarkers of exposure, and cholinesterase activity as a biomarker of effect, or with signs and symptoms of cholinergic effects. Furthermore, it is possible that metabolites preformed in the environment may also contribute to urinary DAP levels and inorganic phosphate may be alkylated within the body to form DMP (Bouvier, et al., 2005), thus interpreting the results of DAP tests must be done with caution (Sudakin & Stone, 2011).

### 6.4.5 Method of Urine Collection

Choices for urine collection include a first morning void spot urine sample (also known as the 8 hour specimen); or a 24-hour urine sample. However, the latter can be difficult to obtain (Bouvier, et al., 2005), increases participant burden and requires strategies to minimise and deal with missing voids.

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124 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods.
A first morning void is likely to contain higher levels of analytes as the urine is generally more concentrated, due to the length of time it has remained in the bladder. Previous studies have reported that first morning void samples were consistently found to be the best predictors of weighted-average daily metabolite concentration, a finding which also held after creatinine-adjustment (Kissel, et al., 2005). First morning void samples are therefore preferential when spot sampling is being conducted as part of a biological monitoring study and the use of creatinine corrected, spot urine samples is consistent with the sampling performed for the NHANES (Barr, et al., 2004).

6.4.6 Creatinine Correction

When spot urine samples are used creatinine correction is generally recommended. This is important when comparing results within and between individuals as different hydration status at the time of collection will affect the water content of the sample and result in a more concentrated or dilute sample. The creatinine corrected result is the amount of the OP metabolite in the urine corrected to take into account the amount of creatinine in the urine sample.

Creatinine is metabolic product of muscle tissue and is a normal constituent in urine. In humans the total daily output of creatinine is approximately 1.2 g and the average daily urine volume is around 1.2 L. Therefore, the mean creatinine concentration is approximately 1 g/L for a 24 hour urine sample. In practice, creatinine concentration (as well as any other metabolite concentration, such as OPs) can vary widely in human urine throughout the day depending on the hydration status of the individual. Creatinine correction is a calculation that adjusts the urine concentration in a random spot urine sample to an average concentration of 1 g/L (Taskova, 2012).

After correcting for creatinine, the measurement changes from µg/L (which is the weight of the OP metabolite in 1 litre of urine) to µg/g (the weight of the OP metabolite per 1 gram of creatinine).

6.4.7 Considerations for Eligibility Criteria

Eligibility criteria need to be carefully considered when planning biomonitoring studies so as to minimise confounders that may unduly influence the results. A number of issues were considered in the planning of the BMT.
For instance, residential location may be a concern. In the South Australian study some DAP levels were considerably higher in children living in rural areas (Babina, et al., 2012) and a US study has also demonstrated higher levels of OP residues in rural compared to urban dwellings (Lu, et al., 2004).

Participants may be exposed to a range of non-dietary residential pesticides including those used for building fumigation, home garden use and pest control around the home. Garden pesticide use has been shown to significantly increase urinary DAP levels (Lu, Knutson, Fisker-Andersen & Fenske, 2001) and studies investigating other pesticides have noted that time spent gardening is positively associated with urinary pesticide levels (Riederer, et al., 2008).

Tobacco use has been positively associated with urinary pesticide levels (Riederer, et al., 2008) so regular smokers may need to be excluded and social smokers asked to abstain during the study period.

Those suffering from medical conditions or taking medications may experience interference with the absorption, metabolism or elimination of pesticides. The number of cytochrome p450-inhibiting medications has been positively associated with urinary pesticide levels (Riederer, et al., 2008). However, as clear evidence for such influences is lacking, medical conditions and medications may simply be recorded for later exploration if required.

As differences occur in detoxification ability with increasing age, and there is increased likelihood of medical conditions or medication use, those over 65 years may not be suitable for inclusion.

The expression of enzymes that detoxify pesticides is lower in children (Huen, et al., 2009; Yang, et al., 2009) and may be down regulated during pregnancy (Fortin, et al., 2012). Given the concerns about increased pesticide exposure during critical periods of development there is a potential for psychological distress if abnormal results are identified. Therefore children, pregnant and lactating women and those planning on conceiving within four months of the study period may not be suitable for inclusion.

\[125\] Refer to 6.3.9 Individual Susceptibility to Pesticides: Population Groups at Increased Risk
The ability to adequately adhere to the dietary intervention requires consideration. Participants whose usual diet contains limited amounts of organic food may be unfamiliar with how to procure reliable organic foods. In addition total organic consumption is rare and not representative of the 'typical' organic consumer so those who consume an almost entirely organic diet may not be suitable.

If participants are required to read and understand detailed written instructions and be able to complete necessary documents and online surveys they will require sufficient computer and English language skills.

People highly dependent on medical care or those with obvious cognitive impairment, intellectual disability or a severe mental illness that would prevent them from being able to adhere to the dietary and other instructions or to complete the documents competently may also not be suitable.
Chapter 7. Summary of the Key Gaps in the Literature

The question as to whether organic diets benefit health and wellness is complex and my approach is to treat it as a giant puzzle with many missing pieces. To this end it is my intention to identify and clarify some of the key pieces so that in time the bigger picture may become clearer. In order to do this I have identified some of the gaps in the current knowledge base that I believe need to be addressed and have conducted a series of studies aimed at doing this. However, there are clearly more gaps than can be addressed in one thesis. The gaps mentioned below have previously been highlighted and footnotes refer back to the full discussions. I bring them together briefly here to provide a rationale for the research questions that guided the projects that will be discussed in the next section.

7.1 Lack of a Clear Profile of Australian Organic Consumers

In order to conduct relevant research to identify potential health benefits or harm minimisation, organic consumers need to be clearly differentiated from conventional (non-organic) consumers. Previous studies have attempted to define the characteristics of organic consumers using socio-demographic and attitudinal methods and some of the key results from previous Australian studies have been reported. However, at the time this research was planned, there was still no general consensus regarding the characteristics and behaviours of organic consumers in Australia.

7.2 Lack of Instruments to Define ‘Organic Diets’

A dose response might be anticipated for any health effects responding to the consumption of an organic diet. However, currently there is no clear definition of what constitutes an ‘organic diet’ or standard methods to quantify organic food consumption. Total 100% organic consumption is rare and the choice to consume organic food may not be consistent across all food categories. For dose responses to be attributed to organic food it would be useful to know more about both the overall organic intake but also specific food categories, whose effects may vary.

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126 Refer to Preface
127 Refer to 2.4 The Person - Organic Consumers
128 Refer to 2.4 The Person - Organic Consumers
7.3 Lack of Good Health Outcome Studies or Direction for Research

Although beliefs about the health benefits of organic foods are generally very positive, even amongst the general population in Australia, evidence of actual health outcomes is lacking. Sufficiently-powered human studies which directly demonstrate health benefits or disease protection as a result of consuming an organic diet are difficult to perform. Because research in the area is still in its infancy exploring the experiences and beliefs of current organic consumers is a valuable source of data and a few European studies have begun to do this.

While studies of nutritional comparisons between organic and conventional foods are in their hundreds, many reviews have not found strong evidence that there are significant or clinically meaningful differences, and this does not appear to be a useful way to determine whether health effects exist. On the other hand studies have reported that a lack of pesticide use in organic agriculture contributes to the perceived health benefits, and there is increasing evidence regarding the negative health effects of pesticides. Whether these effects occur at levels associated with dietary exposure and whether organic diets significantly reduce exposure requires additional research.

7.4 Lack of Biomonitoring Studies in Adults and in Australian Organic Consumers

Currently there are no published studies that use biomonitoring techniques to compare pesticide exposure between adult consumers of organic and conventional food and it is not reasonable to extrapolate from studies in children due to differences in exposure and metabolism. As there are likely to be regional differences in exposure it is also not suitable to extrapolate findings from children in the United States to Australia. Biomonitoring studies measure the amount of a pesticide (or its metabolites) in body tissues, so to a limited extent they can account for poorly understood processes such as...

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129 Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?
130 Refer to Chapter 4, What Evidence is there that Organic Diets Improve Human Health and Wellness?
131 Refer to 4.10 Difficulties associated with Investigating Health Outcomes of Organic Diets
132 Refer to 4.6 Self-reported Health
133 Refer to 5.3 The Problem with Nutritionism
134 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
135 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
bioaccumulation, excretion and metabolism.\textsuperscript{136} Unfortunately, many of the currently available methods have been designed for use in occupational settings and may lack the sensitivity required to detect differences in dietary exposure.

### 7.5 Gaps, Research Questions and Projects

Table 7.1 provides a summary linking the gaps in the literature, the research questions and the projects that will address them.

The main research questions are:

- What are the socio-demographic characteristics, behaviours and beliefs of dedicated organic consumers in Australia?
- Do dedicated organic consumers in Australia believe organic diets are healthier? If so why?
- What percentage of food servings consumed by dedicated organic consumers in Australia is from organic produce?
- How does the intake of organic produce by dedicated organic consumers in Australia vary by food category?
- What are the specific health related beliefs and experiences of dedicated organic consumers in Australia?
- Does a largely organic diet reduce OP pesticide exposure in Australian adults?
- Are commercially available testing methods sufficiently sensitive to detect dietary differences in OP pesticide exposure?

**Hypothesis 1** – In Australia dedicated organic consumers believe that consuming an organic diet is beneficial for health.

**Hypothesis 2** – Consuming a minimum of 80% of food servings from organic produce reduces urinary dialkylphosphate metabolites in Australian adults.

\textsuperscript{136} Refer to 6.4 Biomonitoring for Pesticide Exposure: Considerations
Table 7.1. Gaps, Research Questions and Projects

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<td>OCS/ OHWS - Socio-demographics</td>
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<td>Are commercially available testing methods sufficiently sensitive to detect dietary differences in OP pesticide exposure?</td>
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Chapter 8. Organic Consumption Survey (OCS) and Organic Food Intake Survey (OFIS)

8.1 Abstract (OCS)

At present there is a lack of clear consensus regarding the profile of Australian organic consumers. The Organic Consumption Survey (OCS) was developed and tested following a review of the existing literature, and conducted online in Australia in 2010 targeting dedicated organic consumers. The purpose was to identify the socio-demographic characteristics, consumption patterns and beliefs amongst this group. Three hundred and eighteen usable surveys were submitted. The majority of respondents were female (80.3%), 25-55 years old (80.3%), from urban areas (61.2%), born in Australia (68.9%) and were in a healthy weight range (55.5%). Income did not appear to have a strong impact on organic uptake but nearly two thirds of OCS respondents held a tertiary degree qualification with over a third holding postgraduate degrees. In general the demographic characteristics of respondents did not appear to differ with the level of organic consumption. Based on self-reports, 37.4% claimed to have consumed mostly (>65%) certified organic food in the previous 12 months, rising to 60.4% when ‘likely’ organic foods were also included. The majority (56.3%) of respondents were able to achieve both 65% overall organic food intake and a minimum of 35% certified organic food. Organic fruit and vegetables had the highest uptake by organic consumers and animal flesh products the lowest. Consumer beliefs were strongly driven by concerns about the effects of pesticides on human health and the environment. The vast majority agreed with the statements: ‘organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ (95.4%); and ‘organic foods are better for the
environment than conventionally grown foods (97%). Around a quarter (24.7%) said that health related concerns influenced their decision to consume organic foods and 76.9% said that scientific evidence had a moderate or strong influence on their beliefs about organic food. Cost and convenience appeared to become less important in those with high consumption of organic food. Clearer definitions of organic consumers should allow for more rigorous research evaluating the purported health benefits of organic foods in the future.

8.2 Abstract (OFIS)

Dedicated organic consumers who completed the Organic Consumption Survey (OCS) were invited to test a three-day 'Organic Food Intake Survey' (OFIS) in order to quantify the percentage of organic food they consumed and assess organic food consumption by food category. Nineteen respondents returned the surveys providing a total of 57 sampling days. Based on self-reports, the percentage of respondents that consumed more than 65% organic food in the previous 12 months was 52.6% for certified organic food and 73.6% when 'likely' organic foods were also included. On the whole the 'actual' levels of organic consumption (based on quantification of serving sizes by food category) were slightly higher than the initial self-reported estimates of the respondents, although these differences were not statistically significant. During the recording period the mean percentage of certified organic food was 63.0% (95%CI 51.8, 74.2), rising to 76.3% (95%CI 68.0, 84.5) when 'likely' organic foods were also included. The majority (63%) were able to achieve both a 65% overall organic food intake including a minimum of 35% certified organic food. Overall the percentage of servings that came from organic food was lowest for animal protein (56.8%) and highest for fruit (80.1%) and vegetables (83.2%). Vegetables (19.0%) and animal protein (16.6%) had the highest contribution from 'likely' organic sources, many of which appeared to be sourced from home gardens or farmer's markets where production methods were discussed with producers. The OFIS allows for a degree of quantification of organic consumption which may assist researchers in determining whether dose dependant responses in health outcomes occur as a result of consuming an organic diet.
8.3 Background

Previous studies have attempted to define the characteristics of organic consumers using socio-demographic and attitudinal methods and some of the key results from previous Australian studies were reported previously. However there is still no general consensus and some of the Australian data is either dated or has investigated organic consumers only as a subset of the wider population so that the sample size for the more dedicated organic consumers was actually quite small.

8.4 Aims

Organic Consumption Survey (OCS)

- To determine the characteristics of ‘dedicated Australian organic consumers’ including socio-demographic characteristics, behaviours, and beliefs
- To determine the health related beliefs that compel organic consumers to consume organic food
- To explore general consumption trends amongst current dedicated Australian organic consumers
- To explore differences in the uptake of organic foods from different food categories

Organic Food Intake Survey (OFIS)

- To explore general consumption trends amongst current dedicated Australian organic consumers
- To develop a method to quantify the level of organic consumption that may be used in future research
- To explore differences in the uptake of organic foods from different food categories

8.5 Design/ Methods for the OCS and OFIS

Summary

A preliminary set of questions was developed for both the OCS and the OFIS based on a review of the existing literature on organic consumers, dietary surveys and survey design. Following ethics approval from RMIT University’s Human Research Ethics Committee both surveys were piloted early in 2010. Some minor revisions were made based on the

137 Refer to 2.4 The Person - Organic Consumers
feedback and results, and then the OCS was formally conducted online from August to October. The OFIS remained open until December in an attempt to increase respondent numbers. Prospective participants were recruited through advertisements in organic outlets and websites. As the intent was to target dedicated adult organic consumers, participants were asked to confirm that they were over 18 years and make a deliberate choice to consume organic foods on at least a weekly basis. After completing the anonymous online OCS survey, respondents were given the option to also receive the electronic documents for the OFIS, complete the food diary over a 3-day period and return it via email. The OFIS utilised a modified version of the ‘Australian Guide to Healthy Eating’ (AGHE) food categories and serving sizes to quantify the level of organic food intake. Following the study, some of the questions from the ‘Factors affecting chemical exposure and food behaviour’ section of the OCS were used to design the Chemical Exposure and Food Behaviour Survey (CEFBeS).

8.5.1 Development of the OCS

The development of the OCS involved not only a review of the existing data regarding Australian organic consumers but also a review of the relative strengths and weaknesses of various survey approaches (Thompson & Subar, 2001; Walonick, 2004). After careful consideration, a preliminary set of questions was developed for the OCS based on questions used in previous Australian surveys (Lea & Worsley, 2008; Lea & Worsley, 2005; Lockie, et al., 2004; Lockie, et al., 2002; Meldrum, 2005a, 2005b; Newspoll, 2008).

At the time the OCS was developed the Australian Organic Market Report (Kristiansen, Henryks & Smithson, 2008) reviewed, but did not gather, original data on organic consumers, however more recent reports have done this (A. Mitchell, Kristiansen, Bez & Monk, 2010; Monk, et al., 2012).

Use of an internet-based survey design

The survey was created to be conducted online using the Survey Monkey® Survey Tool. In the past the demographic profile of the internet user was not necessarily representative of the general population (Walonick, 2004) however this is changing rapidly. Concerns regarding the use of internet-based surveys include coverage bias (the fact that some people do not have access to, or choose not to use the internet) and a lack of familiarity with internet tools (Solomon, 2001). Such factors may result in underrepresentation especially of certain age, ethnic and socioeconomic groups.
compromising the representativeness of the sample and thus the generalisability of the results. However, in more recent times internet-based surveys have demonstrated equivalence to conventional interview methods (Moloney, et al., 2009).

**Pilot phase of the OCS**

Following ethics approval from RMIT University’s Human Research Ethics Committee the OCS was tested on a small convenience sample which included both nutritionists and laypersons in April and May 2010. In the initial test phase the respondents were not required to be dedicated organic consumers. Eight of the respondents then repeated the survey at least two weeks later to test-retest reliability.

The pilot questionnaire included sections on:

- **Organic Food Consumption and Purchasing Behaviour**
  - Including: ‘Over the past year what proportion of the food you ate was prepared from organic food (either certified or noncertified)?’; What percentage of your weekly food budget is spent on organic food products (certified and/ or non-certified)?

- **Attitudes to Organic Food** (six questions with sub-questions)
  - Specific questions relating to attitudes included: ‘How much do you agree or disagree with the following statements?’ e.g. Organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues; Organic foods are better for the environment than conventionally grown foods etc

- **Factors Affecting Chemical Exposure and Metabolism** (eight questions with sub-questions)
  - This included questions on ‘Height’ and ‘Weight’ in order to calculate the BMI as well as questions about other potential sources of exposure and food preparation behaviours

- **Basic socio-demographic characteristics** (12 questions)
  - Including: gender, age, income, education level etc

**Results of the pilot phase**

A total of 27 respondents submitted the pre-test survey which was a 60% response rate. The average time taken to complete the survey was 38 minutes.

Data analysis was conducted using SPSS for Windows statistical software (version 18). An ‘Organic Consumption Score’ of ‘Low’ or ‘High’ was created for each individual from
three items and then repeated with six items pertaining to the level of organic food consumption. The median values were used to distribute the groups roughly evenly between ‘Low’ and ‘High’ and there was 100% agreement between the three item and six item scores for each individual.

Based on the results and feedback from the pilot study respondents, minor revisions were made to the survey to improve the clarity and workability of the instrument. Some questions were reworded to improve clarity, reordered to improve the flow and others removed to shorten the time required to complete the survey and thus improve response rates. The final survey was completed in half the time to the pre-test survey.

8.5.2 Development of the OFIS

When developing the OFIS\textsuperscript{139} the relative strengths and weaknesses of various methods were considered.\textsuperscript{140} This required weighing the benefits of an instrument that could produce quantifiably precise data against the burden on participants as well as researchers.

In terms of internal validity, precision is important because it would allow a large scale study to explore whether specific foods or food categories have a stronger influence on exposure. However, studies of this size are costly and unlikely to be conducted in the foreseeable future. In smaller scale trials where participants may act as their own controls (in order to reduce the between group differences that may confound results), the similarity of the diets may be more important. In other words, we need to know whether a participant maintained a fairly similar diet when they were eating conventional food to when they were eating organic food, as patterns of pesticide use will vary between food categories so substantial differences in intake from the different food categories may have a significant effect on the results.

\textit{Retrospective or prospective?}

Options included interview-assisted 24-hour dietary recall such as that used in the NHANES in the US; and a food propensity questionnaire (FPQ) which is a type of food frequency questionnaire (FFQ) without portion size (Thompson & Subar, 2001). While retrospective methods such as the FFQ are more likely to obtain general information on a participant’s usual dietary intake the participant is in effect being asked to engage in a ‘creative process’ and there will be an element of recall bias. Recording foods as they are

\textsuperscript{139} Appendix 3. OFIS Worksheet (Example)
\textsuperscript{140} Appendix 3. Comparison of food intake survey methods
consumed via a food record is more likely to prevent omissions and portion sizes are likely to be more precise, so prospective methods will more accurately reflect recent intake. However such methods do not account for seasonal variability and may affect food behaviour, as people become more conscious of their food choices, and this can affect how typical of usual intake the collected responses are.

It was felt that a food intake questionnaire would be more accurate as it relies on short term recall of specific eating episodes. Probes are considered useful for improving recall (Thompson & Subar, 2001) so these were included in the instructions.\textsuperscript{141}

**Participant burden**

Both the length of the survey and the length of the recording period can have an impact on the reliability of the data derived. Long, detailed and difficult to complete surveys may increase participant fatigue resulting in a non-response bias. For practical reasons a relatively brief instrument was the preferred choice for this study to minimise the burden on both participants and researchers.

**Food categories**

The OFIS used a modified version of the Australian Guide to Healthy Eating (AGHE) (Department of Health & Aging [DHA], 2008) food group categories and serving sizes. This provided a relatively simple method of data collection that would allow for quantification of organic intake.

The Australian Guide to Healthy Eating (AGHE) uses six categories:

1. Bread, cereals, rice, pasta, noodles
2. Vegetables, legumes
3. Fruit
4. Milk, yoghurt, cheese
5. Meat, fish, poultry, eggs, nuts, legumes
6. Extra foods

A slight rewording of these categories was used in the OFIS to improve understanding:

1. Grains - Bread, cereals, rice, pasta, noodles
2. Vegetables including legumes (raw or lightly cooked e.g. green beans, peas)
3. Fruit
4. Dairy - Milk, yoghurt, cheese

\textsuperscript{141} Appendix 3. OFIS Instructions for use
5. Animal protein sources - Meat, fish, poultry, eggs,
6. Plant protein sources - nuts, legumes (dried peas/beans requiring significant cooking e.g. lentils, chickpeas, red kidney beans)
7. Extra foods

The duplication of ‘legumes’ was clarified to avoid confusion. To this end green beans and peas which can be consumed raw or lightly cooked were included with ‘2. Vegetables, legumes’, while dried peas/beans such as chickpeas, lentils and red kidney beans, that require more significant cooking times were included under ‘6. Plant protein sources - nuts, legumes’. As many participants may be more familiar with older food group classifications such as grains and dairy, these terms were also incorporated.

Animal and plant sources of protein were separated as some toxicants can bioaccumulate in the fatty tissue of animals. This also allowed us to identify vegetarian participants without including additional questions.

**Determining portion size**

Portion size was included in the OFIS to enable assessment of the relative amount of organic food in the diet. Various methods for estimating portion size were considered: weighing (using a scale), recording volume (using a household measure e.g. cups, tablespoons), or estimating (using models, pictures or no particular aid) (Thompson & Subar, 2001). Methods that use estimation may not be as quantifiably precise but reduce participant burden and this was considered to be more important (Thompson & Subar, 2001).

Previous studies suggest that small portion sizes tend to be overestimated and large portion sizes underestimated and that portion sizes of foods that are commonly consumed in defined units (e.g., slices of bread, pieces of fruit) are more easily reported (Thompson & Subar, 2001). The decision was therefore made to estimate portion size using serving sizes from the AGHE.

**Mode of administration**

I considered whether the survey should be self-administered or conducted by interview. Interviewer probing can improve the comprehensiveness of the data and reduce omissions but can also be time consuming and costly. Ultimately I wanted a survey that could be adapted and utilised more widely in future studies with larger numbers of participants and self-administered surveys are more amenable to this.
The reliability of self-administered internet-based surveys has also been shown to be comparable to telephone-administered interviews (Rankin, et al., 2008). Furthermore interview assisted data can be prone to interviewer-bias by leading participants, and participants may be more inclined to provide responses that they believe will ‘please’ the interviewer (Adamsen, et al., 2007).

**The OFIS prototype**

The final result was an ‘estimated food record’ where the participant records all food and beverages consumed at the time (or close to the time) of consumption and estimates portion size based on the AGHE guidelines. The survey could be completed electronically or printed out and completed by hand. It used a prospective self-administered design recording food intake based on serving sizes and recorded within various food categories.

A preliminary version of the OFIS was provided to a focus group which included nutritionists and laypersons and adjustments were made based on their feedback.

As with the OCS, participants were asked to estimate the percentage of organic food they consumed during the previous year and their weekly expenditure on organic foods prior to completing the OFIS. During the 3-day period respondents recorded all food and beverages consumed (including the approximate amounts) under the specified food categories: grains, vegetables, fruit, dairy, animal protein, plant protein and ‘extra’ foods. They were also asked to report on the organic status of the food consumed (certified organic, likely organic, likely conventional or unknown).

Participants were provided with an example worksheet to assist in understanding how to complete the OFIS as well as detailed instructions to clarify the meaning of all terms used in the OFIS. For instance pictures of the various certification logos used in Australia were included to assist participants in confirming whether produce was ‘certified organic’.

‘Likely organic’ foods were defined as: ‘no ‘certified organic’ label is visible on the product or at the point of sale but the food had been purchased from a farmers’ market, farm gate or local food initiative where non-certified ‘organic’ food is traded on a ‘trust’ basis.” The term ‘Likely organic’ was also used to describe food that may have been home grown with a specific intent to avoid the use of any synthetic chemicals such as insecticides, weed...

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142 Refer to SDR discussion in [2.4.4 Organic Consumers – When do they Eat Organic?](#)
143 Appendix 3. OFIS Instructions for use
killers, fertilisers etc." ‘Likely conventional’ foods were those where there was no reason to believe the food was organic and this included commercially prepared food where no specific organic claims were made. ‘Unknown’ was only to be used if there was a likelihood that a food might be organic but the person preparing the food had no commercial interest in saying either way. The instructions also included prompts to assist with memory recall. At the end of each day participants were asked to estimate how typical of their usual daily food intake and how accurate their responses had been.

8.5.3 Recruitment for the OCS and OFIS

A dedicated study website\(^{144}\) was created which provided information to prospective participants about the purpose and conduct of the study. This included links to the Project Information Statements\(^ {145}\) and an opportunity to register for the mailing list to receive updates on the research. Prospective participants were directed to the website by way of flyers, direct email, social media and interviews in the media.

The OCS was targeted at dedicated organic consumers who were likely to be at the high-end of consumption trends, rather than those for whom organic consumption was occasional or incidental. Participants were recruited through retail outlets and websites that sell or promote organic produce. Unlike the pilot phase, prospective participants were asked to confirm that they considered themselves to be a regular ‘organic consumer’ (i.e. agreed with the statement ‘I make a deliberate choice to consume at least some organic foods on a weekly basis’). Participants’ consumption patterns where then explored further in the surveys.

Flyers were delivered to retail outlets such as organic grocers and certified organic stalls at Farmers’ markets. Notices were also posted on websites that sell or promote organic produce. An email was sent to the researchers personal contacts and other organisations such as organic industry groups with a request that the email be forwarded to potential participants. Social media, including Facebook and Twitter, were also used to direct potential participants to the website. A media release was circulated by RMIT University Marketing and Communications resulting in a number of radio and print interviews and an appearance on the SBS Insight television program ‘Organic or not’.

\(^{144}\) Appendix 3. Website content (OCS / OFIS) <www.rmit.edu.au/wellness/organicresearch>
\(^{145}\) Appendix 2. OCS Project Information Statement; Appendix 3. OFIS Project Information Statement
Interested parties were directed via a link on the website, and also in the email, to the anonymous online survey. At the conclusion of the survey participants were redirected to the study website where they were able to register for a mailing list to receive updates about the results and other research projects. This created a database of contacts for the later studies. OCS respondents were also invited to participate in the OFIS and more information was located on the study website.

8.5.4 Inclusion Criteria

Both surveys targeted self-reported organic consumers and commenced with three questions asking participants to agree with the following statements before proceeding:

- “I consider myself to be a regular ‘organic consumer’ (i.e. I make a deliberate choice to consume at least some organic foods on a weekly basis)”.
- “I am over 18 years of age.”
- “I have read and understood the ‘Project Information Statement’ and agree to participate in the (survey).

8.5.5 Conduct of OCS

With ethics approval from RMIT University’s Human Research Ethics Committee, the resulting survey was formally conducted over a two month period from mid-August to mid-October 2010 using the Survey Monkey® online survey tool. The survey was completely anonymous and no data was recorded that would identify participants.

8.5.6 Conduct of the OFIS

At the conclusion of the OCS, participants were invited to complete the additional OFIS for 3 days to more accurately assess the percentage of organic produce they consume. Interested parties were directed to the study site where they could register an email address to receive more information and electronic delivery of the OFIS survey forms.

Once the OFIS documents were returned, they were checked for missing or ambiguous information and participants contacted via email to resolve any queries prior to de-identification. The survey forms were coded and the participants email address was deleted to maintain anonymity. I converted the portion sizes recorded by the participants to ‘serving sizes’ using the AGHE guidelines. This information was then entered into an excel spreadsheet for use in data analysis.

146 Appendix 2. OCS Survey <www.surveymonkey.com/s/OCS>
147 Appendix 2. Ethics approval (OCS & OFIS)
At the end of the survey period any remaining email addresses linked to unreturned surveys were also deleted. Email addresses were not made available to any third party, and no information was collected or stored with any details that could be used for identification.

**8.6 Data Analysis**

Group based data analysis for the OCS was conducted using SPSS for Windows (version 18) and response frequencies were calculated for each of the questions. An ‘Organic Consumption Score’ (/10) was created for each individual based on questions relating to the frequency and quantity of organic food consumed. The frequency and quantity score were both scored out of 5 (between 1 and 5, with 5 indicating the highest frequency or quantity of organic consumption) and then added together to give a total score out of 10. The Visual Binning feature in SPSS was used to separate the sample into three equal groups, with each group containing approximately one third of the data points. The cut-off points were ‘low’ (<6.93), ‘moderate’ (6.93-8.13) or ‘high’ (>8.13).

The frequency score was based on an average of how often respondents ate organic foods from different food groups. The quantity score was based on the percentage of the time the respondent opted for organic options.

Data analysis for the OFIS was conducted using Microsoft Excel 2007 and SPSS statistical software (version 18). Response frequencies were calculated to determine the percentage of food servings that were derived from organic or certified organic produce. This occurred for overall consumption and was also broken down by food category.

**8.7 Results and Discussion**

Some of the key findings from these studies were presented at the *Food Quality and Health Conference* in the Czech Republic in May 2011 and the *IFOAM conference* in South Korea in October 2011. They were also published in the *Journal of the Science of Food and Agriculture* (Oates, et al., 2012).\(^\text{148}\)

A total of 320 OCS surveys were returned. Two of the surveys were excluded because they did not meet the inclusion criteria for being a regular organic consumer. This left data from 318 surveys for the OCS. The average time taken to complete the survey was just

\(^\text{148}\) Appendix 6.
under 20 minutes. Nineteen respondents returned the completed OFIS documents giving a total of 57 sampling days. Because respondents self-selected to access the online surveys, it is not possible to establish response rates.

8.7.1 Socio-demographic Characteristics of Respondents

The results indicated that the majority of respondents in the OCS were female, 25-55 years old, well educated, born in Australia, residing in urban areas and in a healthy weight range (Table 8.1). Respondents in the OHWS had very similar characteristics and these will be discussed later. Respondents for the OFIS were a subgroup of those in the OCS however demographic data was not collected separately. For the most part the demographic characteristics of respondents did not appear to differ with the level of organic consumption (low, moderate or high).

Table 8.1. Demographic Characteristics of Respondents in the OCS

<table>
<thead>
<tr>
<th></th>
<th>% of survey respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>80.3</td>
</tr>
<tr>
<td>Male</td>
<td>19.7</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>2.4</td>
</tr>
<tr>
<td>25–34 years</td>
<td>28.9</td>
</tr>
<tr>
<td>35–44 years</td>
<td>29.3</td>
</tr>
<tr>
<td>45–54 years</td>
<td>22.1</td>
</tr>
<tr>
<td>55–64 years</td>
<td>12.9</td>
</tr>
<tr>
<td>65 years or older</td>
<td>4.4</td>
</tr>
<tr>
<td><strong>Highest level of education</strong></td>
<td></td>
</tr>
<tr>
<td>No degree</td>
<td>34.7</td>
</tr>
<tr>
<td>Undergraduate degree</td>
<td>31.6</td>
</tr>
<tr>
<td>Postgraduate degree</td>
<td>33.7</td>
</tr>
</tbody>
</table>
### Weekly Income

<table>
<thead>
<tr>
<th>Weekly Income</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; $400</td>
<td>10.6</td>
</tr>
<tr>
<td>$400 - $599</td>
<td>10.6</td>
</tr>
<tr>
<td>$600-799</td>
<td>11.4</td>
</tr>
<tr>
<td>$800-999</td>
<td>11.4</td>
</tr>
<tr>
<td>$1,000-1,299</td>
<td>15.0</td>
</tr>
<tr>
<td>$1,300-1,599</td>
<td>12.6</td>
</tr>
<tr>
<td>$1,600-1,999</td>
<td>11.0</td>
</tr>
<tr>
<td>&gt;$2,000</td>
<td>17.3</td>
</tr>
</tbody>
</table>

### Country of birth

- **Australia**: 68.9%
- **Other country**: 31.1%

### Location

- **Rural**: 38.8%
- **Urban**: 61.2%

### Body mass index (kg m$^{-2}$)

- **<20 (underweight)**: 11.0%
- **20–25 (healthy weight)**: 55.5%
- **25–30 (overweight)**: 20.6%
- **>30 (obese)**: 12.8%

*Note: a version of this table was published in: Journal of the Science of Food and Agriculture 92/14 © 2012 Society of Chemical Industry, first published by John Wiley & Sons Ltd*

### Gender

There were approximately four times as many female respondents compared to males in the OCS. This finding was relatively consistent throughout the survey period. The high number of females is comparable with earlier studies (Lea & Worsley, 2008; Lea & Worsley, 2005; Lockie, et al., 2002) although the effect was more pronounced here. For instance studies in the general population found 44.1% of females and 33.8% of males.
reported consuming certified organic foods (Lockie, et al., 2002). Some authors have attributed this gender difference to the commonly associated responsibility for feeding children and other family members (Lockie, et al., 2004). Indeed, most of the respondents (70.5%) reported that they did all or almost all of the household shopping and many (68.9%) had children living at home, including 55% who had children under 5 years of age.

Female gender tends to be predictive of a more positive response to organic food in some studies (Lea & Worsley, 2005) but others fail to show a significant interaction between gender and the value placed on organic products (Paull, 2007).

The gender bias in the OCS may have been more marked than previous surveys as females may be more likely to frequent the organic outlets and websites targeted in our recruitment processes. Responses to another recent Australian survey about organic food was also dominated by female respondents (75%) (Pearson, 2012).

**Age**

The majority of respondents in the OCS were in their middle years. Categorical data was collected in the OCS so it was not possible to determine a mean but the median age was 35-44 years. It has previously been reported that younger age (<40 years) is predictive of a more positive response to organic food (Lea & Worsley, 2005). Other studies report little variation across age groups until the 60s when organic consumption dropped to 29.9% (Lockie & Donaghy, 2004).

**Education**

Nearly two thirds of OCS respondents had tertiary qualifications including over a third who had a postgraduate qualification. This is considerably higher than the Australian average of 17% with an undergraduate Bachelor Degree and 6.7% with postgraduate qualifications (ABS, 2011a). The Australian Bureau of Statistics figures are slightly higher in the age group 35-44 years, at 21.2% and 8.7% respectively, but this is still lower than the OCS cohort. Education is the factor most consistently associated with an increased propensity for organic consumption (Forman & Silverstein, 2012).

In the OCS 20.1% had a tertiary science qualification and 12.6% had a postgraduate qualification in the sciences. Contrary to a stereotype that assumes organic consumers are driven by an irrational fear of technological development, previous studies have also
reported that increasing education (especially science education) is a positive predictor for organic consumption (Lea & Worsley, 2005; Lockie, et al., 2002).

The value placed on organic food appears to increase with education. An Australian study involving 221 respondents reported that those with a primary school education placed no additional value on organic or certified organic foods while the secondary education group valued organic at a premium of 6.2% and certified organic at a 12.9% premium. The tertiary educated respondents valued organic and certified organic even higher with 9.5% and 17.9% premiums respectively (Paull, 2007).

**Income and employment**

Amongst the OCS respondents 40.3% were employed full-time and 25.8% part-time or casual. The median household income was AU$1,000–1,299 /week or $52,000-67,599 /year. There was a marked increase up to but only a slight increase beyond AU$400-599 /week ($20,800-31,199 /year).

The income level of respondents was higher than the Australian average for the same period but this may be reflective of the higher education levels in the OCS cohort. In Australia in 2009–10 the median household income was AU$715 and average weekly disposable income was AU$848/ household (ABS, 2012c). In the OCS 73.56% of low consumers and 69.88% of high consumers reported a weekly household income in excess of $800/ week.

In the OCS, respondent’s income did not appear to have a strong impact on organic uptake. In fact the percentage of respondents with an income over $1,000/ week was similar for consumers in the low and high consumption groups (21.3% vs. 20.0% respectively). As previously mentioned an earlier Australian study had reported only a slight increase in organic food consumption with increasing income (Lockie, et al., 2002). So while very low income may restrict organic purchasing options, increasing income does not appear to correlate with increased uptake of organic foods.

**Country of birth**

Nearly 70% of OCS respondents were born in Australia and this is consistent with previous research (Lea & Worsley, 2005) and the general population. At the time the OCS was conducted in 2010, 27% of the Australian population was overseas-born (ABS, 2012d).
Residential location

More than 60% of respondents in the OCS resided in urban locations which is consistent with the broader Australian population. In 2011, 66% of the Australian population resided in greater capital cities (ABS, 2012a).

Body Mass Index (BMI)

Around a third of OCS respondents were overweight or obese (Body Mass Index >25 kg/m²). This is substantially lower than the Australian average. According to the National Health Survey (NHS), in 2007-08 61.4% of the Australian population were either overweight or obese (ABS, 2008). More than 10% of the OCS respondents were considered underweight compared to the general population which is around 2% (ABS, 2008).

The difference in these figures may be partially due to the gender bias and lack of respondents over 55 years in the OCS, as rates of overweight and obesity tend to be higher in males and with increasing age. For instance, adult males are more likely to be overweight or obese compared with adult females and females significantly outnumbered males in this cohort (Table 8.2).

Table 8.2. Differences in Overweight and Obesity between Females and Males in the OCS and NHS

<table>
<thead>
<tr>
<th></th>
<th>Females</th>
<th></th>
<th>Males</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OCS</td>
<td>NHS</td>
<td>OCS</td>
<td>NHS</td>
</tr>
<tr>
<td>Normal or underweight</td>
<td>67.7</td>
<td>45.1</td>
<td>62.5</td>
<td>32.3</td>
</tr>
<tr>
<td>Overweight</td>
<td>19.0</td>
<td>30.9</td>
<td>26.8</td>
<td>42.1</td>
</tr>
<tr>
<td>Obese</td>
<td>13.3</td>
<td>24.0</td>
<td>10.7</td>
<td>25.6</td>
</tr>
</tbody>
</table>

In addition levels of obesity tend to be higher in people living in disadvantaged or remote areas, and in those who have lower levels of education (ABS, 2011b) and these characteristics were not highly represented in the OCS cohort.

There is the possibility of a dose response (Figure 8.2) as those in the high consumption group were more likely to be in a healthy weight range, however this will require further investigation to confirm.
Even if this is a true effect, and less organic consumers are overweight or obese compared to their counterparts in the general population, it is not clear whether this is a result of organic consumption or whether people of normal BMI are more likely to choose organic food.\textsuperscript{149}

### 8.7.2 Organic Consumption

**Amount of organic consumption**

Based on self-estimation reports, more than half (60.4\%) of the respondents in the OCS said that ‘most’ of the food they consumed in the previous 12 months was organic (see Table 8.3). In this case ‘most’ was defined as more than 65\%. This figure included both certified and likely organic food, whereas only 37.4\% said that most of the food they consumed was ‘certified organic’. These figures were higher in the subgroup of respondents who also completed the OFIS, 73.6\% for all organic and 52.6\% certified organic.

\textsuperscript{149} This will be explored in more detail in \textit{9.6.6 Health and Wellness Effects Reported by Respondents: Weight management}
HEALTH, WELLNESS AND ORGANIC DIETS

Table 8.3. Estimated Amount of Organic Food Consumed in the Past Year by Self-reported Organic Consumers (N=318)

<table>
<thead>
<tr>
<th>Category</th>
<th>Organic (certified or non-certified)*</th>
<th>Certified Organic**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not answer</td>
<td>0</td>
<td>8.8</td>
</tr>
<tr>
<td>Almost none (0-10%)</td>
<td>1.6</td>
<td>4.1</td>
</tr>
<tr>
<td>A little (10-35%)</td>
<td>14.5</td>
<td>21.4</td>
</tr>
<tr>
<td>About half (35-65%)</td>
<td>25.2</td>
<td>28.6</td>
</tr>
<tr>
<td>Most (65-90%)</td>
<td>37.4</td>
<td>21.4</td>
</tr>
<tr>
<td>Almost all (90-100%)</td>
<td>21.4</td>
<td>15.7</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Notes:
* Question: Over the past year what proportion of the food you ate was prepared from organic food (either certified or non-certified)?
** Question: Over the past year what proportion of the food you ate was prepared from ‘certified organic’ food?

During the 3 day recording period of the OFIS only one of the respondents achieved in excess of 90% certified organic, with a further two who consumed in excess of 90% when ‘likely’ organic foods were also included. In the OCS, a surprisingly high number (22%) of respondents reported consuming in excess of 90% organic with over 15% claiming in excess of 90% ‘certified organic’.

The majority (56.3%) of OCS respondents were able to achieve both 65% overall organic food intake, including at least 35% certified organic food. This figure was 63% amongst OFIS respondents. For short term studies participants may be able to consume higher percentages of their food servings from organic sources but for longer term observational studies these may be realistic targets for inclusion criteria. For health outcome based research, such criteria need to be set high enough that they clearly differentiate dedicated organic consumers from those whose consumption is only incidental, but low enough that they are readily achievable by a person motivated to do so.

These figures are higher than previous Australian reports but those surveys targeted the general population so dedicated organic consumers would have been only a small subgroup. The OCS and OFIS surveys specifically targeted dedicated high-end consumers, so estimates would be expected to be higher.
Interestingly, nearly 9% of the respondents didn’t answer the ‘certified organic’ question. There are numerous certification logos, both domestic and international in use in Australia. As a result consumers may not be clear about whether their produce is certified and this may have resulted in the high non-response rate to this question. The peak industry body, the Organic Federation of Australia, is currently developing a single logo in an attempt to reduce this confusion. While pictures of the logos were included in the OCS survey, just as they were in the OFIS, the OCS was a retrospective report of consumption so respondents who do not actively look for certification logos may not have been able to answer this question.

Table 8.4. Organic Consumption Reported in the OFIS

<table>
<thead>
<tr>
<th></th>
<th>Estimated a Mean (%) [95%CI]</th>
<th>Documented b Mean (%) [95%CI]</th>
<th>Mean Difference c Mean (%) [95%CI]</th>
<th>t, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any organic</td>
<td>69.7 [60.1, 79.4]</td>
<td>76.3 [68.0, 84.5]</td>
<td>6.6 [-1.1, 14.2]</td>
<td>t = 1.80, p = .09</td>
</tr>
<tr>
<td>Certified only</td>
<td>58.9 [47.8, 70.1]</td>
<td>63.0 [51.8, 74.2]</td>
<td>4.1 [-5.5, 13.6]</td>
<td>t = 0.90, p = .38</td>
</tr>
</tbody>
</table>

Note: a version of this table was published in: Journal of the Science of Food and Agriculture 92/ 14 © 2012 Society of Chemical Industry, first published by John Wiley & Sons Ltd

a Estimated consumption is based on the previous 12 month period in both the OCS and the OFIS

b Documented consumption is based on results recorded in the 3-day OFIS

c The mean difference is based on each individuals documented organic intake minus the estimated organic intake for each respondent.

On average, ‘documented’ levels of organic consumption over the 3-day recording period of the OFIS were slightly higher than the respondents had initially estimated although this wasn’t statistically significant (p>.05) (Table 8.4). Although concerns about over-reporting are often raised, the tendency for higher end organic consumers to understate their purchase frequency has been reported in other studies (Pearson, et al., 2011).

It may not have been entirely appropriate to compare the results given that the initial self-report was based on an estimate of the previous 12 months whereas the ‘documented intake’ was based on a 3-day recording period. Given the small number of respondents
the findings may have been skewed by individual results. For instance, in one case the respondent had only recently converted to organic food, so the estimation which was based on the entire 12 month period was artificially low as there were several months where no organic food had been consumed.

Respondents in the OFIS reported that their responses were largely accurate ($M=92.3\%$; 95%CI [89.4, 95.2]) and typical ($M=87.5\%$; 95%CI [83.0, 92.1]) of their usual dietary intake. In terms of accuracy, these figures were based on quantification of serving sizes by food category so they will not be completely precise. Respondents were asked to estimate their serving sizes, for example a cup of rice, a medium sized apple, but there will naturally be a margin of error.

In terms of typicality, the act of completing a diet survey can affect eating behaviour as respondents become more conscious of the choices they make. As occurs in practice when patients are asked to complete a food diary they are often faced with three choices: eat a food and record it, and take the risk that your choice will be judged negatively by the practitioner (or researcher in this case); eat the food and don’t record it, while justifying to yourself that it is not something you would normally eat so it would be ‘misleading’ to record it; or choose not to eat the food so that you don’t have to record it. In addition the mere notion of a ‘typical’ diet is abstract. Most people don’t eat the same foods every day and there will be seasonal variation in food choices. Asking a person to describe a typical diet or to compare a 24 hour recording period with this ‘abstract notion’ is asking them to engage in a creative process and can never be completely accurate.

**Spending on organic**

When comparing OCS respondents in the low, moderate and high consumption groups, one of the more obvious differences was the percentage of their weekly food budget that was spent on organic options (Figure 8.3). Overall, the mean estimated weekly expenditure on organic food (either certified or ‘likely’) was $69.3\%$ ($SD=27.5$) in the OCS and $74.3\%$ ($SD=22.6$) in the OFIS (Oates, et al., 2012).
While the OCS and OFIS specifically targeted organic consumers, the 2012 AOMR (which targeted the general population) reported that most (58%) households spend less than 10% of their house-hold food-spend on organic options. In the AOMR only 14% of respondents spent more than half of their budget on organics, and 71% spend less than one fifth (Monk, et al., 2012).\textsuperscript{150}

### 8.7.3 Food Categories

The uptake of organic food was highest for fruit and vegetables and lowest for animal flesh products (meat, poultry, and fish) (Table 8.5).\textsuperscript{151} This was the case for both the frequency with which the food was consumed (e.g. daily, every 2-3 days etc) and the overall percentage of the food servings consumed in a typical week that were from organic sources. The OFIS recorded the quantity (relative amount) of organic food consumed within each food category, and the OCS recorded the frequency with which organic options were consumed within different food categories.

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\textsuperscript{150} Refer to \textit{2.4.3 Organic Consumers – What do they Eat?}

\textsuperscript{151} Much of the following discussion has previously been reported in the \textit{Journal of the Science of Food and Agriculture} (Oates, et al., 2012). (Appendix 6)
Table 8.5. Organic Consumption by Food Group: Based on the Relative Amount in the OFIS and Frequency of Intake in the OCS

<table>
<thead>
<tr>
<th>Food categories</th>
<th>OFIS</th>
<th>OCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days consumed /57 (%)</td>
<td>Average servings/ day (#)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>57 (98.3%)</td>
<td>4.6</td>
</tr>
<tr>
<td>Fruit</td>
<td>52 (89.6%)</td>
<td>3.0</td>
</tr>
<tr>
<td>Dairy</td>
<td>46 (79.3%)</td>
<td>1.7</td>
</tr>
<tr>
<td>Grains</td>
<td>56 (96.5%)</td>
<td>2.7</td>
</tr>
<tr>
<td>Plant protein sources</td>
<td>40 (69.0%)</td>
<td>1.7</td>
</tr>
<tr>
<td>Animal protein sources</td>
<td>43 (74.1%)d</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Note: this table was previously published in Journal of the Science of Food and Agriculture 92/14 © 2012 Society of Chemical Industry, first published by John Wiley & Sons Ltd

* Only the days consumed are included in the analysis.

a Number and (percentage) of the 57 sampling days in the OFIS where the foods were consumed (19 respondents over 3 days).

b Fruit and vegetables were grouped together in the OCS.

c Legumes were the only plant proteins recorded in the OCS.

d Animal products were grouped together in the OFIS.

For the purpose of analysis, recording days where the food was not consumed were not included. Over the 3-day OFIS recording period, one respondent did not consume any animal protein, however, amongst all respondents there were 15 recording days that were free of animal protein. One respondent did not consume any plant protein but there were
18 plant protein free recording days; and while two respondents did not consume any dairy, overall there were 12 days where dairy products were not recorded.

During the 3-day OFIS recording period, the percentage of servings that were organic was highest for fruit and vegetables and lowest for animal protein (Table 8.5). The contribution from ‘likely’ organic sources was highest for vegetables (19.0%) and also animal protein (16.6%). Comments suggested that these were largely from home grown vegetables and eggs. Some ‘likely’ foods were not explained, although a number of respondents reported having discussed production methods with sellers at farmers’ markets.

**Frequency by food category**

As with the amount of organic food recorded in the OFIS, the frequency of consumption in the OCS was again highest for fruit and vegetables and lowest for animal protein. The vast majority consumed organic fruit and vegetables on at least a weekly, if not daily basis. A number of OCS respondents reported that they did not consume animal proteins; meat (27.9%), poultry (23.5%), seafood (20.6%) and eggs (4.8%), but animal proteins still had the lowest frequency of organic consumption after excluding these respondents from the analysis.

Higher uptake of organic fruit and vegetables compared to animal products was also reported in the 2012 AOMR. In this survey 60% of general consumers had purchased some organic fresh fruit and vegetables in the previous 12 months but this figure rose to 92% amongst the ‘Leader’ group. This is compared with 35% overall and 72% of the ‘Leaders’ who had purchased organic red meat in the same period (Monk, et al., 2012).

The increased uptake of organic fruit and vegetables might be because consumers are more sensitive to price increases in absolute terms rather than relative terms and more tolerant of paying higher premiums for lower priced foods such as fruit and vegetables (Pearson & Henryks, 2008). Fresh fruit and vegetables have a relatively high market share and are considered an entry point for many new organic consumers (Pearson, et al., 2011).

Reports of organic fish consumption were low but this is unsurprising considering that certified organic sources of fish and seafood are uncommon in Australia. Although the

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152 Refer to [2.4.3 Organic Consumers – What do they Eat?](#)
surveys allowed for the inclusion of ‘wild-caught’ seafood as organic, this is not always labelled, making it difficult for consumers to assess.

**Specific food choices**

Many respondents (67%) in the OCS said there were specific foods that they selected for their organic status although these varied considerably between individuals. As previously mentioned most consumers are ‘switchers’ (Henryks & Pearson, 2011) and may have a predilection for specific organic products but not others.

Many respondents in the OCS identified trying to avoid specific conventional foods that they believed were heavily sprayed with pesticides. Some were less concerned about foods that have a removable peel (e.g. bananas, melons, nuts with hard shells) and more concerned about those with edible skins or with large surface areas to absorb chemicals. Some organic foods were purchased because respondents believe the organic options taste better. Other respondents were specifically concerned about animal welfare; or antibiotic and hormone use; and favoured organic meat, dairy, eggs and honey. There were also some that identified specific products such as coffee where there were concerns for the health and welfare of producers. The sources of these beliefs were rarely identified but where respondents reported sources of information in their comments, they were generally from overseas sources where pesticide regulations and patterns of use may vary. No one mentioned cost or availability in their comments.

**8.7.4 Beliefs**

Overall 95.4% of OCS respondents said that they agreed or strongly agreed with the statement: ‘Organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ and this belief was stronger in those with higher levels of organic consumption (Figure 8.4). Such beliefs have been previously reported in Australian studies.²⁵³ Twenty-five percent of respondents said that health related concerns influenced their decision to consume organic food.

²⁵³ Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?
Differences between low, moderate and high organic consumers in their reported belief that ‘organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’.

Only 8.9% agreed with the statement “In Australia conventionally farmed foods are well regulated by government bodies ensuring minimal pesticide residues remain on foods”. Although the majority (75.4%) agreed that organic certifying bodies were ensuring that organic produce was pesticide free.

OCS respondents were not confident that pesticide residues in food are safe. In fact only 5.6% agreed that “The amounts of pesticide residues remaining on conventionally farmed produce are not likely to be harmful to my health”. This is unsurprising given the challenges faced when conducting risk assessment.\(^{154}\)

Few believed that government bodies were ensuring that imported food adhered to Australian standards, 17.3% for conventional and 18.9% for organic food; with many unsure 39.9% and 50.5% respectively.

Although health-related issues have previously been rated higher than environmental issues in shaping consumer preference for organic food (Mondelaers, Verbeke & Huylenbroeck, 2009), the OCS respondents placed environmental concerns slightly above personal health concerns. Only 2% agreed that government regulations adequately

protect the environment from damage, with 97% saying that they agreed or strongly agreed with the statement: ‘Organic foods are better for the environment than conventionally grown foods’.

**Barriers to organic consumption**

The major barriers to organic consumption that arise in most surveys are price, convenience, and trust (Meldrum, 2005a). This was confirmed by OCS respondents who said they would be more inclined to purchase organics if they were more available/convenient (70.4%); if the price premium was less than 20% (65.4%); and if there was a single identifiable organic logo they could trust (46.5%).

While convenience may act as a barrier to organic consumption, in reality supply chains have improved in recent years increasing the variety and year round availability of organic products (Pearson & Henryks, 2008).

The price premium has previously been identified as a key barrier to organic consumption with 71% of Australian respondents claiming that they would buy more organic products if prices were lower (Meldrum, 2005a). However, cost is not always a deterrent. Price sensitivity for low-cost, low-volume food items may not be significant and price may also be viewed by some individuals as a surrogate for quality (Pearson & Henryks, 2008). In OCS respondents cost and convenience were less important to those with high consumption than those with low organic consumption. Both the OCS and previous studies have demonstrated that income has little impact on the decision to purchase organic foods (Lockie, et al., 2002) or the value placed on it (Paull, 2007).

In Australia there are eight certifying bodies using various certification logos and previous Australian consumer surveys have reported that that 72% of regular organic food buyers would prefer to have a single certification symbol to lessen confusion (Newspoll, 2008).

**The influence of scientific evidence on beliefs**

Overall 76.9% of OCS respondents said that scientific evidence had a moderate or strong influence on their beliefs about organic food (Figure 8.5). Other sources of beliefs came from: ‘personal experience’ (94%), ‘makes sense/seems logical’ (93%), ‘information from organic certifying bodies’ (65%), ‘information from food manufacturers’ (62%), and ‘family/friends’ (54%).

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\(^{155}\) Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food? Barriers to organic food purchase
Figure 8.5. The percentage of organic consumers who said that scientific evidence has an influence on their beliefs about organic foods (based on level of consumption).

Hoekfens (Hoekfens, Verbeke, Aertsens, Mondelaers & Camp, 2009) has contested that there is a gap between perception about the health benefits of organic foods and the available scientific evidence to support this perception, noting that perception is stronger with higher frequency of consumption. In the OCS high end consumers were less influenced by scientific evidence than low end consumers.

In the 2012 AOMR 25% claimed that ‘a lack of reliable information to convince me it is healthier’ was a barrier to purchasing organic. Concerns about the lack of (or lack of dissemination of) scientific data supporting health benefits has also arisen in other Australian research. For instance, in a focus group conducted by Lockie, Lyons, Lawrence and Mummery (2002) a participant made the following comment:

‘First I’d like to see logical appropriate evidence produced that the extra expense will result in improved health, longer life, more brains … I’ve heard a lot from the food Nazi’s telling me how good it is for me. But they haven’t actually been able to demonstrate to my satisfaction that it would be better for me.’

Amongst the OCS respondents 58% said that ‘More evidence that eating organic food reduces exposure to pesticide residues compared to eating conventionally farmed food’
would result in a moderate or strong increase their consumption of organic food (Figure 8.6).

![Figure 8.6](image)

*Figure 8.6. The percentage of organic consumers who said that ‘more evidence that eating organic food reduces exposure to pesticide residues’ would increase their consumption of organic food (based on level of consumption).*

This was more pronounced for low and moderate consumers, so this may be an opportunity for the organic industry to increase sales by supporting and promoting the distribution of research findings. Respondents also wanted more evidence that current levels of pesticides are harmful to health (61%) and that organic farming practices are better for the environment (60%), saying that this information would also influence their consumption of organic produce.

As a marketing strategy, assessing attitudes and beliefs that motivate consumer behaviour is often regarded negatively due to its ability to manipulate consumption beyond the needs of the consumer. However ‘societal marketing’ may also have a positive impact if the outcome is the promotion of healthier and more environmentally friendly purchasing behaviours (Pearson, et al., 2007).

In Australia organic food sales only account for around 1% of the food and beverage market (Monk, et al., 2012) and there is often a discrepancy between having positive attitudes to organic foods and actually purchasing them (Shepherd, et al., 2005).
Relatively small increases in motivation may be sufficient to dramatically increase organic consumption (Lockie, et al., 2002). Opportunities therefore exist to increase sales of organic food products by increasing sales to existing organic consumers or demonstrating the value of organics to conventional consumers who already express positive beliefs (Pearson & Henryks, 2008). Education has been identified as a key barrier to overcome in this endeavour. Education strategies serve two main purposes, to reinforce the choice for organic consumers and to educate conventional consumers who may be inquisitive about the potential benefits of organic foods (Paull, 2007).

**Other beliefs**

Respondents also reported other factors that had a moderate or strong influence on their decision to purchase organic food. These included: where the food was grown (90%), the amount of processing (90%), the amount of packaging (88%), whether the food was in season (86%), the nature of the seller (80%), whether the farmers received a fair price and conditions (80%) and the distance it had travelled (79%). Organic producers need to take care not to disregard these co-influences.

**8.7.5 Purchasing Behaviours**

The OCS asked respondents to report on where they purchased various broad categories of food in the previous month: fruit and vegetables; meat, poultry and seafood; and other organic products.

Multiple channels were used to source fruit and vegetables. The most common outlets used (where people obtained more than 65% of their products) were grocers (27.1%), farmers’ markets (18.5%) and health/wholefood stores (14.2%). It is possible that some respondents were unclear about the distinction between a grocer and a health food store and in some ways these outlets are similar and may be considered together. A number of people also reported sourcing their produce from their own or someone else’s garden, with some utilising home delivery services but very few using large supermarkets except for occasional purposes (Table 8.6).
Table 8.6. Sources of Organic Fruit and Vegetables (%)

<table>
<thead>
<tr>
<th>Source</th>
<th>All or almost all</th>
<th>Most (65-90%)</th>
<th>About half (35-65%)</th>
<th>A little (10-35%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>17</td>
<td>10</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Health/ wholefood store</td>
<td>7</td>
<td>7</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Own/ other’s garden</td>
<td>7</td>
<td>6</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>Delivery service</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Large supermarket chain</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

A number of OCS respondents reported that they did not consume meat (27.9%), poultry (23.5%), or seafood (20.6%). For those who did many used multiple channels to source products. The most common outlets used (where people obtained more than 65% of their products) were butchers (23.4%), fishmongers (18.4%), health/ wholefood stores (14.1%), large supermarkets (13.7%) and farmer’s markets (13.4%). However many outlets were also used occasionally (Table 8.7).

Table 8.7. Sources of Organic Meat, Poultry and Seafood (%)

<table>
<thead>
<tr>
<th>Source</th>
<th>All or almost all</th>
<th>Most (65-90%)</th>
<th>About half (35-65%)</th>
<th>A little (10-35%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butcher</td>
<td>17</td>
<td>6</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Fishmonger</td>
<td>14</td>
<td>5</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Health/ wholefood store</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Large supermarket chain</td>
<td>4</td>
<td>10</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Own/ other’s garden</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>
Again multiple channels were used to source other organic products which included: eggs, dairy, grains, legumes and pre-packaged foods. The most common outlets used (where people obtained more than 65% of their products) were health/wholefood stores (20.4%), large supermarkets (13.4%) and grocers (12.6%). A number of people also reported sourcing occasional produce from farmers’ markets, their own or someone else’s garden (mostly eggs), or small supermarkets or local stores (Table 8.8).

Table 8.8. Sources of Other Organic Produce (%)

<table>
<thead>
<tr>
<th></th>
<th>All or almost all (90-100%)</th>
<th>Most (65-90%)</th>
<th>About half (35-65%)</th>
<th>A little (10-35%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health/wholefood store</td>
<td>8</td>
<td>13</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Large supermarket chain</td>
<td>4</td>
<td>9</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Own/other’s garden</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Small supermarket/local store</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>24</td>
</tr>
</tbody>
</table>

The 2012 AOMR\textsuperscript{156} considered supermarkets to be the main outlet for people purchasing organic products with approximately three quarters of surveyed respondents using this option for at least some products. This was less common in the high end consumers (the Leaders), who were less inclined to use supermarkets favouring other outlets such as grocers, wholefood stores, markets and online alternatives. Multi-channel purchasing was also reported by many consumers (Monk, et al., 2012).

The results aren’t entirely comparable as they are not broken down into different categories and purchasing behaviour does appear to vary with the amount of organic food consumed and the OCS respondents are likely to be at the higher end of consumption.

\textsuperscript{156} Refer to 2.4.5 Organic Consumers – Where do they Get their Food?
8.7.6 Food Preparation Behaviours

The organic status of some food categories appeared to have an influence on food preparation behaviours. Many of the OCS respondents said there were certain foods they would not eat unless they were organic, in particular certain fruits and vegetables. Respondents who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit (OR 3.565; 95%CI 1.433, 8.867) and vegetables (OR 3.456; 95%CI 1.61, 7.418).\textsuperscript{157}

It is assumed that this behaviour is to remove unwanted pesticides. However this activity may be resulting in a loss of nutrients located in the skins and may not necessarily achieve the intended purpose.\textsuperscript{158}

Based on my literature review, there have been no previous studies investigating the food preparation behaviours of organic consumers. While there are mixed reports regarding whether, which and to what extent organic foods are higher in nutrients (Brandt, et al., 2011; Dangour, Dodhia, Hayter, Aikenhead, et al., 2009; Lairon, 2010; Smith-Spangler, et al., 2012)\textsuperscript{159} this activity may increase any nutritional differences between organic and conventional produce. So at the point of consumption conventional foods may be markedly different in their nutritional value because they are not consumed in the same way. This may be further exacerbated because nutrient degradation during storage may occur quicker in conventional than organic foods (Zapata, Tucker, Valero & Serrano, 2012).

8.7.7 Non-dietary Sources of Pesticide Exposure

For the most part OCS respondents did not have high rates of exposure to non-dietary sources of pesticides.\textsuperscript{160} Most said that to their knowledge they were never or rarely exposed to commercial fumigation products (83.9%), pet pesticide treatments (66.4%), household insecticides (65.5%), personal insect repellents (62.1%) or garden pesticides from home, public parks etc (59.9%). Many respondents commented that they opt for natural alternatives to pesticides whenever possible. There were some products that respondents believed they were seasonally exposed to, but not in the previous two

\textsuperscript{157} Previously reported in an article published in the Journal of the Science of Food & Agriculture (Oates, et al., 2012) (Appendix 6)
\textsuperscript{158} Refer to 6.3.3 Food Preparation Effects on Pesticide Exposure
\textsuperscript{159} Refer to 5.2.2 Product: Nutritional Differences between Organic and Conventional Produce
\textsuperscript{160} Refer to 6.3.4 Non-dietary Sources of Pesticide Exposure
months: personal insect repellents (28.3%), garden pesticides (22.3%) and household insecticides (18.2%). The survey was conducted during the Australian spring.

Questions about non-dietary sources of pesticide exposure were also reused in the CEFBeS as a supporting instrument for the biomonitoring study.

### 8.8 Limitations

It is possible that some respondents may have over-estimated their organic intake in the OCS, and this may be partly due to the use of Likert scales which may be susceptible to ‘socially desirable responding’ (Adamsen, et al., 2007). Likert scales also allow respondents to declare that numerous options are equally desirable and do not present them in the context of the trade-offs that need to be made during real-life decision making (Adamsen, et al., 2007).

In addition to some of the limitations I have already mentioned I should reiterate that the participants were self-selected and the sample may not be representative. The recruitment processes and use of internet-based surveys may have resulted in an overrepresentation of certain age, gender and socioeconomic groups.

Response rates to the OFIS were rather low despite multiple attempts to minimise respondent fatigue suggesting that the instrument requires further development to improve its acceptability. In an attempt to keep the survey relatively simple, some detail was lost and the estimation method that was used may not be quantifiably precise. However, we felt these compromises were necessary to reduce the burden on respondents and therefore reduce the risk of missing or inaccurate data. In addition even though respondents largely reported that their responses were accurate and typical of their usual dietary intake, it should be stressed that act of completing a diet survey can affect eating behaviour.

### 8.9 Application

Occasional organic consumption may not be relevant when considering the contribution of organic diets to health and wellness. While the inclusion criteria targeted those who make a deliberate choice to consume organic food where possible, this may be interpreted very differently by different people. For research purposes some level of quantification is

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161 Refer to SDR discussion under 2.4.4 Organic Consumers – When do they Eat Organic?
required to determine if there is a dose related response to an organic diet and the OFIS provides a means of achieving this.

These surveys have allowed us to better understand current trends in consumption and other factors relevant to organic consumers. This informed the inclusion criteria used in the biomonitoring trial.

Some of the findings may be useful for developing marketing strategies for the organic industry. In addition consumers are frequently motivated by definable targets. In the future the OFIS could be developed into a smart phone application allowing consumers to set organic consumption targets for themselves and monitor their progress.

8.10 Conclusion

The OCS has provided an updated and detailed profile of dedicated Australian organic consumers. Respondents were asked to confirm that they made a conscious choice to consume organic food at least weekly.\(^{162}\) This is in contrast to a number of previous studies that reported on the general population and regarded organic consumers as those who had purchased any organic food in the previous 12 months. Females, those with higher education qualifications and in a healthy weight range were strongly represented.

The OCS and OFIS confirmed that while consumption of a 100% organic diet is rare and thus lack relevance for research purposes, many organic consumers were able to achieve a mostly (>65%) organic diet. However a mostly certified organic diet was more difficult to achieve. The OFIS proved to be a useful tool for assessing the level of organic intake. Organic fruit and vegetables had the highest uptake and animal flesh products the lowest. Many of the organic consumers surveyed did not eat various food groups unless they were organic. Those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit and vegetables.

The OCS results support the hypothesis that ‘Organic consumers believe that consuming an organic diet is beneficial for health’. Environmental concerns also appeared to be very strong contributors to the decision to favour organic foods. Around a quarter said that specific health related concerns influenced their decision to consume organic foods and the majority said that scientific evidence influenced their beliefs about organic food.

\(^{162}\) As the results indicated that many respondents were consuming organic food daily, this criterion was narrowed to daily consumption for the OHWS.
This high-end consumption cohort is of greater interest for health research as occasional consumption of organic food would not be expected to have a significant effect on health outcomes. The findings from these studies informed the design of the BMT, including eligibility criteria, and the development and refining of instruments to record food intake and confounders that may influence biomonitoring results. As a result of this research I was better able to conduct the BMT in a manner that would be more rigorous and meaningful to consumers.
Chapter 9. Organic Health & Wellness Survey (OHWS)

9.1 Abstract
Consumers believe that organic foods are healthier than conventional foods, yet there has been very little research into specific health benefits of organic diets. The purpose of the Organic Health and Wellness Survey (OHWS) was to gain a better understanding of the beliefs, personal wellbeing and health experiences reported by regular organic consumers and to use this information to direct future research. Dedicated organic consumers, who make a deliberate choice to consume at least some organic foods on most days, were recruited through advertisements in retail outlets and websites that sell or promote organic produce. A total of 404 useable surveys were submitted. The majority of OHWS respondents were female (81.4%), tertiary educated (73.4%), in a healthy weight range (59.7%), with a mean age of 41.2 years. Respondents generally scored well on the
AAustralian Unity Personal Wellbeing Index for adults (PWI-A), a measure of subjective wellbeing ($M=77.5; 95\% \text{ CI } [76.2, 78.8])$. Overall 75.7% said they perceived their overall health to be better since moving to an organic diet, and the average improvement was around 2.5 points on a 10-point scale. The health benefits most commonly reported by respondents were improvements in: resistance to and recovery from illness (71.1%), physical energy (61.1%), condition of skin/ hair/ nails (58.4%), mental alertness (56.7%), mood stability (56.3%), and sense of satiety (55.4%). Many (62.5%) reported that they had also made other dietary or lifestyle changes around the time they moved to an organic diet that may have had an impact on their health, and respondents often referred to psychological benefits from purchasing products they believe reflect their values. Of the 24% who reported pre-existing health conditions, 96% believed that the condition had improved since moving to organic food. Organic consumers' decisions to purchase organic food were driven more by risk aversion (especially to pesticides) than nutritional superiority. Respondents held strong beliefs around the ability of organic diets to prevent a range of conditions including cancer (80.2%), allergic conditions (75.6%) as well as behavioural (74.8%) and developmental problems (71.9%) in children. This suggests that respondents are aware of some of the evidence on the health impact of pesticides. The study highlights opportunities for future research into some of the more commonly reported wellness effects.

### 9.2 Background

Consumers of both conventional and organic food believe that organic foods are healthier than conventional foods (Lea & Worsley, 2005; Lockie, et al., 2002). The results of the OCS further suggest that more than 95% or organic consumers believe that organic food is healthier than conventionally grown food, with 25% of respondents stating that health related concerns influenced their decision to consume organic food.$^\text{163}$ Despite these beliefs, there has been very little research into specific health benefits of organic diets. (Dangour, et al., 2010; Smith-Spangler, et al., 2012).$^\text{164}$ As consumers may be unwilling to pay the price premiums for organic food without some evidence of specific benefits, the lack of research into health benefits of organic food may be a limiting factor to organic food consumption which, as of 2012 only accounted for 0.8–1.2% of Australian food sales (Monk, et al., 2012).

$^\text{163}$ Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?
$^\text{164}$ Refer to Chapter 4, What Evidence is there that Organic Diets Improve Human Health and Wellness?
To date many of the assumptions about the health benefits of organic diets are based on knowledge of the negative health effects of pesticides (Sanborn, et al., 2012). Yet negative health effects may take decades to evolve, and identifying dietary pesticide exposure as a cause, or organic diets as a preventative strategy, is extremely difficult.

While prospective population studies that demonstrate the health effects of organic diets are challenging to design, fund and implement, it is possible to perform retrospective studies of dedicated organic consumers to try to ascertain if they experience any obvious health benefits. Researchers in Europe have recently investigated this (K. Huber, et al., 2005; Rembialkowska, et al., 2008; van de Vijver & van Vliet, 2012) and a number of perceived benefits including improved resistance to and recovery from illness, a positive effect on mental wellbeing and fewer digestive complaints. A comparison of the results of the current study and the previous research from Europe is presented below.

Armed with this retrospective qualitative information we can assess whether there is a biologically plausible rationale for the most commonly reported findings and whether there are more objective markers that could be utilised to confirm the findings in future prospective research.

**Are organic consumers healthier... or do they just think so?**

When this study was first launched I received a scathing email that was also directed to senior staff at my university. The attack came from an employee of Australia’s food regulatory body. I suspect the person in question had missed the project information statement that would have alleviated their concerns. Instead they determined that the purpose of this study was to demonstrate that “Pesticide and other chemical residues consumed as part of a normal diet affect the health of humans.”

Let me say from the outset, that is not the intended purpose of the OHWS. To clarify, the intended purpose is to determine the health and experiences of dedicated organic consumers... or do they just think so?

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165 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
166 Refer to 4.6 Self-reported Health
167 Refer to a discussion of these studies in 4.6 Self-reported Health
organic consumers and inform future research not to prove any causal relationships. However, I believe that it is essential that we do not discount the importance of a person's subjective experience of health. Just as we might ask... am I really happy... or do I just think so? We might equally ask... am I really healthy... or do I just think so? “... for there is nothing either good or bad, but thinking makes it so.” (Hamlet Act 2, scene 2)

9.3 Aims

- To determine the characteristics of ‘dedicated Australian organic consumers’ including socio-demographic characteristics, behaviours, and beliefs
- To explore general consumption trends amongst current dedicated Australian organic consumers
- To determine the health related beliefs that compel dedicated organic consumers to consume organic food
- To identify any health benefits dedicated organic consumers believe are derived from consuming an organic diet

With regard to the specific health and wellness outcomes that organic consumers believe benefit from consuming an organic diet the study will explore:

- Do dedicated organic consumers perceive that changing to organic food has improved their health?
- Which medical conditions do dedicated organic consumers report to have personally benefited from consuming organic food?
- Which conditions do dedicated organic consumers believe can be prevented by consuming organic food?
- How do dedicated organic consumers compare with the general Australian adult population on the Personal Wellbeing Index (PWI-A).
- What health related beliefs about organic food have the strongest influence on purchasing behaviour?
- Which conditions do dedicated consumers report to have experienced as a result of consuming conventional foods?
- What other factors might explain the perceived health benefits reported by dedicated organic consumers (e.g. other dietary, lifestyle changes)?
• How do health perceptions amongst dedicated organic consumers compare between different countries (results will be compared with a similar study from The Netherlands)?

9.4 Design / Methods for the OHWS

Summary
A preliminary set of questions was developed for the OHWS based on a review of the existing literature and results from the OCS, and feedback was sought from the primary author of the Dutch study and other colleagues working in the field. A combination of closed and open questions were used to provide both quantitative and qualitative data. A number of the questions from the OCS were repeated in the OHWS to allow for comparison of the study respondents. This included basic socio-demographic questions as well as questions about food consumption and purchasing behaviour. Following ethics approval from the Science, Engineering & Health College Advisory Network of the Human Research Ethics Committee of RMIT University, the OHWS survey was conducted over a two month period from mid-October to mid-December 2011 using the Survey Monkey® online survey tool. As with the OCS, the OHWS used retail outlets and websites that sell or promote organic produce to target dedicated organic consumers, who were likely to be at the high-end of consumption trends. The survey was completely anonymous and no data was recorded that would identify respondents. All participants were asked to confirm that they were over 18 years of age agreed with the statement ‘I make a deliberate choice to consume at least some organic foods on most days’.

9.4.1 Development of the OHWS
It was clear from the results of the OCS that respondents had positive attitudes to organic foods and strong beliefs about its’ ability to support good health. When they were asked if they had any health related concerns (including medical conditions, allergies, intolerances etc) that affected their decision to consume organic foods, 25% responded ‘yes’ and described a wide array of conditions. These were coded into categories and subcategories and the most commonly reported conditions were included in the development of the OHWS questions. Some respondents included comments such as “I didn’t realise though until I actually made the switch, how beneficial it was to my

168 Appendix 4. OHWS Ethics approval
169 Appendix 4. OHWS Survey
170 Refer to 8.7.4 Beliefs
wellbeing”. It was clear that the survey would benefit from including not only clearly defined health conditions but also indicators of wellness.

A combination of closed and open questions were used to provide both quantitative and qualitative data. Closed questions generally utilised likert scales and incorporated a comments option which allowed respondents to ‘tell their stories’.

As with the OCS, the development of the OHWS considered the relative strengths and weaknesses of various survey approaches (Thompson & Subar, 2001; Walonick, 2004). A literature search revealed a well described study on self-reported health benefits associated with organic diets, conducted by the Louis Bolk Institute in The Netherlands (van de Vijver, 2010). This study was used extensively for the design of the OHWS to facilitate comparison of the results.

A preliminary set of questions was developed and feedback was sought from the primary author of the Dutch study and other colleagues working in the field. A number of the questions from the OCS were repeated in the OHWS to allow for comparison of the study respondents. This included basic socio-demographic questions as well as questions about consumption and purchasing behaviour, with some of the consumption questions being slightly rewritten to improve their clarity. Again respondents were asked about their consumption of specific food categories as well as overall consumption. While beliefs were covered to some degree in the OCS, the OHWS explored some of the health related beliefs in more detail (Figure 9.1).

The final survey was created online using the online Survey Monkey® Survey Tool. The suitability of using an internet-based survey was previously discussed.

9.4.2 Recruitment for the OHWS

As with the OCS, the OHWS targeted dedicated organic consumers who were likely to be at the high-end of consumption trends, rather than those for whom organic consumption was occasional or incidental. A study website provided information to prospective participants about the purpose and conduct of the study. This included links to the Project

171 Refer to 8.5.1 Development of the OCS
172 The key findings from this study were later published in The Journal of the Science of Food and Agriculture (van de Vijver & van Vliet, 2012) but this occurred after the OHWS was conducted.
173 Refer to 8.5.1 Development of the OCS: Use of an internet-based survey design
174 Appendix 4. Website content (OHWS) <www.rmit.edu.au/wellness/organicresearch>
Information Statement\textsuperscript{175} and to register for the mailing list to receive updates on the research.

Participants were recruited through retail outlets and websites that sell or promote organic produce. Flyers were delivered to retail outlets such as organic grocers and certified organic stalls at Farmers’ markets. Notices were also posted on websites that sell or promote organic produce.

An email was also sent to the researchers personal contacts and other organisations such as organic industry groups with a request that the email be forwarded to potential participants. Social media, including Facebook and Twitter, were also used to direct potential participants to the study website. In addition a media release was circulated by RMIT Marketing and Communications. Interested parties were directed via a link on the website, and also in the email, to the anonymous online survey.\textsuperscript{176}

9.4.3 Inclusion Criteria

The OHWS commenced with three questions asking participants to confirm the following statements before proceeding:

- “I consider myself to be a regular ‘organic consumer’ (i.e. I make a deliberate choice to consume at least some organic foods on most days)”\textsuperscript{176}. This was stricter than the OCS, which asked for confirmation of weekly organic consumption, as health effects are generally considered to be dose dependent.
- “I am over 18 years of age.”
- “I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Organic Consumption Survey’.”

Participants’ consumption patterns where then explored further in the surveys to confirm their organic status.

9.4.4 Conduct of OHWS

Following ethics approval from the Science, Engineering & Health College Advisory Network of the Human Research Ethics Committee of RMIT University,\textsuperscript{177} the OHWS survey\textsuperscript{178} was conducted over a two month period from mid-October to mid-December.
HEALTH, WELLNESS AND ORGANIC DIETS

2011 using the Survey Monkey® online survey tool. The survey was completely anonymous and no data was recorded that would identify respondents.

9.5 Data Analysis

Group based data analysis was conducted using SPSS for Windows statistical software (version 18). As with the OCS an organic consumption score was created for each respondent based on their response to questions about the frequency and quantity of organic food consumed. The frequency score was based on an average of how often respondents ate organic foods from different food groups. The quantity score was based on the percentage of the time the respondent opted for organic options.

The frequency and quantity score were both scored out of 5 (between 1 and 5, with 5 indicating the highest quantity or frequency of organic consumption) and added together to give a total score out of 10. The Visual Binning feature in SPSS was used to separate the sample into three equal groups, with each group containing approximately one third of the data points.

Comments were collated and coded into categories and used to assist with interpretation of the findings. Descriptive statistics were utilised for the majority of the survey questions. A Pearson product-moment correlation coefficient was computed to assess the relationship between beliefs about organic food categories and the amount of the time, and the frequency with which, they were consumed. A paired samples t-test was used to assess the difference between respondents reported sense of wellness before and after moving to organic food.

9.6 Results and Discussion

A total of 447 people entered the survey of which 28 did not complete any questions. Of the 94% who completed questions 15 were excluded as they did not meet the inclusion criteria: 12 were not regular consumers and 3 were under 18 years. This left 404 usable surveys.

With regard to the organic consumption score, the cut-off points in the OHWS were 'low' (<6.35), 'moderate' (6.35-7.44) and 'high' (>7.44). In comparison the cut-off points in the OCS were ‘low’ (<6.93), ‘moderate’ (6.93-8.13) and ‘high’ (>8.13).179 These were used to

179 Refer to 8.6 Data Analysis
determine whether the socio-demographic or other findings differed with the level of consumption.

Only the three inclusion criteria questions were set up for forced completion so respondents were permitted to skip other questions if they chose. The majority of questions included options for comments and respondents used this feature extensively to ‘tell their stories’.

The average time to complete the survey was 16.4 minutes. It is not possible to establish response rates because respondents self-selected whether to access the online surveys or not.

9.6.1 Socio-demographic Characteristics of Respondents

On the whole the socio-demographic characteristics of respondents in the OHWS were similar to Australian respondents in the OCS (N=318) (Table 9.1) and Dutch respondents (N=565) in a similar study (van de Vijver & van Vliet, 2012).

Table 9.1. Socio-demographic Characteristics of Respondents in the OHWS and OCS (% of Survey Respondents)

<table>
<thead>
<tr>
<th></th>
<th>OHWS</th>
<th>OCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>81.4</td>
<td>80.3</td>
</tr>
<tr>
<td>Male</td>
<td>18.6</td>
<td>19.7</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 years</td>
<td>5.7</td>
<td>2.4</td>
</tr>
<tr>
<td>25–34 years</td>
<td>25.9</td>
<td>28.9</td>
</tr>
<tr>
<td>35–44 years</td>
<td>33.0</td>
<td>29.3</td>
</tr>
<tr>
<td>45–54 years</td>
<td>19.5</td>
<td>22.1</td>
</tr>
<tr>
<td>55–64 years</td>
<td>13.5</td>
<td>12.9</td>
</tr>
<tr>
<td>65 years or older</td>
<td>2.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Highest level of education

<table>
<thead>
<tr>
<th></th>
<th>OCS</th>
<th>OHWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No degree</td>
<td>26.6</td>
<td>34.7</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>32.1</td>
<td>31.6</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>41.3</td>
<td>33.7</td>
</tr>
</tbody>
</table>

Body mass index (kg m\(^{-2}\))

<table>
<thead>
<tr>
<th></th>
<th>OCS</th>
<th>OHWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20 (underweight)</td>
<td>12.6</td>
<td>11.0</td>
</tr>
<tr>
<td>20–25 (healthy weight)</td>
<td>59.7</td>
<td>55.5</td>
</tr>
<tr>
<td>25–30 (overweight)</td>
<td>18.6</td>
<td>20.6</td>
</tr>
<tr>
<td>&gt;30 (obese)</td>
<td>9.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

Location

<table>
<thead>
<tr>
<th></th>
<th>OCS</th>
<th>OHWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>23.3</td>
<td>38.8</td>
</tr>
<tr>
<td>Urban</td>
<td>76.7</td>
<td>61.2</td>
</tr>
</tbody>
</table>

Country of birth

<table>
<thead>
<tr>
<th></th>
<th>OCS</th>
<th>OHWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>77.0</td>
<td>68.9</td>
</tr>
<tr>
<td>Other country</td>
<td>23.0</td>
<td>31.1</td>
</tr>
</tbody>
</table>

While comparisons with the general Australian population are sometimes made throughout this section, it is recognised that the study population surveyed is not a representative sample. Given that the recruitment methods were similar it is likely that a proportion of respondents who completed the OCS also completed the OHWS, and this may explain some of the similarities. As the OHWS, the OCS, and the Dutch study all used a self-selecting cohort of respondents it is difficult to say whether the characteristics are those of organic consumers as a group, or simply of those dedicated organic consumers who are more motivated and able to complete an online survey. The high number of extensive comments received suggested that respondents were those highly motivated to tell their stories.
**Gender**

As with the OCS\(^{180}\) females outnumbered males 4:1 (81.4%), and this was similar in the study conducted in The Netherlands where 83.2% of the respondents were female (van de Vijver & van Vliet, 2012).

**Age**

The mean age in the OHWS was 41.2 years. The age ranges were similar for the OCS\(^{181}\) and OHWS (Table 9.1). The Dutch study did not report mean age but categorical results were not dissimilar (van de Vijver & van Vliet, 2012) (Table 9.2). The mean age of females in a Polish study was 42.3 years (Rembialkowska, et al., 2008).

<table>
<thead>
<tr>
<th>Age</th>
<th>OHWS</th>
<th>Dutch study</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20 years</td>
<td>1.1</td>
<td>0</td>
</tr>
<tr>
<td>20–30 years</td>
<td>14.4</td>
<td>12.4</td>
</tr>
<tr>
<td>30–40 years</td>
<td>34.5</td>
<td>25.4</td>
</tr>
<tr>
<td>40–50 years</td>
<td>25.6</td>
<td>25.4</td>
</tr>
<tr>
<td>50–60 years</td>
<td>16.7</td>
<td>20.8</td>
</tr>
<tr>
<td>60 years or older</td>
<td>7.8</td>
<td>15.9</td>
</tr>
</tbody>
</table>

**Education**

Again the education levels were similar in respondents to the OCS and OHWS. As previously discussed\(^{182}\) these rates are higher than the general Australian population with 73.4% of respondents having completed a tertiary degree or postgraduate program. The education system in The Netherlands differs from Australia, however the Dutch respondents also had had high levels of university education with 74.2% reporting their highest level of education as HBO (45.6%) or University (28.6%) (van de Vijver, 2010).

\(^{180}\) Refer to 8.7.1 Socio-demographic Characteristics of Respondents: Gender

\(^{181}\) Refer to 8.7.1 Socio-demographic Characteristics of Respondents: Age

\(^{182}\) Refer to 8.7.1 Socio-demographic Characteristics of Respondents: Education
Country of birth and residential location

On the whole there were more respondents who were born in Australia and who live in urban areas in the OHWS (77.0%) compared to the OCS (68.9%) (Table 9.1).^183

Body Mass Index (BMI)

As occurred in the OCS^184 rates of overweight and obesity (27.7%) were substantially lower than the general Australian population (61.4%) (ABS, 2008). Amongst the OHWS respondents the rates of overweight and obesity varied inversely with their organic consumption score, with 32.1% in low consumers, 25.7% in moderate and 25.0% in high organic consumers. Low rates of overweight and obesity in the cohort may be partially due to the relative lack of males, older individuals and people living in disadvantaged or remote areas amongst the OHWS respondents compared to the general population (who are more likely to be obese). In addition there were more females (35%) than males (23%) in the high consumption group and females are less likely to be overweight or obese.^185

9.6.2 Organic Consumption

Amount of organic consumption

Based on self-estimation reports, the percentage of people in the OHWS that consumed most or all (i.e. >65%) organic food in the previous 12 months was 50.1% for certified organic food and 68.1% when ‘likely’ organic foods were also included. In the OCS^186 the figures were somewhat lower. Levels of consumption were not reported in the Dutch study. In the Polish study participants were allocated to the ‘organic group’ if they had consumed a minimum of 25% for more than 6 months (Rembialkowska, et al., 2008).

Duration of organic consumption

The Australian OHWS and Dutch consumers were similar in terms of how long they had been consuming organic food (Table 9.3). Amongst the Australian respondents 43.2% reported that they had consumed organic food for less than 5 years compared to 39% of the Dutch respondents (van de Vijver & van Vliet, 2012). Half of the Polish participants had consumed organic for less than 4 years (Rembialkowska, et al., 2008). The OCS did not report duration of consumption so this could not be compared.

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^183 Refer to 8.7.1 Socio-demographic Characteristics of Respondents: Country of birth
^184 Refer to 8.7.1 Socio-demographic Characteristics of Respondents: Body Mass Index (BMI)
^185 Possible explanations and direction for future research are discussed later under 9.6.6 Health and Wellness Effects Reported by Respondents: Weight management
^186 Refer to 8.7.2 Organic Consumption: Amount of organic consumption
Table 9.3. Duration of Organic Consumption (% Survey Respondents)

<table>
<thead>
<tr>
<th>Duration of Organic Consumption</th>
<th>OHWS</th>
<th>Dutch study</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>8.5</td>
<td>7.8</td>
</tr>
<tr>
<td>&lt;5 years</td>
<td>34.7</td>
<td>31.2</td>
</tr>
<tr>
<td>5–10 years</td>
<td>24.9</td>
<td>21.7</td>
</tr>
<tr>
<td>10–20 years</td>
<td>16.2</td>
<td>19.3</td>
</tr>
<tr>
<td>&gt;20 years</td>
<td>15.7</td>
<td>20.0</td>
</tr>
</tbody>
</table>

**Spending on organic**

Overall, the mean estimated weekly expenditure on organic food (either certified or ‘likely’) was 70.4% ($SD=23.0$) in the OHWS compared with 69.3% ($SD=27.5$) in the OCS and 74.3% ($SD=22.6$) in the OFIS.\(^{187}\) There was a difference in the weekly expenditure depending on the level of consumption as would be expected (Figure 9.2).

![Figure 9.2](image-url)  
*Figure 9.2. The percentage of the weekly food budget spent on organic food (based on level of consumption). A comparison of results from the OHWS (N=340) and the OCS (N=318).*

\(^{187}\) Refer to 8.7.2 Organic Consumption: Spending on organic
9.6.3 Food Categories

As with the OCS\textsuperscript{188} the most popular organic foods were fruit and vegetables and the least popular were meat products (including poultry and fish). Organic grains, eggs and dairy also recorded high uptake amongst respondents (Table 9.4). Fruit vegetables, dairy, eggs and grains were also the most popular organic choices in the Dutch study with consumption exceeding \( >70\% \) in these food categories (van de Vijver & van Vliet, 2012).

9.6.4 Beliefs

\textit{Health Beliefs and Level of Consumption by Food Category}

Beliefs about the health effects of organic food were not consistent across all food categories. Overall higher consumption of various food categories, such as vegetables and fruit, was consistent with respondents reporting that they chose organic versions of these foods because they believe they are better for health (Table 9.4).

A Pearson product-moment correlation coefficient was computed to assess the relationship between beliefs about organic food categories and the amount of the time and the frequency with which they were consumed (Table 9.4). Without exception there was a significant positive correlation \((p<.001)\) between the variables. So beliefs about the health benefits of a particular food category correlated with the amount of the time respondents reported eating organic options and the frequency with which they ate organic options.

The significance of this correlation was maintained regardless of whether weekly consumption or 2-3 times weekly consumption was used. So if respondents identified the organic option of the food category as being better for health then they were likely to consume the organic version most of the time (i.e. \( >65\% \) of the time they ate the food); and eat the organic option at least 2-3 times/ week. If they did not identify health beliefs for that organic food category they were likely to consume the organic version less than 65\% of the time and less often than once per week.

\textsuperscript{188} Refer to 8.7.3 Food Categories
Table 9.4. *Foods Selected for their Organic Status because they are Believed to be Better for Health, and the Amount and Frequency with which Organic Options are Consumed (% of Survey Respondents)*

<table>
<thead>
<tr>
<th>Food category</th>
<th>Belief (^a)</th>
<th>Amount (^b)</th>
<th>Frequency (^c) at least 2-3x/week</th>
<th>Frequency (^c) at least once/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>92.1</td>
<td>86.1*</td>
<td>93.1*</td>
<td>97.4*</td>
</tr>
<tr>
<td>Fruit</td>
<td>90.0</td>
<td>81.1*</td>
<td>93.6*</td>
<td>85.8*</td>
</tr>
<tr>
<td>Eggs</td>
<td>72.1</td>
<td>84.8*</td>
<td>67.0*</td>
<td>85.6*</td>
</tr>
<tr>
<td>Grains</td>
<td>65.2</td>
<td>71.6*</td>
<td>73.2*</td>
<td>84.6*</td>
</tr>
<tr>
<td>Dairy</td>
<td>62.4</td>
<td>72.2*</td>
<td>73.6*</td>
<td>86.2*</td>
</tr>
<tr>
<td>Nuts &amp; seeds</td>
<td>60.3</td>
<td>67.9*</td>
<td>63.1*</td>
<td>78.0*</td>
</tr>
<tr>
<td>Poultry</td>
<td>52.1</td>
<td>60.9*</td>
<td>40.3*</td>
<td>68.5*</td>
</tr>
<tr>
<td>Legumes</td>
<td>48.2</td>
<td>73.2*</td>
<td>42.6*</td>
<td>71.1*</td>
</tr>
<tr>
<td>Red meat</td>
<td>47.6</td>
<td>54.0*</td>
<td>39.3*</td>
<td>68.0*</td>
</tr>
<tr>
<td>Fish/ seafood</td>
<td>25.2</td>
<td>37.7*</td>
<td>19.7*</td>
<td>39.7*</td>
</tr>
</tbody>
</table>

\(^a\) Percentage of respondents who said they selected organic options for the above food categories because they 'believe they are better for health'

\(^b\) Percentage of respondents who reported eating organic options of the food category 'most' (at least 65%) of the time

\(^c\) Percentage of respondents who reported eating organic options of the food categories at least 2-3 times per week, or at least once per week

*Pearson product-moment correlation coefficient is significant at the \(p<.001\) level

As a general rule a Pearson’s correlation coefficient (\(r\)) greater than .3 is considered to be a medium strength positive association. Out of 30 comparisons 87% exceeded this level. The strongest correlation was between health related beliefs and consuming organic meat most of the time \(r(237) = .479, p < .001;\) closely followed by health related beliefs and consuming organic fruit at least weekly \(r(324) = .474, p < .001.\) The weakest correlation, however, was for health related beliefs and the consumption of organic fruit most of the time, \(r(315) = .243, p < .001.\) Similarly the correlation with the amount of organic vegetables was also weaker \(r(318) = .260, p < .001.\)

These weaker correlations may be due to respondents consuming organic fruit and vegetables most of the time due to reasons other than health.
The frequency with which respondents consumed organic versions of meat and poultry (more than 2-3 times/week) were also below the $r=.3$ level although still significant ($p<.001$). However the correlations with consuming organic versions of these products most of the time were both $r>.45$. The likelihood that respondents consume meat and poultry less frequently than 2-3 times per week anyway may have influenced this result and the higher price point may mean that although they mostly consume organic options when they do consume meat, they don't consume it regularly. This is consistent with respondents commenting that they consume less meat since moving to organic foods.¹⁸⁹

The influence of beliefs on consumption patterns may suggest that some sectors of the organic industry are doing a better job than others at promoting the potential health benefits of consuming organic versions of these foods, and this is having a direct effect on uptake. Studies have shown that the provision of information about organic farming systems to consumers increases their liking of and willingness to pay for products such as organic beef (Napolitano, et al., 2010).

The relationship between beliefs in the health benefits of organic food and its consumption is not necessarily a direct one as most people report positive beliefs about organic food but few actively consume it. Similarly, organic consumers' consume some organic food categories more than others. Barriers such as cost and availability also play a role.

Future research may investigate the average premium for these foods categories to see whether the correlation with health beliefs becomes stronger or weaker with decreasing or increasing premiums.

**Beliefs: Process and product attributes influencing health beliefs and purchasing**

In addition to health beliefs about specific categories of organic foods, consumers also hold beliefs about the process and product attributes of organic foods that they believe contribute to the health benefits. Purchasing decisions may be influenced by the desire to avoid negative traits associated with conventional foods or to seek positive traits associated with organic food. When OHWS respondents were asked why they thought organic food was healthier, and what influence that belief had on their decision to consume organic food, they generally rated avoidance of negative traits more highly (Figure 9.3). In other words they believed the health benefits were related to what was not

¹⁸⁹ Refer to 9.6.10 Other Dietary and Lifestyle Changes that may Influence Health; and 11.4.2 Other Factors that may Contribute to Health Benefits for Organic Consumers
in their food, such as pesticides, hormones and veterinary medicines; rather than any nutritional superiority or psychological benefits.

Figure 9.3. Health beliefs influencing purchasing behaviour (N=404).

I have previously said I don’t believe that research evaluating nutritional differences between organic and conventional food is a particularly effective way of assessing the health effects of organic diets. It may also not be a particularly strong motivator for organic consumption which would explain why organic sales are on the increase (Monk, et al., 2012) despite the negative assessment of the highly publicised FSA report regarding the nutritional superiority of organic foods (Dangour, Dodhia, Hayter, Allen, et al., 2009).

Beliefs: What conditions can be prevented by consuming organic diets?

The majority of respondents reported positive beliefs about the ability of organic food consumption to reduce the incidence of certain diseases. Beliefs were particularly strong

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190 Appendix 1. Full page image
191 Refer to 5.3 The Problem with Nutritionism
around prevention of cancer (80.2%), allergic conditions (75.6%) as well as behavioural (74.8%) and developmental problems (71.9%) in children (Figure 9.4).

![Figure 9.4. Beliefs about organic food consumption preventing disease (N=370).](image)

I have previously reviewed some of the known health effects of pesticides as well as the known health effects of organic diets. It would appear that some of the beliefs reported by OHWS respondents are consistent with available literature and I will highlight a few key reports to illustrate this.

The belief that organic food may protect against cancer isn’t surprising given the links between occupational exposure to pesticides and cancer risk reported in the US Agricultural Health Study and that emerging evidence that a number of pesticides are carcinogenic (Alavanja & Bonner, 2012; Weichenthal, et al., 2010). Biomarkers which indicate potential benefits for reducing the incidence or progression of cancer have also been reported to be higher following the consumption of organic compared conventional

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192 Appendix 1. Full page image
193 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
194 Refer to Chapter 4. What Evidence is there that Organic Diets Improve Human Health and Wellness?
produce (Olsson, et al., 2006; Ren, et al., 2001). In addition the 2008-09 President’s Cancer Panel Report recommended choosing ‘food grown without pesticides or chemical fertilisers’ and raised particular concerns for children (Reuben, 2010).

To date the most compelling study on the health benefits of organic food investigated allergies and reported a reduction in infantile eczema (Kummeling, et al., 2008). Another study of anthroposophical children also reported lower incidence of allergic symptoms (Alfvén, et al., 2006) and some pesticides are thought to be immunotoxic which may contribute to the risk of allergies (Corsini, et al., 2012). There have also been recent reports linking higher levels of urinary OP pesticide levels with increased ADHD prevalence (Bouchard, et al., 2010) and poorer intellectual development (Bouchard, et al., 2011) in children. A number of pesticides specifically target the nervous system and studies have also reported poor mental development and pervasive developmental problems in exposed children (Eskenazi, et al., 2008).

In addition studies in animals have demonstrated effects on immune function (M. Huber, et al., 2010), weight control mechanisms and insulin resistance (Lim, et al., 2009).

Liver disease had the lowest number of respondents reporting prevention beliefs (51.3%) and to date there hasn’t really been any research to explore this. This is interesting given that the majority of respondents reported that avoiding chemicals such as pesticides influenced their decision to consume organic. The liver plays a vital role in metabolising these chemicals and it is a common belief amongst naturopaths that exposure to environmental toxicants can cause ‘encumbrance of the liver’. However this is often seen as a cause of ill health but not necessarily the end result. In other words liver encumbrance is thought to contribute to a variety of conditions including allergies and fatigue but this is not necessarily expected to result in actual liver disease.

It is interesting that the most highly ranked perceptions about the preventative health effects of organic diets are a reflection of the available evidence for organic diets and pesticide health effects. Given that these were not conditions they claimed to have personally experienced themselves, this suggests that the respondents, who are generally well educated, are either directly or indirectly aware of this research, albeit limited.

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195 Refer to 4.8 Functional Biomarkers in Humans
196 This will be discussed further in 9.6.6 Health and Wellness Effects Reported by Respondents: Possibilities for future research
As many of these conditions may have an epigenetic component, or take decades to evolve, it would be extremely difficult to design trials to assess the role of organic diets as a preventative strategy. For this reason the OHWS was more interested in exploring the sorts of short-term effects experienced by respondents.

9.6.5 Self Reported Measures of Wellness

Previously I have described concepts of health and wellness and have used the term ‘health’ generically to describe all that falls under that umbrella. However, at this point it is useful to differentiate between specific health conditions and the broader understanding of wellness. Later I will come back to the specific health conditions that respondents reported as having been influenced by their move to an organic diet. Firstly however we will look at a more subjective experience of wellness.

The OHWS looked at self-reported wellness, and changes in wellness in a number of ways. We asked respondents to complete the short version of the PWI-A to compare their responses with the general Australian population. As we were interested in the contribution that an organic diet may have had to this we included a broad question asking respondents how they thought their health had changed since moving to an organic diet. This was further explored by asking respondents to rate their overall sense of wellness on a scale from minus five (-5) to plus five (+5) both before and since moving to organic food. We then explored specific effects to see if there were any that were commonly reported and may warrant investigation in future research.

**Personal Wellbeing Index (PWI-A)**

The PWI-A was included in the OHWS survey as a means of assessing respondent’s subjective wellbeing and comparing this with the general population.

Data sets from individual respondents who consistently reported perfect 10 scores in all domains were removed prior to analysis, and scores were converted to the 100 point scale, as recommended in the PWI manual (International Wellbeing Group [IWG], 2006). Based on the most recent PWI-A survey (27.0) the mean for the PWI in the Australian population is 75.4 points (standardised on a 0-100 scale) (Cummins, et al., 2012). The mean PWI-A score for the OHWS cohort was 77.5 (SD 12.8; 95% CI [76.2, 78.8]) (Figure 9.5). This is above the upper end of the Australian adult normative range (73.7 - 76.7 points) which has been calculated using data collected from over 60,000 representative adults who completed the PWI-A over the years 2001-2012.
Figure 9.5. Boxplot representing the range of responses to the PWI-A from OHWS respondents (N=373).

Differences in the means were particularly apparent in the domains of community connectedness (4.83 points higher in the OHWS respondents), achieving in life (4.46) and health (4.22) (Figure 9.6).

Figure 9.6. Comparison between OHWS respondents (N=373) and Australian averages for the different domains of the PWI-A.¹⁹⁷

¹⁹⁷ Appendix 1. Full page image
The role of community connectedness was reflected in the following respondent’s comment:

“I feel connected to where my food comes from. I love to take organic food as gifts and I enjoy buying it to serve to friends. I also feel buying organic is an investment in all futures… I feel positive and empowered. I also feel part of a community a movement … That must be healthy …”

Interestingly ‘spiritual fulfilment’ was the only domain where the OHWS respondents scored lower than Australian averages. This may be because spirituality and religiosity are sometimes confused.

**Perceived change in wellness**

Overall 75.7% of OHWS respondents said they perceived their overall health to be a little or a lot better since moving to organic food (Table 9.5). Similarly in the Dutch study 70.1% of the respondents reported an ‘improvement in general health’ (van de Vijver & van Vliet, 2012). The move to organic food was perceived to have had a moderate or strong influence on these health changes in 77.9% of OHWS respondents.

<table>
<thead>
<tr>
<th>“Since moving to (more) organic food I have noticed that my overall health is…”</th>
<th>% of survey respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>a lot worse.”</td>
<td>0.8</td>
</tr>
<tr>
<td>a little worse.”</td>
<td>0.5</td>
</tr>
<tr>
<td>about the same (I haven't noticed any changes, either positive or negative).”</td>
<td>18.5</td>
</tr>
<tr>
<td>about the same (some symptoms have improved and some have worsened).”</td>
<td>4.4</td>
</tr>
<tr>
<td>a little better.”</td>
<td>35.2</td>
</tr>
<tr>
<td>a lot better.”</td>
<td>40.5</td>
</tr>
</tbody>
</table>

This perception was further explored by asking respondents to rate their overall sense of wellness before and since moving to organic food. Responses were recorded on a scale where -5 represented ‘extreme or disabling illness’, zero (0) was neutral (i.e. the absence of illness but without a sense of ‘wellness’), and +5 was an ‘extreme sense of wellness’ (Figure 9.7).
Figure 9.7. Boxplot of wellness ratings, before and after moving to an organic diet (N=345).

A paired samples t-test was conducted using the after-before self-reported ratings. Of the 318 respondents who completed this section there was a statistically significant difference between their reported sense of wellness prior to and since moving to organic food, $t(317) = 17.54, p<.001$ (Table 9.6).

Table 9.6. Self-reported Wellness Rating Prior to and Post Moving to Organic Food Consumption

<table>
<thead>
<tr>
<th>Wellness rating (Before)</th>
<th>Wellness Rating (After)</th>
<th>Difference (After minus Before)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>5.22</td>
<td>2.297</td>
<td>7.68</td>
</tr>
</tbody>
</table>

9.6.6 Health and Wellness Effects Reported by Respondents

One of the main objectives of the OHWS was to identify areas that may be suitable for future research. The focus here was on the more everyday indicators of wellness rather than diagnosed pathologies.

The benefits most commonly reported by respondents were improvements in: resistance to and recovery from illness (71.1%) and physical energy (61.1%) (Figure 9.8).
In the Dutch study an improvement in general health (70.1%) including improved ‘general resistance’ (25.7%) and feeling ‘more energetic’ (38.3%) were also the most commonly reported effects in those who reported improvements after moving to organic food.

A finding which surprised the Dutch researchers was that 18.6% of respondents mentioned ‘better skin, hair and nail condition’ (van de Vijver & van Vliet, 2012). Improved condition of skin/ hair/ nails was also reported by 58.4% of the OHWS respondents. Another area that may be worthy of further inquiry was the effect on satiety (55.4%) and weight (43.4%).

While the Dutch study asked open questions about improvements in health, this section of the OHWS included closed questions with largely pre-specified categories. These categories were included because they were commonly reported by respondents in the OCS and the Dutch study. However the use of closed questions may have resulted in an...
over-representation of effect. Nevertheless reported benefits were generally consistent between the Australian and Dutch respondents (Table 9.7). In addition many of the categories had been mentioned by respondents in comments boxes prior to the occurrence of this question in the survey. They were also reiterated and expanded on later when respondents were given the opportunity to answer more open questions.

Table 9.7. Reported Improvement for those Similar Health Categories in the Dutch Study.

<table>
<thead>
<tr>
<th>Category</th>
<th>% of total respondents (N = 566)</th>
<th>% of those who noticed an effect (n = 397)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better general health</td>
<td>49.6</td>
<td>70.1</td>
</tr>
<tr>
<td>More energetic</td>
<td>26.9</td>
<td>38.3</td>
</tr>
<tr>
<td>Positive effect on mental well-being</td>
<td>21.6</td>
<td>30.0</td>
</tr>
<tr>
<td>Improved general resistance</td>
<td>18.0</td>
<td>25.7</td>
</tr>
<tr>
<td>Improved condition of skin, hair and/or nails</td>
<td>13.1</td>
<td>18.6</td>
</tr>
<tr>
<td>Improved satiety</td>
<td>9.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Concentration</td>
<td>6.7</td>
<td>9.6</td>
</tr>
<tr>
<td>Weight loss</td>
<td>4.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Improved sleep</td>
<td>1.2</td>
<td>1.7</td>
</tr>
</tbody>
</table>

In the Polish study insufficient data was reported to compare these results directly but in comparison to the conventional consumers the organic consumers reported more rarely contracting infectious diseases or experiencing headache; fewer problems with the digestive, circulatory and integumentary (skin) system; fewer hospitalisations and cancers (Rembialkowska, et al., 2008). In the German nun study after four weeks on the biodynamic (organic) intervention, the nuns reported better health including improved concentration; fewer headaches and migraines; lower blood pressure; improved appetite, sleep, stress resistance and immunity (fewer T-helper cells, more natural killer cells) (K. Huber, 2005, cited in Rembialkowska, et al., 2008).

**Possibilities for future research**

Several of the above findings provide a useful inventory of wellness outcomes that may warrant future research. Many of the outcomes reported may be due to nutritional
differences, or reduced toxins, between organic and conventional diets that may result in more optimal nutrition at a tissue level in organic consumers.

This is not simply down to any subtle differences at a product level, but may also result from the likelihood that organic consumers may eat more nutrient dense foods such as fruit and vegetables, or experience less demand for nutrients required for the metabolism of chemicals. So the net effect may be improved nutritional status and this may have an impact on the wellness outcomes reported in the OHWS.

The role of exposure to pesticides, food additives and other chemical inputs in conventional food might also be worthy of further investigation, particularly with regard to effects on the nervous system. This may be of particular interest for exploring differences in cognition, mood and behaviour.

Organic consumers may also be inclined to engage in additional health-promoting activities such as exercise and stress reduction techniques or enjoy psychological benefits from their food choices that may contribute to some of the reported effects.

Several outcomes have additional preliminary evidence supporting a biological rationale for these effects, for example resistance to/ recovery from illness, and weight control, and warrant future research.

*Resistance to/ recovery from illness*

The OHWS and the European studies suggest that organic consumers report lower rates of infection and improved recovery times as a result of consuming an organic diet. While such self-reports do not provide conclusive evidence of an effect there is preliminary data from experimental studies that indicate a biological rationale for these reports.

Although a great deal more research is required in this area, concerns have been raised regarding the potentially toxic effects of pesticides on the immune system (Corsini, et al., 2012), with animal feeding experiments confirming differences in immune function after the consumption of organic and conventional feed (Finamore, et al., 2004; M. Huber, et

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200 Refer to 5.2.2 Product: Nutritional Differences between Organic and Conventional Produce
201 This will be discussed in more detail in 11.4.1 Response to Concerns that the Additional Expense of Organic Food will Negatively Impact Food Behaviours
202 Refer to 5.1 Why Might Organic Diets Improve Health and Wellness?
203 These will be discussed shortly under 9.6.10 Other Dietary and Lifestyle Changes that may Influence Health; and 9.6.9 Psychological Effects of Organic Diets
Immunotoxic effects are believed to be the result of mutations in genes which code for immunoregulatory factors, resulting in changes in immune tolerance and activation pathways (Corsini, et al., 2012). Concerns have also been raised regarding other immunological effects such as hypersensitivity reactions, certain autoimmune diseases and cancers (Corsini, et al., 2012).

The immune system also requires a number of nutrients to function effectively so suboptimal nutrition may impair this function increasing the incidence and severity of infection. Studies could potentially be designed drawing on methodologies used in trials investigating the role of nutritional supplements or other therapies in reducing the incidence and severity of infections.

**Weight management**

There may be justification for future research into the role of organic diets for assisting with weight control. Respondents in the OCS and OHWS had substantially lower rates of overweight and obesity than Australian norms although this may have been due to factors other than organic diets. An Italian study reported a reduction in fat mass after 14 days on an organic Mediterranean diet (De Lorenzo, et al., 2010), and respondents in both the OHWS and Dutch study (van de Vijver & van Vliet, 2012) reported improved satiety.

This improved satiety may be the result of subtle differences in the levels or bioavailability of nutrients or phytonutrients, and studies have indicated that organic food has less fluid and more dry matter (Lairon, 2010; Rembialkowska, 2007), so on a plate the same amount of food may have a greater concentration of nutrients and be more satisfying, and thus reduce caloric intake. In the German nun study total daily energy intake was lower in the biodynamic phase, as was protein intake from animal produce but not from plant products and there was a higher intake of dietary fibre which also contributes to satiety (K. Huber, 2005, cited in Meier-Ploeger, 2005).

Paula Baillie-Hamilton (Baillie-Hamilton, 2002) has proposed a number of mechanisms explaining how exposure to chemicals (including pesticides) may affect the body’s natural weight-control mechanisms (hormones and neurotransmitters) and interfere with metabolic processes resulting in changes in appetite, food efficiency, and macronutrient

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204 Refer to 4.9 Animal Studies
205 Refer to OCS and OHWS results in 8.7.1 Socio-demographic Characteristics of Respondents: Body Mass Index (BMI); and 9.6.1 Socio-demographic Characteristics of Respondents: Body Mass Index (BMI)
metabolism. Another possible mechanism may be the use of antibiotics and growth promoters in animal production for the purpose of increasing weight.\(^\text{206}\)

There is a commonly held belief amongst naturopaths that when the liver is overburdened with the responsibility of detoxifying chemicals the body will utilise adipose (fatty) tissue as a safe method of storage. This prevents the toxicants from circulating around the body (where they may cause damage to organs or systems), until the body is ready to deal with them. It is believed that while the liver remains burdened with incoming toxicants the body is reluctant to breakdown fatty tissue making weight loss difficult. The increased exposure to environmental toxicants, including pesticides and other chemicals and pharmaceutical products used in conventional agriculture, is therefore considered to compromise weight regulation.

There is some research to support these beliefs. Body fat may be a physiological attempt to protect more sensitive target tissues by acting as a reservoir for fat soluble toxicants (Geyer, et al., 1993); and certainly older classes of pesticides (such as organochlorines) are known to accumulate in adipose tissue (Stellman, et al., 1998). It has been speculated that ‘greater fat stores may increase the body's capacity to accumulate lipophilic contaminants (those with an affinity for binding to or dissolving in fat)’ (Schildkraut, et al., 1999) and even the newer classes of pesticides contain lipophilic components.

In the large multi-country PARSIFAL study, children representing the anthroposophic lifestyle (which includes the consumption of organic and biodynamic food) had a non-significant lower bodyweight compared with reference children (Alfvén, et al., 2006). Studies have also shown that chickens fed conventional feed experience higher weight gain over their lifespan than those on a comparable organic diet (M. Huber, et al., 2010). Animal studies have also revealed that chronic administration of the herbicide atrazine may contribute to the development of insulin resistance, decrease basal metabolic rate and increase body weight and intra-abdominal fat stores by disrupting mitochondrial function and suppressing the insulin-mediated phosphorylation of Akt. This occurred without changing food intake or physical activity level, although a high-fat diet did further exacerbate insulin resistance and obesity (Lim, et al., 2009). This is further supported by data from the Centre for Disease Control (CDC) in the US showing an apparent overlap between areas of heavy atrazine use and the prevalence obesity (BMI > 30) (Mokdad, et al., 2001).

\(^{206}\) Refer to 2.3.2 Veterinary Medicines; and 2.3.3 Hormones and Growth Promotants
9.6.7 Reported Reactions to Conventional Foods

The avoidance of negative traits has been previously reported to drive behaviour. In order to better understand this, the OHWS asked participants if they believed that they (or their child) had experienced symptoms as a result of consuming conventional food.

A total of 243 respondents reported having experienced conditions that they believed were associated with consuming conventional food. Amongst these respondents 29% reported one condition but the mean number of reported conditions was 2.8. These included gastrointestinal (56.8%) skin (49.0%) and respiratory (32.5%) reactions (Figure 9.9). ‘Other conditions’ included: headache, migraine, insomnia, fatigue, lowered mood and poor concentration.

While some of the reported reactions may be explained by other factors, such as coffee causing insomnia, MSG causing headaches, additives causing hyperactivity in a child; this data suggests that one of the factors that motivated respondents to continue with an organic diet is a belief they had experienced a reaction to conventional food.


9.6.8 Changes in Ongoing Health Conditions after moving to Organic Foods

In addition to closed questions discussed above, open questions were also asked, such as:

‘Have you (or your child/children under 18 years) experienced any ongoing* health problems that you believe have changed as a result of moving to (more) organic food?  
* You do not need to report on occasional symptoms or symptoms which you believe are related to factors other than diet.’

Of the 370 respondents who responded to this question, 89 (24.1%) reported that they had noticed changes in their own (73.8%) or their child's health (26.2%) since moving to organic food. Of these 30.6% reported more than one noticeable change. Open questions were included to allow respondents to discuss the conditions and changes they had noticed at length. Again conditions within the gastrointestinal and integumentary (skin) systems were the most commonly discussed. There were a number of reports within various systems that may be considered ‘allergic’ or ‘autoimmune’ so the immune system was also highly featured.

The vast majority said the symptoms were a little (22.6%) or a lot (71.4%) better after moving to organic food. Most (80%) of the respondents reported that the symptoms had been occurring for at least 12 months prior to moving to organic food. Only 6.8% reported changes within a few days but 34.2% reported that they noticed changes within a month of moving to organic food.

Symptoms had been discussed with a doctor, specialist or other health professional in 79.7% of cases and improvements were confirmed by these health practitioners in 48.7% of cases. A further 48.7% reported that their symptoms had improved so they didn’t bother discussing them with the health practitioner again.

When asked if they thought that organic food might have a positive effect on their symptoms prior to moving to an organic diet, 69.2% responded that they were. This is similar to the Dutch study in which 65% responded affirmatively to a similar question (van de Vijver & van Vliet, 2012).

Respondents were also asked to describe other changes (if any) that they had noticed since moving to an organic diet. This provided an opportunity for respondents to discuss
issues that they might not have considered to be ‘ongoing health problems’ that were active prior to moving to an organic diet. A total of 191 respondents responded to this question citing everything from additional serious medical conditions to improvements in everyday health indicators. There was substantial crossover with some of the indicators that were previously discussed\textsuperscript{207} in particular resistance to infection, fatigue (both physical and mental) and weight control. Respondents also took this opportunity to discuss broader indicators of wellness such as connection to community, sensory attributes relating to the enjoyment of eating and psychological benefits.

9.6.9 Psychological Effects of Organic Diets

The focus of the OHWS was on health related beliefs, however a number of respondents made a point of commenting that this was only one of the reasons they purchased organic food, for example:

\begin{quote}
“Only part of the reason I buy organic is health, I also do it for environmental, social responsibility and ethical reasons.”
\end{quote}

Although psychological benefits rated quite low when respondents were asked what influenced their decision to consume organic food, there may have been some confusion about what this question was asking. There is a psychological benefit associated with making purchasing decisions that you believe generate the characteristics you value. For instance a consumer may believe that by purchasing organic foods which they perceive to have reduced contaminants and superior nutritional value, they are purchasing ‘good health’ (Grossman, 1972). Similarly by purchasing produce that they perceive to have a reduced impact on the environment, they are investing in the long term future and health of the planet and its inhabitants (Williams & Hammitt, 2000). This is likely to generate a ‘feel good’ factor that may indirectly have a positive effect on health and wellness.

This factor was noted in the Dutch study. Thirty per cent reported that eating organic food had a beneficial effect on mental wellbeing. The authors put this down to: a sense of ‘doing good for the world’; and the benefits derived from choosing products that are produced with the environment and animal well-being in mind (van de Vijver & van Vliet, 2012). This ‘feel good’ factor was also reflected by a number of OHWS respondents in various ways, and with different emphasis on what made them feel good, for instance:

\begin{quote}
“Being someone who loves food, eating food that tastes real has made a huge difference in our enjoyment of the meals we prepare, as well as easing our social
\end{quote}

\textsuperscript{207} Refer to 9.6.5 Self Reported Measures of Wellness: Perceived change in wellness
conscious as we’re doing our bit for the earth, as well as making us feel better about ourselves”

A number of respondents acknowledged that this feel good factor may have influenced the perceived improvement in their wellness, for instance:

“How much of this is a placebo affect I could not say, but there is something psychologically benefiting from eating organic and feeling good about that, and this seems to transfer to physical wellbeing.”

While these are not objective markers, wellness is largely subjective and respondent’s experiences should not be discounted.208

9.6.10 Other Dietary and Lifestyle Changes that may Influence Health

In addition to psychological factors there may be other explanations for why respondents perceived that their wellness improved after moving to an organic diet.

In the Polish study the nutritional patterns of the organic consumers were determined to be more in line with the recommendations of nutritionists, for instance: eating more regular meals (including breakfast) and generally eating more frequently, less fast food, drinking more fluids and paying more attention to the presence and quantity of synthetic substances in the diet. The organic consumers also reported exercising more and including stress management techniques (Rembialkowska, et al., 2008). From the limited data available from the German nun study it would appear that the overall nutrient levels and fat intake were similar during each phase, daily energy intake was lower in the biodynamic phase, as was protein intake from animal produce but not from plant products and there was a higher intake of dietary fibre (K. Huber, 2005, cited in Meier-Ploeger, 2005).

A number of OHWS respondents commented that it is whole diet that is important not just whether it is organic. For instance:

“it’s not just organic food; it’s the type of food. Certain foods, whether organic or not, make you feel bad.”

Amongst respondents, 62.5% reported that they had also made other dietary or lifestyle changes around the time they started eating (more) organic food or that other factors had

208 This will be discussed in more detail in the final discussion. Refer to 11.4.3 Psychological Benefits Associated with Organic Diets
occurred that may have had an impact on their health. Examples of these additional changes were reflected in some of the following comments:

“More wholefoods, less processed foods.”
“Eating more fresh, locally produced food.”
“Consume less red meat.” or “Became vegetarian.”
“Exercised more. I think eating really fresh organic food made me want to get fitter as well.”
“Meditation” and “Yoga”
“Reduced chemical use in the household and in personal care products.”

This was also the case in the Dutch study where respondents reported that the shift to organic food coincided with eating less meat and more freshly prepared foods (van de Vijver & van Vliet, 2012). The study also noted that organic product ranges differ with less availability of pre- pared and snack foods and this is likely to have an influence on food choices.

9.7 Limitations

The results of this survey come from a self-selected sample of self proclaimed dedicated organic consumers and will not necessarily be representative of all organic consumers. Respondents were motivated to participate because they had a story to tell. This was reflected in the large number of comments that were received throughout the survey as well as the personal communications I received outside the survey. Nevertheless the results from the socio-demographic and consumption sections of the survey were highly consistent with those from the OCS and the Dutch study, and health reports were also similar between the OHWS and the Dutch study.

The subjective and retrospective nature of the survey along with a lack of objective markers and health outcomes means that it is not possible to conclude that organic diets have the beneficial effects reported by respondents.

It is acknowledged that many other factors influence health. Some of these may occur in conjunction with, or as an indirect result of, adopting an organic diet, such as eating a healthier diet in general, engaging in other health promoting activities, or having a more positive outlook. However, I believe that it is important not to reduce the health and wellness effects of an organic diet down to its product attributes alone.
9.8 Application

While a study of this nature cannot prove causation, some of the more common benefits reported such as improved resistance to and recovery from illness, and improved sense of satiety after eating, have biological rationales and objective markers that could be utilised for further exploration in controlled clinical trials. The fact that there were similar findings in these geographically opposed countries suggests directions for future investigation.

9.9 Conclusion

The OHWS results support the hypothesis that ‘Organic consumers believe that consuming an organic diet is beneficial for health’. Many respondents were driven more by risk aversion (especially to pesticides) than nutritional superiority. Higher consumption of various food categories, such as vegetables and fruit, was consistent with respondents reporting that they chose organic versions of these foods because they believe they are better for health.

The OHWS respondents scored well on the PWI-A and reported significant improvements in their overall sense of wellness since moving to an organic diet. The benefits most commonly reported by respondents included improvements in resistance to and recovery from illness, physical energy, condition of skin/ hair/ nails, mental alertness, mood stability, and sense of satiety. Many of the reports were similar to those from respondents to European studies.

Many respondents reported that they had made other dietary or lifestyle changes around the time they moved to an organic diet or that other factors had occurred that may have had an impact on their health.

Respondents held strong around beliefs around the ability of organic diets to prevent a range of conditions including cancer, allergic conditions, and behavioural and developmental problems in children. These beliefs reflect the available evidence for organic diets and pesticide health effects, suggesting that respondents are aware of and influenced by the available evidence. Future research may benefit from a focus on some of the more commonly reported everyday wellness effects such as resistance to and recovery from illness/ infection and weight management.
Chapter 10. Biomonitoring Trial (BMT)

10.1 Abstract
Organophosphate pesticides are widely used in food production and have been associated with negative effects on human health. Organic food sales are increasing as consumers believe it to be healthier than conventionally grown food because it generally contains no pesticide residues. While studies in children suggest organic diets reduce pesticide exposure, children are more highly exposed to pesticides because of their body weight and less efficient metabolism. A prospective, crossover study was conducted to assess organophosphate exposure in a group of thirteen Australian adults. Participants consumed a largely organic diet for a 7-day period which was compared to 7 days on a largely conventional diet. Participants kept food diaries and were asked to ensure that a minimum of 80% of their food servings were organic or conventional during each phase. Urinary levels of six dialkylphosphate metabolites were analysed in first-morning voids collected on day 8 of each phase using GC-MS/MS. Limits of detection were 0.11-0.51 μg/L and results were creatinine corrected to account for the effects of urine dilution or concentration in spot samples. As the distributions of the metabolite levels were not normal, the non-parametric Wilcoxon matched pairs signed-ranks test was used for paired samples to determine whether there were significant differences between phases. The
mean total DAP results in the organic phase were 89% lower than in the conventional phase ($M=0.032$ and 0.294 respectively, $p=.013$). For total dimethyl DAPs there was a 96% reduction ($M=0.011$ and 0.252 respectively, $p=.005$). Although the mean total diethyl DAP levels in the organic phase were half that of the conventional phase ($M=0.021$ and 0.042 respectively), the difference was not statistically significant. The most frequently detected metabolites were DMTP and DEP in the conventional phase and DEP in the organic phase. Overall the consumption of organic food resulted in a statistically significant reduction in urinary dimethyl DAPs indicating reduced exposure to organophosphate pesticides. Large scale studies are now required to confirm this result.

10.2 Background

Organic sales are on the increase (Monk, et al., 2012) with consumers believing that organic food is healthier than conventionally grown food because it contains fewer pesticide residues (Oates, et al., 2012). Organophosphate pesticides (OP) are of particular concern because of their prevalence of use, high detection rates in the general population (Babina, et al., 2012; Barr, et al., 2004), and associations with negative effects on human health even at low doses (Bouchard, et al., 2010; Bouchard, et al., 2011; Ross, et al., 2013).

Studies demonstrating clear harm as a result of dietary pesticide exposure are lacking as are studies investigating the ability of organic diets to mitigate such harm. To date a number of studies have demonstrated reduced pesticide metabolite residues in the urine of children eating mostly organic diets but no studies have been published on adults or in Australian populations. Therefore a prospective, randomised, crossover study, was conducted entitled 'Intrapersonal variation in pesticide residues in response to an organic diet: a biomonitoring trial' (BMT), in an attempt to begin filling in some of the gaps.

10.3 Aims

- To determine whether consumption of a mostly organic diet for 7 days would reduce urinary DAP metabolites (markers of OP pesticide exposure) in Australian adults
- To determine whether commercially available tests are sufficiently sensitive to detect urinary DAP metabolites resulting from dietary exposure

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209 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?: Risk to consumers
210 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
• To test the OFIS as a method of quantifying the amount of organic food consumed, both overall and within selected food categories

_A priori:_

• The mean level of all participants individual DAPs, total DAPs, total ethyl and total methyl DAPs will be compared across phase one and two and statistically analysed to determine whether differences are significant

• If all test results fall below the limits of quantification (LOQ) for any specific metabolite it will be deemed that the available laboratory tests are not sensitive enough to detect urinary levels of that metabolite arising from dietary exposure, or that the metabolite is absent from Australian consumers

• In the organic phase participants are required to consume a minimum of 80% of their food servings from organic produce and in the conventional phase must consume a minimum of 80% food of their food servings from conventional produce. Participants will be excluded from the group analysis if their OFIS surveys reveal that they have not met this requirement.

### 10.4 Design / Methods for the BMT

**Summary**

Following ethics approval from RMIT University’s Human Research Ethics Committee prospective participants were screened by telephone to confirm their eligibility for the study. Fifteen volunteers, who met the inclusion criteria were invited to participate in the study and upon enrolment, were randomly assigned to either a largely organic or conventional diet for 7 days. They were asked to complete a food intake survey (OFIS) during each period, and on day 8, provide a first morning urine sample and complete the CEFBeS. After day 8 participants were then crossed over and directed to undertake the alternate diet for a 7-day period, and upon completion provide a second urine sample and again complete the online CEFBeS. Prior to commencement, all participants were provided with copies of necessary documents and equipment including clear written instructions on how to complete documents and collect urine samples. All documents and specimen containers were coded to protect the participants’ identity and to blind laboratory technicians to the phase of the study.
10.4.1 Design

A prospective, randomised, single-blinded, cross-over study was employed. Block randomisation, with randomly selected block sizes of 4, was conducted using StatsDirect Statistical Software (https://statsdirect.com), to determine the order that participants would undertake the organic and conventional phases of the study. Laboratory technicians were blinded to subjects’ diet but double blinding was not possible as participants knew which diet they were eating. The study was approved by the RMIT University Human Research Ethics Committee.

10.4.2 Population

Prospective participants were notified about the study using a variety of electronic sources. A study website provided information to prospective participants about the purpose and conduct of the study, links to the Project Information Statement and registration to a mailing list to receive research updates. Prospective participants, including those who had previously expressed interest in the study by joining the mailing list, were directed to the website by way of direct email. Participants in the earlier OCS and OHWS surveys were recruited through flyers available at retail outlets and notices posted on websites that sell or promote organic produce. Ultimately, a mailing list was generated that contained contact details of potential volunteers that had been previously recruited via these sources.

The researcher sent personal emails to relevant contacts, such as organic industry groups, and invited them to pass study information onto others in an attempt to recruit further participants. Social media, including Facebook and Twitter, were also used to direct potential participants to the website and a media release circulated.

Interested parties were asked to contact the researcher by email or phone to discuss the study. Once the prospective participant had the opportunity to have all of their questions answered and read the ‘Project Information Statement’ screening was conducted to confirm eligibility.

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211 Although the order of the diets was randomly allocated, in practice a number of participants ignored this and completed the phases in the order that best suited them. In several cases these were participants from the same household who participated concurrently in the study making it impractical to complete different phases at the same time. However as participants were aware of which phase of the study they were completing this is unlikely to have introduced additional bias.

212 Appendix 5. Ethics approval BMT

213 Appendix 5. Website content BMT <www.rmit.edu.au/wellness/organicresearch>

214 Appendix 5. Project Information Statement and Consent Form
Participants were non-smoking, adults, who sourced their own food from a variety of locations including supermarkets, farmer’s markets and local grocers, and were asked to maintain their usual dietary choices. This provided the study with greater external validity and relevance to the general community and allowed the study to be conducted within the limited resources available.

10.4.3 Screening and Exclusion / Inclusion Criteria

**Screening**

Prospective participants were screened by telephone interview using a screening questionnaire. The researcher obtained verbal consent, screened prospective volunteers, entered the data into the restricted access website database (Survey Monkey®), and oriented each participant. The screening process served several purposes, it ensured volunteers met eligibility criteria, and enabled confirmation of their English literacy and likely ability to complete the study. It also created the basis for a good working relationship between the researcher and the participant which is considered important for improving retention rates (Moloney, et al., 2009).

**Exclusion / Inclusion Criteria**

Exclusion criteria were chosen to reduce the effect of suspected confounders (egg non-dietary pesticide exposure, smoking, medications, diseases, pregnancy), increase the likelihood of adequate study completion, and allow good external validity and relevance to the broader population (Table 10.1).

Exclusion criteria were:
- A high possibility of exposure to non-dietary sources of OP pesticides during the study period. This included those living in rural areas, although semi-rural areas were allowed if there was no nearby agriculture.
- A high possibility of exposure to a range of residential pesticides including those used for building fumigation, home garden use and pest control around the home.
- Use of tobacco products. These have been shown to positively correlate with urinary pesticide levels (Riederer, et al., 2008). Regular smokers were excluded and social smokers were asked to abstain during the study period.
- Those with medical conditions or taking medications that may interfere with the absorption, metabolism or elimination of pesticides.

Appendix 5. BMT Screening Questionnaire
Refer to 6.4.7 Considerations for Eligibility Criteria
- Aged under 18 or over 65. Under 18 year olds were not able to provide informed consent and over 65 year olds were excluded due to differences in detoxification ability with increasing age.
- Women who were pregnant or lactating. The expression of enzymes that detoxify pesticides may be down regulated during pregnancy (Fortin, et al., 2012). There was a potential for psychological distress if abnormal results were identified in pregnant or lactating women.
- Being highly dependent on medical care or suffering obvious cognitive impairment, intellectual disability or mental illness that would prevent them from being able to adhere to the dietary and other instructions or to complete the required documentation.

Inclusion criteria were:
- Self-reported intake of 35-90% organic food. During the study participants were required to consume a largely organic diet and prospective participants whose usual diet contained limited amounts of organic food were considered unlikely to be familiar enough with procuring organic foods to undertake this.
- Able and willing to complete the study and the documentation required. Participants were required to have sufficient computer and English language skills to read and understand detailed written instructions and be able to complete the necessary documents and online surveys. This was assessed during the telephone screening questionnaire but it cannot be completely guaranteed that such participants were not enrolled.

Table 10.1. Exclusion and Inclusion Criteria Checklist

<table>
<thead>
<tr>
<th></th>
<th>Exclusion</th>
<th>Inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td>Rural or semi-rural with risk of agricultural exposure</td>
<td>Inner-urban, suburban, semi-rural without nearby agriculture</td>
</tr>
<tr>
<td>Non-dietary pesticide exposure (known)</td>
<td>High possibility</td>
<td></td>
</tr>
<tr>
<td>Smoking behaviour</td>
<td>Smokers</td>
<td>Social smokers asked to abstain</td>
</tr>
</tbody>
</table>

As clear evidence for such influences is generally lacking, for the most part medical conditions and medications were simply recorded in the CEFBeS for later exploration if required.
<table>
<thead>
<tr>
<th>Medical status</th>
<th>Diseases that may potentially affect pesticide metabolism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication use</td>
<td>Medications that may affect pesticide metabolism</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;18, &gt;65</td>
</tr>
<tr>
<td>Critical developmental periods</td>
<td>4 months planned pre-conception (male and female), pregnancy, lactation</td>
</tr>
<tr>
<td>Diet</td>
<td>&lt;35% or &gt;90% organic</td>
</tr>
<tr>
<td>English and computer literacy</td>
<td>Low</td>
</tr>
</tbody>
</table>

Following confirmation of eligibility, participants were asked to sign and return a consent form and were allocated a participant code. This code was used on urine samples and surveys to provide anonymity for the participant and to blind laboratory technicians to the origin of the samples.

### 10.4.4 Conduct of BMT

![Figure 10.2. Design of biomonitoring trial.](image)

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218 Appendix 1. Full page image
**Pre-study**

Following screening, randomisation and providing informed consent, participants received electronic copies of the ‘Letter to participants’\(^{219}\) explaining the conduct of the study as well as required documents to complete the OFIS.\(^{220}\) They were then asked to complete the ‘CEFBeS (Baseline)’\(^{221}\) online via Survey Monkey\(^{\circ}\).

Participants were provided with all of the necessary equipment\(^{222}\) and written instructions required for the collection, storage and transportation of urine samples.\(^{223}\) The primary researcher was available to answer any questions.

**During the study**

During the study period participants undertook either a largely conventional diet or a largely organic diet each for a 7-day period. Participants were asked to consume as close to 100% conventional or organic food as possible during each of the study phases. During this period they were asked to record their food intake in the OFIS.

On the morning of day 8, participants provided a 200mL urine sample that was transported by the researcher to the Tullamarine branch of AsureQuality Laboratory where it was stored at -20°C before being transported to the Wellington (NZ) laboratory. The samples remained stored at -20°C until they were ready to be analysed for the six DAP metabolites.

Following urine collection, participants were asked to submit their OFIS surveys via email or in hard copy, the details were checked by the researcher (a qualified nutritionist) and participants were contacted to resolve any queries. The study protocol required participants to consume a minimum of 80% of their diet as conventional or organic, depending on the phase. This was based on the percentage of servings recorded in the OFIS. All urine samples were sent for urinalysis but only those meeting the inclusion criteria were used in the group analysis.

On the morning of day 8, participants were asked to complete the CEFBeS,\(^{224}\) which allowed for later exploration of potential confounders if anything unexpected arose in the

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\(^{219}\) Appendix 5. BMT Letter to participants

\(^{220}\) Appendix 3. OFIS Worksheet (Example), OFIS Instructions for Use

\(^{221}\) Appendix 5. CEFBeS (Baseline)

\(^{222}\) Appendix 5. Equipment

\(^{223}\) Appendix 5. Instructions for urine collection and transport

\(^{224}\) Appendix 5. CEFBeS (Organic Phase), CEFBeS (Conventional Phase)
results. The participants were then requested to consume the alternate diet and repeated the process. A washout period was not required of participants however participants were permitted to take a break between the study phases if they desired, and ten participants took this option.

**At the end of the study**

At the completion of the study, individual test results were provided to participants. The results were accompanied by a cover letter explaining the results in lay terms and giving a clinical perspective.\(^{225}\)

**10.4.5 Documentation**

*Food intake survey (OFIS).*

The OFIS was used as a means of confirming that participants were meeting the dietary intake requirements for each phase and that dietary patterns were relatively consistent across the organic and conventional phases. The OFIS had been previously tested in a pilot study involving a subset of participants from the OCS. The OFIS worksheet was accompanied by detailed instructions and a sample worksheet for reference.\(^{226}\) It included pictures of the various certification logos used in Australia which adhere to ‘The Standard’ to aid participants in identifying certified organic food sources (AQIS, 2009). Participants were asked to record any organic produce consumed as either certified organic or ‘likely organic’ in the OFIS worksheet.\(^{227}\)

*Chemical Exposure and Food Behaviour Survey (CEFBeS).*

The CEFBeS was developed to identify possible non-dietary factors that may affect exposure to or elimination of pesticides. The baseline CEFBeS\(^{228}\) confirmed participants had met eligibility criteria and collected additional information, in the participants’ own words, about other factors that may affect study results. A modified version of the CEFBeS\(^{229}\) was then used at the end of each study period to record any behaviours or exposures that occurred during the study period that may have influenced the results and also identify any factors that could give rise to unexpected results.

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\(^{225}\) Appendix 5. BMT Results - Letter to Participants

\(^{226}\) Appendix 3. OFIS Worksheet (Example), OFIS Instructions for Use

\(^{227}\) Refer to 8.5.2 Development of the OFIS: The OFIS prototype

\(^{228}\) Appendix 5. CEFBeS (Baseline)

\(^{229}\) Appendix 5. CEFBeS (Organic Phase), CEFBeS (Conventional Phase)
**Privacy**

Surveys and urine samples were coded to protect the identity of participants during the study but then re-identified afterwards so that participants could receive their individual results at the end of the study period. The codes were stored on a password protected computer accessible only to the investigators.

**10.4.6 Choice of Analytes**

Urinalysis of six DAPs (DMP, DEP, DMTP, DETP, DMDTP, DEDTP) was chosen based on an assessment of possible analytes previously conducted and published in the *International Journal of Environmental Research and Public Health* (Oates & Cohen, 2011).^{230}

**10.4.7 Urine Collection**

The BMT used a first morning void, spot urine sample (also known as the 8 hour specimen). Participants were asked to collect and pool any urine voided overnight and refrigerate it until morning so that a true 8-hour specimen could be attained. A 200mL sample was required for analysis due to the low LODs.

Following urine collection, participants completed a ‘Sample Collection Form’ and filled in relevant information on the specimen label, such as date/time of collection and confirmation that the sample was a first morning void.

The urine sample was either placed in an esky containing frozen ice sheets for immediate transportation, or placed in the participant’s home freezer until it could be collected. Samples were personally collected by the researcher to ensure speedy delivery and reduce the chance of degradation during transport. This generally occurred early on the day of collection or the next business day. Following collection the samples were taken directly to the AsureQuality Ltd office in Tullamarine, Victoria where they were stored at -20°C prior to being transported by airfreight to their laboratory in Wellington, New Zealand.

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^{230} Refer to **6.4.2 Choice of Analytes**

^{231} Appendix 5. Urine Sample Submission Form

^{232} Appendix 5. Specimen label
10.4.8 Analytical Methods

Urinalysis of the six DAPs was performed by AssureQuality Limited using gas chromatography tandem mass spectrometry (GC-MS/MS). AssureQuality Limited is accredited to NZS ISO/IEC 17025:2005 by International Accreditation New Zealand (IANZ:131) and has one of the widest scopes of accreditation in the Southern Hemisphere.233

Analysis was conducted based on the method described by Bravo et al (Bravo, et al., 2004). The sample was extracted and further purified using solid-phase extraction. Measurement was performed using GC-MS/MS of a derivative. Results were reported to two significant figures in micrograms per litre (μg/L) present in the sample on an as received basis. Additionally, values corrected for the level of creatinine in the urine sample were reported to two significant figures in micrograms per gram of creatinine (μg/g creatinine). Creatinine analysis and correction are discussed below.

Samples were destroyed in accordance with the laboratory's procedures eight weeks after results were reported.

10.4.9 Quality Assurance

AsureQuality Limited has quality assurance processes in place to ensure that the data generated is accurate, reliable and defensible. ‘Results are checked and verified to be accurate. All analyses are conducted using validated methods on properly functioning/calibrated equipment by expert analysts trained and proficient to perform the specific test including the use of certified standards and reference materials where available.’ AsureQuality participates in proficiency testing studies as required as part of standard accreditation programs (ISO 17025). Samples were coded and technicians were blinded to the origin of the samples.

Validation

Validation was performed on human urine matrix. The validation set consisted of five batches of fortified samples. A linearity test comprising nine fortification levels demonstrated that the DAPs were satisfactorily recovered over the concentration range of 0.0005 – 0.2 mg/kg. A replicate analysis of urine samples fortified at a level of 0.001 mg/L was used to calculate the LOD and LOQ of the method. Estimates of repeatability and

233 The details for the laboratory can be accessed at: <http://cabis.ianz.govt.nz/ianzwebportal/ViewScope.aspx?Program=398204f4-d1a5-4116-86e6-1839e7b7ac6e>
intermediate precision were based on 26 fortifications at levels of 0.001, 0.01 and 0.1 mg/L. Uncertainty of measurement (U), with a confidence interval of 95%, was estimated from the standard deviation of the within laboratory reproducibility (intermediate precision) (Taskova, 2012).

**Quality control data from routine analysis**

A reagent blank test, a matrix blank test and at least three fortified blank samples were run with each batch of samples. In addition, a quality control sample fortified at 0.010 mg/L level was run with each batch. Batch acceptance criteria required that the coefficient of determination for calibration curves should be $R^2 > 0.97$, and percent recovery for the batch should be within 2 standard deviations from the mean percent recovery established by the validation. Individual sample acceptance criteria required that the internal standard response for an individual sample should exceed 33% of the mean internal standard response of the recovery samples. Positive sample acceptance criteria required that ion ratios and retention times of the analytes and internal standard should be consistent with the values established by the validation (Taskova, 2012).

### 10.4.10 Quantification Limits

The detection and quantification limits of the six DAPs measured are presented below.\(^{234}\)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>LOD (μg/L)</th>
<th>LOQ (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethylphosphate (DMP)</td>
<td>0.42</td>
<td>1.3</td>
</tr>
<tr>
<td>Diethylphosphate (DEP)</td>
<td>0.51</td>
<td>1.5</td>
</tr>
<tr>
<td>Dimethylthiophosphate (DMTP)</td>
<td>0.28</td>
<td>0.83</td>
</tr>
<tr>
<td>Diethylthiophosphate (DETP)</td>
<td>0.16</td>
<td>0.49</td>
</tr>
<tr>
<td>Dimethyldithiophosphate (DMDTP)</td>
<td>0.14</td>
<td>0.43</td>
</tr>
<tr>
<td>Diethyldithiophosphate (DEDTP)</td>
<td>0.11</td>
<td>0.33</td>
</tr>
</tbody>
</table>

LOD = Limits of Detection  
LOQ = Limits of Quantification

\(^{234}\) Refer to 6.4.3 Choice of Quantification Limits
10.4.11 Creatinine Correction

Creatinine testing was performed by Aotea Pathology, New Zealand (Roche Modular P800, Jaffe Rate blanked, compensated).

Creatinine results were reported in mmol/ L; these were then converted to g/ L creatinine by multiplying by the molar mass of creatinine (113.12) and dividing by 1000. The formula for creatinine correction of the results is:

\[
\frac{\text{Concentration of analyte (wt/vol)}}{\text{Concentration of creatinine (wt/vol)}} = \frac{\text{wt analyte}}{\text{wt creatinine}}
\]

For example, if the non-corrected concentration of DMP is 3.6µg / L and the creatinine level is 15.9 mmol/L (equivalent to 1.8 g / L creatinine), then the following equation would apply:

\[
3.6 \text{ µg / L DMP} ÷ 1.8 \text{ g / L creatinine} = 2.0 \text{ µg DMP / g creatinine}
\]

10.5 Data Analysis

Data analysis was performed using SPSS for Windows statistical software (version 18).

10.5.1 Estimation of Non-detectable and Non-quantifiable Results

For the purpose of determining central tendency and dispersion (variability) numerical figures are required so assumptions needed to be made to deal with non-detectable (ND) and non-quantifiable (NQ) results. As with previous studies (Curl, et al., 2003; Oglobline, et al., 2001) all samples containing concentrations below the limits of detection were assumed to have a concentration equal to one half of the LOD. This method was chosen to estimate ND results over an alternative method used in the NHANES (Barr, et al., 2004), where the LOD is divided by the square root of 2. The Curl study is the only published report comparing DAPs between organic and conventional groups and Oglobline is the only study which reports DAP levels in non-occupationally exposed Australian adults. So for comparison purposes the same method was used.

Given that the laboratory also provided a LOQ we used a similar method whereby samples containing concentrations below the limits of quantification were assumed to have a concentration equal to the midpoint between the LOD and the LOQ (see Table 10.3). These are referred to as the adjusted results and were used to calculate measures of central tendency and dispersion (variability).
Table 10.3. LOD, LOQ, Adjusted ND and NQ in the Biomonitoring Trial

<table>
<thead>
<tr>
<th>DAP</th>
<th>LOD</th>
<th>LOQ</th>
<th>Adjusted ND</th>
<th>Adjusted NQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethylphosphate (DMP)</td>
<td>0.42</td>
<td>1.3</td>
<td>0.210</td>
<td>0.860</td>
</tr>
<tr>
<td>Diethylphosphate (DEP)</td>
<td>0.51</td>
<td>1.5</td>
<td>0.255</td>
<td>1.005</td>
</tr>
<tr>
<td>Dimethylthiophosphate (DMTP)</td>
<td>0.28</td>
<td>0.83</td>
<td>0.140</td>
<td>0.555</td>
</tr>
<tr>
<td>Diethylthiophosphate (DETP)</td>
<td>0.16</td>
<td>0.49</td>
<td>0.080</td>
<td>0.325</td>
</tr>
<tr>
<td>Dimethyldithiophosphate (DMDTP)</td>
<td>0.14</td>
<td>0.43</td>
<td>0.070</td>
<td>0.285</td>
</tr>
<tr>
<td>Diethyldithiophosphate (DEDTP)</td>
<td>0.11</td>
<td>0.33</td>
<td>0.055</td>
<td>0.220</td>
</tr>
</tbody>
</table>

LOD = Limits of Detection
LOQ = Limits of Quantification
ND = Not Detected, levels below the LOD
NQ = Not Quantified, levels greater than or equal to the LOD and less than the LOQ

10.5.2 Calculation of Total DAPs

In line with the previous study of DAPs in children consuming organic or conventional food (Curl, et al., 2003) we also calculated the molar sums of the dimethyl-containing and diethyl-containing metabolite so that each participant received a score for combined total DAPs (ΣDAP), total dimethyl DAPs (ΣMP) and total diethyl DAPs (ΣEP). To calculate the total molar metabolite quantities (μmol/g) for each participant, the individual DAP result (μg/g) was divided by its molecular weight (g/mol) before being added together.

ΣMP = [DMP]/125 + [DMTP]/141 + [DMDTP]/157
ΣEP = [DEP]/153 + [DETP]/169
ΣDAP = ΣMP + ΣEP

DEDTP (185g/mol) was not included in this calculation due to the very low frequency of quantifiable detections. This metabolite had also not been included in the Curl study (Curl, et al., 2003).

10.6 Results and Discussion

10.6.1 Socio-demographic Characteristics of Participants

Eighteen participants living in the greater Melbourne and Geelong areas of Victoria met the inclusion criteria and were enrolled in the biomonitoring study. Three withdrew for personal reasons prior to commencing the first phase of the study. Fifteen participants commenced the study but one withdrew, also for personal reasons, after completing only
the first phase. A further participant was excluded from the group analysis due to an a priori requirement that participants consume at least 80% organic food during that phase. The participant averaged only 65% organic servings during the organic phase including 50% certified organic. Consumption was below 50% organic on a number of days. The participant was contacted to see if they would like to repeat the organic phase but did not respond. Thus a total of 13 matched samples were available for the group analysis. The demographic characteristics of the included participants are presented in Table 10.4.

Table 10.4. Demographics (N=13) of BMT Participants

<table>
<thead>
<tr>
<th>Gender</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>9 (69)</td>
</tr>
<tr>
<td>Male</td>
<td>4 (31)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>42 years</td>
</tr>
<tr>
<td>Range</td>
<td>24-63 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner-urban</td>
<td>4 (31)</td>
</tr>
<tr>
<td>Suburban</td>
<td>7 (54)</td>
</tr>
<tr>
<td>Semi-rural (no nearby farming)</td>
<td>2 (15)</td>
</tr>
</tbody>
</table>

The ratio of females to males was lower than the OCS and OHWS studies (80.3 and 81.4% respectively). The OCS only collected categorical data for age but the mean age in the OHWS was 41.2 years which is very similar to the current study. Because we had specifically excluded rural areas there was a difference in the ratio of urban and rural participants. In this study 84.6% were from urban areas compared to 61.2% in the OCS and 76.7% in the OHWS. Nevertheless, for the most part the characteristics of the participants in the biomonitoring trial are similar to the other large scale surveys we have conducted.
10.6.2 Consumption Patterns of Participants

Participants consumed an average of 96% of their food servings from conventional produce during the conventional phase and 93% organic produce in the organic phase (this included 83% certified organic produce). The overall number of food servings in the conventional phase compared to the organic phase was very similar, and the average number of servings of each food category was mostly consistent between the phases (Table 10.5).

Table 10.5. Average Number of Daily Servings by Food Category

<table>
<thead>
<tr>
<th>Food category</th>
<th>Average number of servings</th>
<th>Difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFIS (Pilot) N=19</td>
<td>Biomonitoring trial N=13</td>
</tr>
<tr>
<td></td>
<td>Conventional phase</td>
<td>Organic phase</td>
</tr>
<tr>
<td>Grain</td>
<td>2.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Fruit</td>
<td>3.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Dairy</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Animal protein</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Vegetable protein</td>
<td>1.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Total food servings</td>
<td>15.7</td>
<td>13</td>
</tr>
</tbody>
</table>

*Difference in the average number of food category servings in the organic compared to the conventional phase

There was more dairy (7%) in the conventional phase and more grain (6%), vegetable (8%) and fruit (1%) servings during the organic phase. The major difference was that participants consumed more animal protein (44%) in the conventional phase and more vegetable protein (24%) in the organic phase.

Overall the number of food servings was 17% lower during the study periods compared to the pilot phase of the OFIS but nothing that would suggest that consumption was outside the realms of normal dietary deviations between individuals. The similarities within the study participants suggest that participants had for the most part heeded the request to maintain a fairly typical diet in both phases.
10.6.3 Differences in DAPs between the Conventional and Organic Phases

**Significance testing**

As the change in DAP scores did not appear normally distributed, nor was the sample size large enough to apply the central limit theorem, non-parametric statistical tests were used to test for a statistically significant change in DAP scores between the conventional and organic diets. The Wilcoxon signed-rank test, a non-parametric alternative to the paired sample t-test, was used for this purpose. This was also used in the Curl study (Curl, et al., 2003). The Wilcoxon signed-rank test does not require the assumption of normally distributed change scores to be met.

**Individual DAPs**

As previously described ND and NQ results were adjusted to numerical values for the purpose of determining central tendency and dispersion (variability).\(^{235}\)

<table>
<thead>
<tr>
<th>Metabolite</th>
<th>Mean(Median) μg/ g</th>
<th>Sig(^{*})</th>
<th>Standard Deviation μg/ g</th>
<th>Maximum μg/ g</th>
<th>Frequency of quantifiable detection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Con</td>
<td>Org</td>
<td>Con</td>
<td>Org</td>
<td>Con</td>
</tr>
<tr>
<td>DMP</td>
<td>3.9(ND)</td>
<td>ND(ND)</td>
<td>.028*</td>
<td>6.7</td>
<td>-</td>
</tr>
<tr>
<td>DEP</td>
<td>4.8(3.4)</td>
<td>2.8(NQ)</td>
<td>.221</td>
<td>4.5</td>
<td>2.6</td>
</tr>
<tr>
<td>DMTP</td>
<td>29(4.5)</td>
<td>0.98(ND)</td>
<td>.005*</td>
<td>48</td>
<td>2.3</td>
</tr>
<tr>
<td>DETP</td>
<td>1.8(0.50)</td>
<td>0.56(ND)</td>
<td>.263</td>
<td>3.4</td>
<td>0.97</td>
</tr>
<tr>
<td>DMTP</td>
<td>2.3(0.61)</td>
<td>0.35(ND)</td>
<td>.051*</td>
<td>3.9</td>
<td>1.0</td>
</tr>
<tr>
<td>DEDTP</td>
<td>0.12(ND)</td>
<td>0.068(ND)</td>
<td>.144</td>
<td>1.2</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Note: Results reported to two significant figures
Con – Conventional Phase
Org – Organic Phase
ND = Not Detectable, levels below the LOD
NQ = Not Quantifiable, levels greater than or equal to the LOD but less than the LOQ
\(^{*}\) Significance of the difference between the conventional and organic phase
\(^{p}<.05\) (Wilcoxon Signed-Ranks Test)
\(^{1}\) Trend towards significance

\(^{235}\) Refer to 10.5.1 Estimation of Non-detectable and Non-quantifiable Results
Differences in mean urinary DMP and DMTP levels were statistically significant between the conventional and organic phases ($p<.05$) and there was a trend towards significance for differences in DMDTP. None of the diethyl DAPs (DEP, DETP or DEDTP) were statistically significant (Table 10.6).

**Dimethyl DAPs (DMP, DMTP, DMDTP)**

Below is a comparison of the mean creatinine corrected results for each of the dimethyl metabolites (Figure 10.3).

![Figure 10.3. Mean Dimethyl DAPs (Creatinine Corrected) N=13.](image)

There was a considerable amount of variability in the results for DMTP during the conventional phase and this was highly sensitive to creatinine correction. DMP returned no quantifiable results in the organic phase and DMTP was only detected twice. Overall there were only three quantifiable detections for any of the dimethyl DAPs during the organic phase (Figure 10.4).

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Refer to 6.4.6 Creatinine Correction; and 10.4.11 Creatinine Correction
Diethyl DAPs (DEP, DETP, DEDTP)

The diethyl DAPs were more erratic than the dimethyl DAPs, although results in the conventional phase still remained higher than the organic phase (Figure 10.5).

The level of variability was particularly pronounced for the diethyl DAPs and this occurred in both the conventional and organic phases (Figure 10.6).
Figure 10.6: Boxplot representing creatinine corrected diethyl DAPs.

Extreme outliers are marked with an asterisk (*) on the boxplot.

Possible factors contributing to the Diethyl DAP results

There are a number of possible reasons why there were no statistically significant differences between the organic and conventional phases for any of the diethyl DAPs. As different OP pesticides tend to produce different DAPs or combinations of DAPs, the most likely explanation is that participants were exposed to non-dietary sources of pesticides that are metabolised to diethyl DAP metabolites. However, it is also possible that adventitious contamination\textsuperscript{237} of organic produce occurred during production, transport or storage; or that the small amounts of conventional food consumed had high levels of contamination from pesticides that favour the production of diethyl DAPs.\textsuperscript{238}

Influence of creatinine correction

Creatinine correction was used to express the DAP measurements as a ratio of the creatinine concentration (μg/ g creatinine) to account for differences in urine concentration or dilution between participants.\textsuperscript{239} This approach is generally not advocated for urine samples with very low (<2.653 mmol/ L or 0.3 g/ L) or high (>26.53 mmol/ L or 3 g/ L) concentrations of creatinine.

\textsuperscript{237} Refer to 6.3.1 Accidental Contamination of Produce with Pesticides
\textsuperscript{238} These issues will be explored further in 10.6.8 What Factors may have Affected Pesticide Exposure and Metabolism?
\textsuperscript{239} The methods used to do this were described in 10.4.11 Creatinine Correction
The production of creatinine is relatively constant within an individual but is affected by muscle mass. Creatinine levels decrease with age at a rate of 0.76% (95%CI 0.68–0.84%) per year and males have substantially higher levels of urinary creatinine than females (~45% higher). Studies have demonstrated that approximately 9% of adult females fall below the lower limit (Cocker, Mason, Warren & Cotton, 2011).

In this study, of the nine females and four males, three females and one male in the conventional phase and one female in the organic phase returned creatinine results below 2.653 mol/L. In addition one male in the conventional phase recorded creatinine results in excess of 26.53 mol/L. The low creatinine levels which indicate very dilute urine may have been due in part to the fact that we asked for 200mL urine samples in order to get the low limits of detection. Several participants expressed concern that they would be able to produce this much urine and may have drunk a lot more than they needed to the night before the test.

The assumption of a nominal creatinine concentration of 8.8 mmol/L (1 g/L) used in conversions may have unduly influenced the results in some cases. Overall the mean creatinine results were slightly higher than this assumption but were fairly similar between the conventional and organic phases ($p=.82$). However there was considerable variability in the results (Figure 10.7).

\[ Figure \ 10.7. \ Boxplot \ of \ creatinine \ results \ (mmol/\ L) \ N=13. \]

Mild outliers are marked with a circle (O) and the participant number.
The two older female participants (participants 4 and 6) returned creatinine results of 1.1 and 1.3 mmol/L in the conventional phase resulting in substantial corrections. When a participant had low creatinine in a particular phase the measurements for metabolites detected in that phase were adjusted upwards, if the creatinine was very low that adjustment was quite extreme. This was most obvious for DMTP which was corrected from 12 µg/L to 94 µg/g creatinine and from 23 µg/L to 160 µg/g creatinine and produced obvious outliers (Figure 10.8).

![Figure 10.8. Comparison of uncorrected (µg/L) and corrected (µg/g) results for DMTP in the conventional phase.](image)

Mild outliers are marked with a circle (Ø) and extreme outliers are marked with an asterisk (*) on the boxplot. The number of the participant is included for reference.

The extent of creatinine correction varied considerably between individuals and study phases. For example, while the creatinine results for participant 4 were 1.1 mmol/L in both phases there was a marked difference between the conventional and organic phases in participant 6, where creatinine results were 1.3 and 7.4 mmol/L respectively. This means that there was a large correction during the conventional phase increasing the values but only a small correction in the organic phase.

Within each particular phase, creatinine correction was not necessarily relative. This is because not every metabolite produced quantifiable results in both phases and the
creatinine correction calculation was only applied by the laboratory to quantifiable results i.e. where numerical figures were available. So ND and NQ results remained unchanged but the quantifiable results were corrected. In addition to some of the low creatinine results that resulted in upward corrections of quantifiable DAP values, the reverse could also occur. This meant that in several cases where creatinine results were higher than 8.8mmol/L the derived figure was corrected to below the LOQ.

It might have been more appropriate to consider the uncorrected results to avoid the erratic effects of creatinine correction, however this would not account for dilution effects. Had the sample been larger we may have been able to exclude results that fell outside of reliable creatinine ranges. Given the small number of participants however, this would have resulted in the loss of five matched pairs. As this was not stated as an a priori requirement, all of the creatinine corrected results were included in the group analysis. Including this data is unlikely to have biased the results towards significance since the presence of these results increased the standard deviation for the sample. When the data was reanalysed using the uncorrected results the overall findings did not change substantially, with the only difference being the DMDTP result, which achieved statistical significance ($p=.033$) using the uncorrected results while only showing a strong trend towards significance using the corrected results.

Nevertheless, the erratic effects of creatinine correction demonstrated in this study, highlight a particular challenge for research of this nature and provide an argument for using 24-hour urine samples rather than first morning void samples in future research. This will however require consideration of how to minimise participant burden and how to deal with missing voids.

**Influence of dose estimation on significance**

As the estimation methods described above, using the midpoint of ND and NQ ranges may have influenced the results, the data was reanalysed using the lowest and highest possible values. This did not have any major effect on the results with the results for DMP and DMTP remaining statistically significant ($p<.05$) and the trend towards significance remaining for DMDTP ($p=.051$).

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240 Refer to 10.5.1 Estimation of Non-detectable and Non-quantifiable Results
10.6.4 Total DAP Results

Total molar metabolite quantities (μmol/ g) were calculated for each participant. Both total DAPs and total dimethyl DAPs were significantly higher in the conventional phase than the organic phase (Figure 10.9). The mean total DAP results in the organic phase were 89% lower than in the conventional phase ($M=0.032\pm0.038$ and $0.294\pm0.0435$ respectively, $p=.013$). For total dimethyl DAPs there was a 96% reduction ($M=0.011\pm0.023$ and $0.252\pm0.403$ respectively, $p=.005$). This represented a nine fold difference in mean total DAPs and a more than a 23-fold difference in total dimethyl DAPs. Although there was a 49% reduction in the mean total diethyl DAP levels in the conventional compared to the organic phase ($M=0.042\pm0.038$ and $0.021\pm0.020$ respectively, $p=.170$), the difference was not statistically significant. This is not surprising given that none of the individual diethyl DAPs displayed statistically significant differences between the study phases.

![Boxplot of Total DAPs, Total Dimethyl DAPs, and Total Diethyl DAPs](image)

**Figure 10.9.** Total DAPs, total dimethyl DAPs and total diethyl DAPs (creatinine corrected).

Mild outliers are marked with a circle (O) and extreme outliers are marked with an asterisk (*) on the boxplot.

---

241 Refer to 10.5.2 Calculation of Total DAPs
These findings were not affected by using the uncorrected results although the significance values are stronger (Figure 10.10). There was around a four-fold difference in total DAPs and a roughly ten-fold difference in total dimethyl DAPs. So regardless of whether the creatinine corrected or uncorrected results were used, the difference between the two phases was statistically significant for both the total DAPs and the total dimethyl DAPs. This was not the case for the diethyl DAPs which did not show significant differences between the study phases using either method.

Figure 10.10. Total DAPs, total dimethyl DAPs and total diethyl DAPs (uncorrected results µg/L)

Mild outliers are marked with a circle (O) and extreme outliers are marked with an asterisk (*) on the boxplot.

The only published study to compare DAP levels between organic and conventional consumers was conducted in children aged 2-5 years (Curl, et al., 2003). Unlike our

242 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
study this was not a crossover design so the groups were independent and non-parametric Mann Whitney U-tests were used to test for statistical significance. The children consuming organic fruit, vegetables and juice had significantly lower levels of total dimethyl DAPs in their urine than children consuming conventional produce \((p=.0003)\). Uncorrected results were used and the mean values differed by a factor of nine (0.04 and 0.34 μmol/L). The total diethyl DAPs did not differ significantly across the two groups \((p=.13)\). These findings are similar to the present study despite differences in metabolism between children and adults.

Effects of using non-parametric tests

As the distributions of the metabolite levels were not normal, the non-parametric Wilcoxon matched pairs signed-ranks test was used for paired samples to determine whether there were significant differences between phases\(^{243}\). These appeared to provide a more accurate representation of the effects. Table 10.7 compares significance values using parametric versus non-parametric tests for statistical significance.

<table>
<thead>
<tr>
<th></th>
<th>Paired samples t-test ((p))</th>
<th>Wilcoxon signed-ranks test ((p))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total DAPs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine corrected</td>
<td>.055</td>
<td>.013</td>
</tr>
<tr>
<td>Uncorrected</td>
<td>.002</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Total Dimethyl DAPs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine corrected</td>
<td>.053</td>
<td>.005</td>
</tr>
<tr>
<td>Uncorrected</td>
<td>.003</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Total Diethyl DAPs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine corrected</td>
<td>.128</td>
<td>.170</td>
</tr>
<tr>
<td>Uncorrected</td>
<td>.205</td>
<td>.182</td>
</tr>
</tbody>
</table>

\(^{243}\) Refer to 10.6.3 Differences in DAPs between the Conventional and Organic Phases: Significance testing
10.6.5 Rates of Detection (Frequency)

For the purpose of determining the rates of detection all results were included. However it should be reiterated that one of the participants was excluded from the group analysis as they did not meet the inclusion criteria of consuming a minimum of 80% of their food servings from organic produce in that phase. A comparison of the matched pairs included in the group analysis was presented previously (Table 10.8).

The most frequently detected metabolites were DMTP and DEP. DMTP was detected at quantifiable levels in all but one of the conventional samples and in six of the organic samples, although only three were at quantifiable levels. DEP was the most commonly detected metabolite in organic samples with 11 detections of which seven were at levels that could be quantified. Interestingly, this was also the metabolite with the highest LOD and LOQ.

<table>
<thead>
<tr>
<th>Table 10.8. Frequency of Detection for Individual Metabolites</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency of detection</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>DMP</td>
</tr>
<tr>
<td>DEP</td>
</tr>
<tr>
<td>DMTP</td>
</tr>
<tr>
<td>DETP</td>
</tr>
<tr>
<td>DMDTP</td>
</tr>
<tr>
<td>DEDTP</td>
</tr>
</tbody>
</table>

*Includes both quantifiable and non-quantifiable detections (>LOD).

At least one metabolite was detected at quantifiable levels in all of the 15 participants during the conventional phase. In the organic phase four of the 13 participants who met the inclusion criteria had no quantifiable detections of which two had no detectable levels of metabolites at all. These high detection rates indicate that it would be useful to conduct larger scale biomonitoring trials to determine where the detected exposure is coming from.
These results suggest that the choice of analytes and test sensitivity (i.e. LODs) can have an impact on the results of biomonitoring studies. For instance, DMTP was the most frequently detected metabolite in the Curl study (87%) (Curl, et al., 2003), and the second most frequent in the current study. However, it was not assessed in the only other known (unpublished) study in adults which was conducted on university aged students in Slovenia (Bavec, et al., 2011). This study only reported on the frequency of detection of DAP metabolites that exceeded 5µg/ L. It reported at least one metabolite in 75% of conventional and 16% of organic samples. Using this approach our 13 matched samples would have reported at least one metabolite in three (23%) conventional and one (8%) organic urine sample. However, this is misleading as eight of the 15 conventional urine samples tested contained DMTP in excess of 5µg/ L compared to none of the organic samples. The inclusion of DMTP at this LOD would have increased the overall detection rate in conventional samples to eight (62%) of 13 matched samples.

DEDTP had the lowest rate of quantifiable detections with only three detections, all during the conventional phase and all within members of the same household. In addition one non-quantifiable detection was also returned in the organic phase. DEDTP was not assessed in the Curl study “due to analytical difficulties” (Curl, et al., 2003).

10.6.6 Sensitivity of Tests: Are the Testing Methods sufficiently Sensitive to Detect Differences in Pesticide Exposure?

One of the aims of the study was to determine whether commercially available analytical methods are sufficiently sensitive to detect differences in dietary exposure. If a large number of ND or NQ results were returned for both phases of the study this would suggested that the tests may lack the required sensitivity.

The results suggest that the tests used were sufficiently sensitive. There was one exception however and this was DEDTP which has also raised concerns in other trials. DEDTP was detected at low levels in only three samples and once creatinine correction was applied, the derived figures were all below the limit of quantification. This is because the creatinine levels of the three participants with quantifiable results were in excess of 8.8mmol/ L suggesting that the urine was quite concentrated and thus the results were corrected downwards to account for this. Had the urine samples been less concentrated, it is unlikely that any samples would have returned quantifiable results for DEDTP.

244 Refer to 6.4.3 Choice of Quantification Limits; and 10.4.8 Analytical Methods
245 Refer to 6.4.4 Analytical Concerns with DAPs
Laboratory comparison

The choice of laboratory proved very important to the success of this study. Initially, a commercial laboratory in Australia (Workcover NSW) that conducts DAP testing for occupational exposure was identified but not used.\textsuperscript{246} Had we used the Workcover laboratory few results would have been produced, as they would have made only one detection using their standard LODs, or eight detections if LODs at 20% were used. As all detections would have occurred in conventional samples, this may have led to an assumption that the organic samples were completely free of residues rather than being significantly lower. A comparison of the LODs used by the laboratories was reported previously in Table 6.1. Below (Table 10.9) is a comparison of the frequency of detection that would have been achieved had we utilised the Workcover NSW laboratory.

Table 10.9. The Impact that the Different Laboratory Choice would have had on Detection Rates\textsuperscript{*}

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Organic</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assure</td>
<td>Workcover</td>
<td>Workcover</td>
<td>Assure</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>NSW</td>
<td>NSW 20%</td>
<td>Quality</td>
</tr>
<tr>
<td>DMP</td>
<td>5 (38%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DEP</td>
<td>8 (62%)</td>
<td>0</td>
<td>0</td>
<td>6 (46%)</td>
</tr>
<tr>
<td>DMTP</td>
<td>12 (92%)</td>
<td>1 (8%)</td>
<td>6 (46%)</td>
<td>2 (15%)</td>
</tr>
<tr>
<td>DETP</td>
<td>7 (54%)</td>
<td>0</td>
<td>1 (8%)</td>
<td>5 (38%)</td>
</tr>
<tr>
<td>DMDTP</td>
<td>7 (54%)</td>
<td>0</td>
<td>1 (8%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>DEDTP</td>
<td>3 (23%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\textsuperscript{*}Based on results from the 13 matched pairs
For the purpose of comparing results between different laboratories the uncorrected results in µg/L were used.

10.6.7 Comparison with the General Population

The results of our study were compared to the NHANES 1999-2000 adult subgroup (Barr, et al., 2004) as this is a large population study with comparable data. The NHANES used similarly low LODs to our study, reported creatinine corrected DAP measurements and included a sample size of 814 participants in the subgroup aged 20 to 59 years. Despite regional differences in pesticide use the frequency of detection of the DAP metabolites was similar in both studies with the exception of DMTP (Table 10.10). However high

\textsuperscript{246} Refer to 6.4.3 Choice of Quantification Limits
frequency of detection for DMTP been reported in Australian studies of non-occupationally exposed adults (Oglobline, et al., 2001) and South Australian children (Babina, et al., 2012).  

Table 10.10. Comparison of the Creatinine Corrected Results of 20-59yo Adults in the US and our Conventional Phase Participants

<table>
<thead>
<tr>
<th>µg/ g creatinine</th>
<th>NHANES</th>
<th>BMT</th>
<th>NHANES</th>
<th>BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMP</td>
<td>NC (0.76)</td>
<td>3.9 (ND)</td>
<td>52</td>
<td>38</td>
</tr>
<tr>
<td>DMTP</td>
<td>1.47 (1.90)</td>
<td>29 (4.5)</td>
<td>63</td>
<td>92</td>
</tr>
<tr>
<td>DMDTP</td>
<td>NC (ND)</td>
<td>2.3 (0.61)</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>DEP</td>
<td>0.90 (0.86)</td>
<td>4.8 (3.4)</td>
<td>69</td>
<td>62</td>
</tr>
<tr>
<td>DETP</td>
<td>NC (0.25)</td>
<td>1.8 (0.50)</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>DEDTP</td>
<td>NC (0.08)</td>
<td>0.12 (ND)</td>
<td>56</td>
<td>23</td>
</tr>
</tbody>
</table>

Mean* (Median) µg/ g

Frequency of quantifiable detection (%)

*geometric mean

NC - not calculated because the proportion of results below the LOD was too high to provide a reliable result

To date the only Australian study of non-occupationally exposed adults (Oglobline, et al., 2001) included 48 participants and reported uncorrected results. The LODs achieved by the laboratory used in this study were lower than the LODs in our study, which may have resulted in a higher rate of detection frequency. Nevertheless the means and standard deviations were fairly similar to those reported for the conventional phase of the BMT (Table 10.11).

247 Main results were presented previously. Refer to 6.2.3 Person: Pesticide Residues in Human Tissue
Table 10.11. Comparison of the Uncorrected Means Based on Results of Non-occupationally Exposed Adults (Oglobline) and our Conventional Phase Participants (Mean±SD) (µg/ L⁻¹)

<table>
<thead>
<tr>
<th></th>
<th>Oblobline</th>
<th>BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMP</td>
<td>9±5</td>
<td>10±10</td>
</tr>
<tr>
<td>DMTP</td>
<td>10±4</td>
<td>8±9</td>
</tr>
<tr>
<td>DMDTP</td>
<td>1±8</td>
<td>2±3</td>
</tr>
<tr>
<td>DEP</td>
<td>3±5</td>
<td>3±3</td>
</tr>
<tr>
<td>DETP</td>
<td>2±4</td>
<td>2±5</td>
</tr>
<tr>
<td>DEDTP</td>
<td>1±NA</td>
<td>1±2</td>
</tr>
</tbody>
</table>

NA – insufficient positive results to calculate SD

For the most part the mean DAP levels during the conventional phase of our study were substantially lower than the four DAPs tested in urban dwelling children in South Australia (Babina, et al., 2012) (see Table 10.12). This is not surprising given that children are disproportionately exposed to pesticides due to their lower body weights and slower metabolism of pesticides.248 However, it is also important to note that exposure in SA children appeared to be higher than similar studies from the US and Germany and the levels in those children living in periurban and rural areas were substantially higher. If this is also the case for Australian adults it may not be appropriate extrapolate findings from the current study to other regions.

Table 10.12. Mean Creatinine Corrected DAP Levels for Urban Dwelling Children in the SA Study vs. Conventional Phase Adults in our Study (Mean±SD) (µg/ g)

<table>
<thead>
<tr>
<th></th>
<th>Babina</th>
<th>BMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMTP</td>
<td>20.2±48.2</td>
<td>29.1±48.3</td>
</tr>
<tr>
<td>DMDTP</td>
<td>12.4±14.9</td>
<td>2.3±3.9</td>
</tr>
<tr>
<td>DEP</td>
<td>7.4±9.5</td>
<td>4.8±4.5</td>
</tr>
<tr>
<td>DETP</td>
<td>8.3±23.5</td>
<td>1.8±3.4</td>
</tr>
</tbody>
</table>

248 Refer to 6.3.6 Interaction with other Chemicals: The Effect of Mixtures; and 6.3.9 Individual Susceptibility to Pesticides: Population Groups at Increased Risk
10.6.8 What Factors may have Affected Pesticide Exposure and Metabolism?

Although pesticide metabolite levels were substantially lower in the organic phase there were still detections in some samples. There are a number of possible reasons for this including:

- the 7-day period was not sufficient time for the body to excrete residues from food consumed prior to the commencement of the organic phase;
- organic producers are using OPs when they shouldn’t be;
- adventitious contamination is occurring in organic produce;
- even the small amounts of conventional food reported in some organic phase diets left detectable residues;
- the participants inadvertently consumed conventional food during the organic phase of the study that was not reported.
- there were non-dietary sources of exposure that contributed to the metabolite levels.

Excretion of DAP metabolites is usually quite rapid (80-90% within 48 hours) (Aprea, et al., 2002) so 7 days should be sufficient time for the body to eliminate them. However, there may be factors such as genetic polymorphisms, medication use or pathological processes that compromise an individual’s ability to metabolise and excrete DAPs within this period. Currently there is insufficient information to be able to predict these effects.

The two older female participants recorded the highest individual metabolite readings and these were for DMTP in the conventional phase. This also resulted in the highest total DAP levels of 0.931 and $1.458 \mu g/ g$ during the conventional phase ($M=0.294$; 95%CI 0.031, 0.557). It is possible that pesticide metabolism in these participants may also have varied from the other participants due to age and medication use.\(^ {249}\)

Although auditing is conducted by certifying bodies to ensure that organic standards are adhered to by producers and suppliers throughout the food supply chain, unscrupulous use of pesticides cannot be ruled out. However certification is a costly and time-consuming process and the risks of non-compliance are high.

The presence of the DAP metabolites returned during the organic phase may also have been the result of adventitious contamination.\(^ {250}\) Contamination of organic produce during

\(^ {249}\) Refer to 6.3.5 Individual Differences in Absorption, Metabolism and Excretion of Pesticides
\(^ {250}\) Refer to 6.3.1 Accidental Contamination of Produce with Pesticides
production, transport or storage has previously been reported in Australia (McGowan, 2003) and abroad (Baker, et al., 2002; Tasiopoulou, et al., 2007; USDA, 2012b).

Although the study was not sufficiently powered to demonstrate a clear dose response between conventional food consumption and urinary pesticide residues, there were some interesting observations. One of the participants needed to be excluded from the group analysis as the OFIS results suggested an average of only 65% organic intake during the organic phase of the study, with a number of days under 50%. Interestingly the total DAPs for this participant were 0.054 μmol/ g during the organic phase which was at the upper end of the confidence intervals for the 13 matched samples (M=.032; 95%CI .010,.055). During the conventional phase the participant had a total DAP of 0.062 μg/ g (M=0.294; 95%CI 0.031, 0.557) which was at the lower end. This suggests that the higher than average amount of conventional food in this participant’s diet during the organic phase resulted in higher than average test results.

It is also possible that participants may not be completely clear about whether the food they are purchasing is organic inadvertently consume conventional food during the organic phase which is not recorded in the OFIS.

While people living in rural areas were ineligible for the study, the exclusion criteria didn’t specify that participants shouldn’t travel to these areas during the study period. Results from the CEFBeS indicated that this was the case for a number of participants who returned unexpectedly high residue results during the organic phase. This was particularly apparent in one participant who spent time camping in a rural area during the organic phase of the study and returned total DAP levels in the organic phase that exceeded those in the conventional phase (0.144 and 0.082 respectively).

CEFBeS results revealed that the participant was camping in a periurban area (the Mornington Peninsula) which, like the periurban area (the Adelaide Hills) reported in the SA study (Babina, et al., 2012), is a prolific wine growing region, and OPs, for example chlorpyrifos, are registered for use in vineyards. Chlorpyrifos metabolises to DEP and DETP which were particularly elevated in this participant during the organic phase.

In the study of SA children aged 3-6 years, the mean DEP levels were more than 10 times higher in the children living in periurban or rural areas than those in urban dwellings. This suggests that agricultural pesticide use in rural and periurban areas may increase non-dietary exposure to pesticides that metabolise to DEP. This includes pesticides such as
chlorpyrifos, coumaphos, diazinon and parathion (CDC, 2008). Of these only chlorpyrifos was detected in food samples (apples, breakfast cereal and cucumber) during the most recent Australian Total Diet Survey (FSANZ, 2011). DMTP and DMDTP were also elevated in this participant and these are metabolites of other OPs registered for use in vineyards such as azinphos-methyl, fenithrothion and methidathion which metabolise to dimethyl DAPs (APVMA, 2012; CDC, 2008). A study of this nature is not designed to attribute individual results to specific pesticides or patterns of use, nevertheless these can be interesting to explore from an individual participant’s perspective.

Several participants from the same household returned quantifiable results for DEDTP in the conventional phase, yet no other participants returned results in either phase. The OPs disulfoton, ethion, and terbufos metabolise to DEDTP (CDC, 2008) however, these were either not tested or returned no quantifiable results in the most recent ATDS (FSANZ, 2011) so it is difficult to speculate whether specific produce consumed in common by the members of this household was a possible cause. Members of this household also returned quantifiable results for DEP, some of which were higher in the organic phase so it is also possible that exposure to a residential pesticide may have contributed to this.

Participants may also be exposed to non-dietary sources of OPs, which may be inhaled or absorbed through the skin, if spending time in fumigated buildings or urban recreational areas such as parks and gardens. However, most people will be unaware of these exposures. An example of this is a participant who reported several incidents in the CEFBeS including being in the process of moving house during the organic phase. This involved spending time in a new garden. The participant also attended a public park for several hours on the evening prior to the test. The participant had no way of knowing whether the property had been recently fumigated or whether OP pesticides had been applied to the garden or the public park. In addition the participant recounted having walked through the pesticide aisle of a hardware store noticing an extremely strong odour. While the participant’s dimethyl metabolites dropped to ND or close to ND levels in the organic phase there were some unexpected results for the diethyl DAPs. DEP dropped from 7.2 to 4.5 µg/g between the conventional and organic phases but was still present at levels above the mean for the organic cohort ($M=2.8±2.6$). DETP rose in the organic phase from ND to 0.67 µg/ g, although this was still a relatively low reading for the organic phase ($M=0.56±0.96$); and DEDTP which was previously non-detectable returned an NQ result. This was the only detection for DEDTP in the organic phase. This participant had reported an almost 100% organic diet with the exception of two condiments. As previously
discussed, it is possible that the diethyl DAPs are more indicative of non-dietary OP exposure, although in a US study in children garden pesticide use demonstrated more of an influence on dimethyl DAPs (Lu, et al., 2001). As a number of OP pesticides have the diethyl metabolites in common it is difficult to attribute individual chemicals, especially when the participant is unaware as to whether, or to what extent, they may have been exposed to non-dietary pesticides from the new home, public park or hardware store.

10.7 Limitations

A number of factors were considered above that may have influenced the results but for the most part these do not appear to have unduly affected the findings. The dose estimation methods used, choice of nonparametric tests for statistical analysis and use of creatinine correction do not appear to have influenced the direction of the findings. Furthermore, the testing methods appeared to be sensitive enough to detect differences in dietary exposure, although this may not be the case for DEDTP and the results highlight how the choice of metabolites tested and LODs could lead to erroneous assumptions, and the difficulties in accounting for non-dietary sources of OP exposure.

Several other potential limitations should also be considered, for instance, the sample size was small and participants may not be representative of the wider community. There are also limitations in the ability of the OFIS to completely quantify the level of organic intake. As a result it is beyond the scope of this study to attribute elevated DAP results to specific foods or behaviours or to demonstrate a clear dose response. Participant burden may have had an impact on the accuracy of the dietary data as participants were asked to complete the OFIS for 7 days. This may be better managed in future research by asking participants to adhere to the diet for 7 days but only record dietary intake for the final 3-4 days. Despite asking participants to maintain their ‘usual’ diets, with the exception of choosing organic or conventional options, the act of participating in a study and keeping a diet diary may also have influenced participants’ food choices.

Biomonitoring itself is still a developing field and collection, transportation and analytical methods are not without flaws. For instance the SA study did not report on DMP or DEDTP due to ‘analytical concerns’ (Babina, et al., 2012). The lack of detections for DEDTP in this study may be due to analytical issues or simply reflective of the specific pesticides represented by this metabolite as DEDTP is only metabolised by a handful of OP pesticides. There is limited data for comparison purposes and it is important to remember that DAPs are only one marker of pesticide exposure. They are representative
of over 70% of pesticides in the OP class but cannot be considered surrogates for exposure to other pesticides.

The study period ran over almost a full year cycle with different participants completing the study at different times. There may have been seasonal variation in the level of DAPs but the samples size was too small to investigate this. The time of the year may have an impact on results as higher pesticide residues appear to be reported in spring and summer months (MacIntosh, Kabiru & Ryan, 2001). Intake of fruit and vegetables may also be higher in the summer months (Lu, et al., 2008).

Pesticide use and food availability differs from region to region so these results may only be applicable to those lining in the greater Melbourne area and surrounds of Victoria, Australia.

10.7.1 Difficulties in Drawing Conclusions from the Data

While the BMT results demonstrate that consumption of a largely organic diet reduces overall pesticide exposure, the clinical significance of this finding is difficult to determine. Research has yet to confirm whether and to what extent dietary pesticide exposure may actually incur harm, so deriving meaning from the results that is relevant to consumers is difficult. Currently there is only limited emerging data to suggest possible harm associated with levels of DAPs that might occur as a result of dietary exposure and this may relate specifically to critical periods of development (Bouchard, et al., 2010; Bouchard, et al., 2011). At this juncture no reference doses exist that might indicate the level at which a specific DAP or combination of DAPs may incur risk in the general population (Sudakin & Stone, 2011). Even if such reference doses did exist, there are many confounding factors determining risks for any individual, including age, comorbidity, concurrent medication use, genetic polymorphisms, the timing of exposure and interactions with other chemical exposures.

10.8 Application

These results may inform health practitioners, policy makers and organic food marketers and consumers when making decisions about the health effects of organic diets. The results may also help to inform future research and the design of more robust trials that also assess health outcomes.

Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
Refer to 6.3 The Problem with Pesticides
Ultimately this should assist consumers in making a more informed decision about whether to incur the additional costs of purchasing organic food in order to reduce their overall exposure to chemicals, in particular OP pesticides.

10.9 Conclusion

The BMT demonstrated that a largely organic diet consumed for one week produced a significant reduction in the levels of urinary OP metabolites in adults when compared to one week on a largely conventional diet. With the exception of DEDTP the results suggest that the tests were sufficiently sensitive to detect differences in dietary exposure.

The OFIS appears to have been largely successful in its intended purpose of confirming the dietary status during each of the trial phases. On average participants were able to attain a largely organic diet during this phase including over 80% certified organic produce and over 90% when likely sources were also included, conventional consumption also exceeded 90% during this phase. The overall dietary pattern was similar between phases with a similar number of overall food servings and consistency between the various food categories. The notable exception was more animal protein in the conventional and more vegetable protein servings in the organic phases. There is no reason to suspect that the conventional phase results were overinflated as a result of this.

As with other free-living adults the study participants were probably exposed to non-dietary sources of OP pesticides during the study period and this is the most likely explanation for the metabolites detected in urine samples during the organic phase. Despite these additional exposures the organic diet was sufficient to cause a statistically significant decrease in overall OP exposure. However, it cannot be assumed that these results can be extrapolated to other pesticides or other regions.

Determining the clinical relevance of the results is complex in light of the limited data providing information on the levels of these metabolites that may cause harm. Further large scale biomonitoring studies with clinical endpoints are required before any meaningful conclusions can be drawn regarding the potential health benefits of reducing pesticide exposure with organic diets.
Chapter 11. Discussion of Key Findings and Associated Issues

Many of the issues below have been discussed in more detail throughout the thesis. This discussion attempts to draw together the key points and discuss the key issues that emerge. Footnotes provide references to more detailed discussions which included the full presentation of data and comparisons with previous research. A number of limitations have previously been discussed in the ‘Results and Discussion’ sections of the relevant chapters but the major ones will be revisited briefly below.

11.1 Background

Health beliefs are important because they drive behaviour, especially if a threat is perceived (Rosenstock, 1966; Rosenstock, Strecher & Becker, 1988), but they may also affect health outcomes. Assessing beliefs that motivate consumer behaviour may be used by unscrupulous marketers to manipulate consumption beyond the needs of the consumer, however ‘societal marketing’ may have a positive impact if the outcome is the promotion of healthier and more environmentally friendly purchasing behaviours (Pearson, et al., 2007).

The beliefs about the health benefits of organic foods are positive amongst Australians (Lea & Worsley, 2005; Lockie, et al., 2002), yet the organic sector only accounts for around 1% of Australian food sales (Monk, et al., 2012) and research into health outcomes from organic diets is limited. Recently there has been a flurry of media attention around reviews reporting that there is a lack of strong evidence for significant or clinically meaningful nutritional or health benefits from organic diets (Dangour, Dodhia, Hayter, Allen, et al., 2009; Smith-Spangler, et al., 2012). As organic foods are generally more expensive than their conventional counterparts, these reports are often accompanied by warnings that it is more important to eat fresh rather than organic produce, suggesting that organic consumers may consume less healthy foods because of the added expense.

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253 Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?: The importance of beliefs
254 Refer to 2.4.7 Organic Consumers – Why do they Consume Organic Food?
255 Refer to Chapter 4. What Evidence is there that Organic Diets Improve Human Health and Wellness?
256 Refer to 5.2.2 Product: Nutritional Differences between Organic and Conventional Produce
Such reviews tend to take a narrow view of ‘health’ and focus on nutritional differences between organic and conventional produce (Dangour, et al., 2010; Smith-Spangler, et al., 2012). While the ideology of ‘nutritionism’ assumes it is the scientifically defined nutrients that determine a food’s value (Scrinis, 2008), there are many factors in the journey from paddock to plate to person that will influence the health of the end consumer.257

In spite of these reviews organic sales in Australia rose 35% between 2010 and 2012 (Monk, et al., 2012)258 and this may be due to consumers placing more value on risk aversion than nutritional superiority. Pesticides may be of particular concern to consumers but studies demonstrating clear harm as a result of dietary pesticide exposure are limited259 and while some studies have demonstrated reduced pesticides in children consuming organic food, as yet there are no published studies comparing pesticide exposures in adults.260

11.2 Hypothesis 1 – In Australia dedicated organic consumers believe that consuming an organic diet is beneficial for health.

The hypothesis is supported by findings not only that OCS respondents reported believing that organic foods were healthier but also by OHWS respondents reporting that they believed they had personally experienced health benefits since moving to an organic diet. The strength of beliefs appears to increase with rising consumption levels, is driven by risk aversion and is not equal across food categories.

The vast majority of OCS respondents agreed or strongly agreed with the statement: ‘Organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ and this belief was stronger in those with higher levels of organic consumption.261 It should also be noted that beliefs around the environmental benefits of organic food production also scored very highly indicating that beliefs and consumption decisions are multi-factorial.

The majority of OHWS respondents said they believed that their overall health was a little or a lot better since moving to organic food and there were a number of specific benefits

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257 Refer to 5.3 The Problem with Nutritionism
258 Refer to 2.1 The Organic Industry
259 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?: Risk to consumers
260 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue: Comparisons between consumers of organic and conventional foods
261 Refer to 8.7.4 Beliefs
reported.\textsuperscript{262} OHWS respondents also reported that their decision to consume organic food was driven more by risk aversion (in particular pesticide avoidance) than positive traits such as nutritional superiority or psychological benefits.\textsuperscript{263}

### 11.2.1 What are the socio-demographic characteristics, behaviours and beliefs of dedicated organic consumers in Australia?

For the purpose of health outcome research it is important to understand the population group under study. At the time this project commenced in 2008 the profile of dedicated organic consumers remained somewhat elusive. Many of the key Australian studies were becoming dated in a field that was changing rapidly, and they generally assessed organic consumers as a subset of the general population so only a small number were dedicated organic consumers.\textsuperscript{264} Since this time the AOMR has begun collecting consumer data and the findings for those expected to be at the higher end of consumption (the ‘Leaders’) were largely similar to the OCS and OHWS results.

Respondents to the OCS and OHWS came from all socio-demographic segments with the majority being female, 25-55 years old, well educated, born in Australia, residing in urban areas and in a healthy weight range. For the most part the demographic characteristics of respondents did not appear to differ with the level of organic consumption (low, moderate or high), and this included income (increasing income did not appear to correlate with increased uptake of organic foods). The ratio of females to males was roughly 4:1.

Female gender is known to be predictive of a more positive response to organic food (Lea & Worsley, 2005) and this is thought to be associated with the responsibility of feeding children and other family members (Lockie, et al., 2004). While other studies have reported similarly high levels of participation by females (Pearson, 2012; van de Vijver & van Vliet, 2012) this result may in part represent an increased willingness or motivation of females to participate and ‘tell their stories’. In addition the recruitment processes and use of internet-based surveys may have resulted in an overrepresentation of certain age, gender and socioeconomic groups.\textsuperscript{265}

Understanding the characteristics (and broad consumption behaviours) of organic consumers informed the inclusion criteria used in the BMT. As the OCS and OHWS only explored high-end consumers, but did so in more depth and with a larger sample than the

\textsuperscript{262} Refer to \textit{9.6.5 Self Reported Measures of Wellness} and \textit{9.6.6 Health and Wellness Effects Reported by Respondents}

\textsuperscript{263} Refer to \textit{9.6.4 Beliefs: Process and product attributes influencing health beliefs and purchasing}

\textsuperscript{264} Refer to \textit{2.4 The Person - Organic Consumers}

\textsuperscript{265} Refer to \textit{8.8 Limitations}
subgroup in the AOMR, the results may also be useful to industry marketers planning strategies to increasing organic consumption. However, because these surveys used a self-selected sample it cannot be assumed that they are completely representative of organic consumers. In addition the results may not be applicable to other regions.

11.2.2 Do dedicated organic consumers in Australia believe organic diets are healthier? If so why?

Several key rationales that explain the perceived health benefits of organic foods have been covered in detail, especially the nutritional and pesticide pathways as well as a brief discussion regarding the possible contribution of other product differences between organic and conventional foods. It appears however, that risk aversion, especially avoidance of pesticides, is particularly important to dedicated organic consumers. This is consistent with the health beliefs model which proposes that a belief in a personal threat together with a belief that a proposed behaviour will be effective in reducing that threat will predict the likelihood of the behaviour being exhibited (Rosenstock, 1982). This is the ‘precautionary principle’ at work, organic consumers perceive that pesticides pose a risk and that organic diets mitigate that risk, and as a result they eat organic food.

Dedicated organic consumers also reported strong opinions with regard to pesticides and were not confident that pesticide residues in food are safe or that conventionally farmed foods are well regulated by governments to ensure they contain minimal pesticide residues. This is likely due to an increasing body of research citing health concerns attributed to occupational and dietary pesticide exposure. A number of concerns have also been raised regarding the regulation and monitoring of pesticides in Australia, including the difficulties associated with predicting whether pesticide exposure will result in harm. For example, accounting for low dose and non-monotonic dose responses, the cocktail effect of mixtures of different chemicals, and the effects of exposure during critical periods of development make risk assessments highly complex and uncertain. There may also be differences in an individual’s exposure to both dietary and non-dietary pesticides and in their ability to metabolise and excrete pesticides. From a monitoring standpoint there is a lack of scope and regularity in the reporting of pesticide residues in food, and very little biomonitoring has been done to assess pesticide exposure in Australian

266 Refer to Chapter 5. The Nutritional Pathway
267 Refer to Chapter 6. The Pesticide Pathway
268 Refer to 2.3 The Product
269 Refer to 8.7.4 Beliefs
270 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
271 Refer to 6.3 The Problem with Pesticides
272 Refer to 6.2.2 Product: Pesticide Residues in Foods
consumers. Furthermore, individuals are generally unaware of their exposure patterns, either current or historical and this contributes to the difficulty in performing studies of specific exposure-outcome relationships.

Whether organic consumers are consciously aware of these issues and the extent to which these beliefs drive behaviour is unclear. However, more than three quarters of OCS respondents said that scientific evidence had a moderate or strong influence on their beliefs about organic food, although this effect weakened as consumption increased. When respondents to the OHWS were asked which conditions they believed that organic diets could assist in preventing, the top ranked conditions were consistent with those where there is some evidence that organic diets reduce incidence (allergic conditions), or where pesticides pose a discernible threat (cancer, developmental and behavioural problems). Yet, while the limited amount of existing research supports the beliefs of dedicated organic consumers, these consumers report that the greatest influence on their beliefs is personal experience.

11.2.3 What percentage of foods servings consumed by dedicated organic consumers in Australia is from organic produce?

Currently there is no consistent definition of an organic diet or an organic consumer, yet some level of quantification of organic consumption is necessary in order to support a dose-response relationship between organic food and health benefits. The majority of self proclaimed dedicated organic consumers who responded to the OHWS, OCS and OFIS, reported consuming ‘mostly’ organic food (> 65%, certified or ‘likely’) and this was confirmed over a 3-day period using the OFIS to quantify the percentage of servings from organic sources. Only a small percentage of respondents consumed in excess of 90% organic food, yet in the BMT where participants attempted to consume a largely organic diet, the average intake was 93% (83% certified organic).

The levels of organic food intake that are readily achievable are likely to vary from region to region so this information may not be applicable to other countries. Quantification of organic food consumption however, is useful for research that attempts to determine any sort of dose-response relationship. If the levels are set too high this may limit recruitment.

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273 Refer to 6.2.3 Person: Pesticide Residues in Human Tissue
274 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
275 Refer to 8.7.4 Beliefs: The influence of scientific evidence on beliefs
276 Refer to 9.6.4 Beliefs: What conditions can be prevented by consuming organic diets?
277 Refer to 8.7.4 Beliefs: The influence of scientific evidence on beliefs
278 Assuming it is sufficiently powered to do so.
opportunities and clinical relevance, while low levels may result in a failure to capture the full health effects of organic diets.

The use of the OFIS, which asks respondents to prospectively record foods as they are consumed, is likely to obtain more accurate information on food type and portion size with less risk of over- or under-reporting than retrospective food frequency questionnaires. A strength of the OFIS is that it provides not only an overall percentage of organic consumption but also allows for a breakdown by food category and distinguishes between certified and 'likely' organic sources. This may be used, for instance, in observational cross-over studies, such as the BMT, to confirm similarity of dietary patterns between phases.

There are limitations in all dietary survey methods and the act of completing a dietary survey can affect eating behaviour. In an attempt to keep the OFIS relatively simple, some detail was lost and the estimation method that was used may not be quantifiably precise. Despite attempts to minimise respondent burden, response rates were disappointing suggesting that the instrument requires further development to improve its acceptability.

11.2.4 How does the intake of organic produce by dedicated organic consumers in Australia vary by food category?

Total organic consumption is uncommon and most consumers alternate between purchasing organic and conventional products (Henryks & Pearson, 2011). Furthermore, the choice to consume organic food is not necessarily consistent across all food categories and any health outcomes may relate only to specific food categories. For instance the KOALA study reported specific benefits from consumption of organic dairy products but not organic diets generally (Kummeling, et al., 2008).

In the OCS and OHWS the most popular organic foods were fruit and vegetables and the least popular were meat products (including poultry and fish), and these results were consistent with previous research. Organic grains, eggs and dairy also recorded high uptake amongst respondents. Fresh fruit and vegetables have a relatively high market

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279 Refer to 8.5.2 Development of the OFIS: Retrospective or prospective?
280 Refer to 10.6.2 Consumption Patterns of Participants
281 Refer to 8.8 Limitations
282 Refer to 8.7.3 Food Categories
283 Refer to 9.6.3 Food Categories
284 Refer to 2.4.3 Organic Consumers – What do they Eat?
share and are considered an entry point for many new organic consumers (Pearson, et al., 2011). The increased uptake of organic fruit and vegetables might be because consumers are more tolerant of paying higher premiums for lower priced foods such as fruit and vegetables (Pearson & Henryks, 2008), however health related beliefs may also play a role.285

The influence of beliefs on consumption patterns may suggest that some sectors of the organic industry are doing a better job than others at promoting the potential health benefits of consuming organic versions of these foods, and this is having an effect on uptake. At present the lack of overall research is accompanied by limited health outcome research for specific food categories. Overtime, larger studies may be able to better differentiate these effects and instruments such as the OFIS will assist in facilitating this.

11.2.5 What are the specific health related beliefs and experiences of organic consumers?

Although beliefs are generally very positive, current evidence of health effects from organic diets is limited.286 Many current assumptions regarding potential effects are based on mitigating harm from pesticide exposure.287 But even if these harms were conclusively established they may be rare or have long latency periods making them impractical to study. Research options are limited by the costs of large-scale long-term studies and the lack of a clear definition of what constitutes an organic diet or even health.288 The scope of the OHWS allowed for exploration not only of beliefs around the prevention and treatment of overt disease but also included self-assessed wellness indicators which may be more practical for research and more meaningful to consumers.

The OHWS respondents believed that consuming organic food could reduce the risk of developing a variety of conditions, in particular cancer, allergic conditions, as well as behavioural and developmental problems in children.289 Allergic conditions are examples of rarely conducted health outcome research on organic diets (Alfvén, et al., 2006; Kummeling, et al., 2008),290 while cancer, behavioural and developmental problems are highlighted as specific concerns in reviews of pesticide health effects (Sanborn, et al.,

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285 Refer to 9.6.4 Beliefs: Health Beliefs and Level of Consumption by Food Category
286 Refer to Chapter 4, What Evidence is there that Organic Diets Improve Human Health and Wellness?
287 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
288 Refer to 2.4.7 Defining Organic Diets; and Chapter 3, Health and Wellness Defined
289 Refer to 9.6.4 Beliefs: What conditions can be prevented by consuming organic diets?
290 Refer to Chapter 4, What Evidence is there that Organic Diets Improve Human Health and Wellness?
Thus it would appear that beliefs reflect the current literature base and this is not surprising given that organic consumers are generally well educated.

There were also many reports of adverse effects respondents believed were associated with consuming conventional food, and around a quarter of the OHWS respondents reported on specific pre-existing conditions they believe had changed since moving to an organic diet, mostly for the better. On the whole the OHWS respondents scored well on the PWI-A and reported significant improvements in their overall sense of wellness since moving to an organic diet.

The benefits most commonly reported by respondents included improvements in resistance to and recovery from illness, physical energy, condition of skin/ hair/ nails, mental alertness, mood stability, and sense of satiety. Many of the reports were similar to those from participants in European studies. These are interesting indicators of everyday wellness, more functional than pathological in nature. There could be a number of possible explanations for these perceived improvements. For instance, even subtle nutritional differences if they occur at a tissue level (and this needs to be distinguished from what happens at a product level and is ‘statistically significant’), may impart benefits beyond simply meeting RDIs. Optimal function may be impaired well before signs and symptoms of overt deficiency arise. It is also possible that pesticides or other agricultural inputs play a role in these conditions or increase demand for nutrients required for their metabolism. There may also be psychological factors or other concomitant behaviours that influence health and wellness and these will be discussed shortly.

Again I stress that this was a self-selected sample that was not necessarily representative of all organic consumers. It is acknowledged that this research is subjective, asking participants to self-assess their health and wellness, and often used closed questions; as such it is not designed to prove causation. It may however identify possibilities for

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291 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?  
292 Refer to 9.6.7 Reported Reactions to Conventional Foods  
293 Refer to 9.6.5 Self Reported Measures of Wellness: Personal Wellbeing Index (PWI-A)  
294 Refer to 9.6.5 Self Reported Measures of Wellness: Perceived change in wellness  
295 Refer to 9.6.6 Health and Wellness Effects Reported by Respondents  
296 Refer to 9.6.6 Health and Wellness Effects Reported by Respondents; and 4.6 Self-reported Health  
297 Refer to 5.2.2 Product: Nutritional Differences between Organic and Conventional Produce: Relevance for health  
298 Refer to 5.1 Why Might Organic Diets Improve Health and Wellness?  
299 Refer to 11.4.2 Other Factors that may Contribute to Health Benefits for Organic Consumers 11.4.3 Psychological Benefits Associated with Organic Diets  
300 Refer to 9.7 Limitations
hypothesis development. For instance several common outcomes were reported in the OHWS and European studies, such as improved resistance to and recovery from illness, increased physical energy and improved sense of satiety after eating. Given that there are biological rationales to explain these effects future research may be warranted.

11.3 Hypothesis 2 – Consuming a minimum of 80% of food servings from organic produce reduces urinary dialkylphosphate metabolites in Australian adults.

The hypothesis is supported by findings from the BMT that consuming a largely organic diet compared to a largely conventional diet for 7 days results in a statistically significant reduction in urinary dimethyl DAPs which reflects reduced exposure to organophosphate pesticides. However, large scale studies are required to confirm this effect.

11.3.1 Does a largely organic diet reduce OP pesticide exposure in Australian adults?

It would appear that Australian organic consumers generally hold strong beliefs that organic diets are beneficial to health because they contain less pesticides. At the very least, for this belief to be more widely accepted, two basic premises need to be established; a) that exposure to pesticides at levels found in the diet can cause harm; and b) that the consumption of an organic diet significantly reduces pesticide exposure. This would not necessarily prove that organic diets are better for health but it at least strengthens the plausibility of the biological rationale.

For the first premise research does appear to be progressing in this area. However the lack of research on pesticide exposure in consumers of organic food requires attention. While diet is considered to be the primary route of exposure for non-occupationally exposed individuals, exposure to non-dietary sources may also occur, as may adventitious contamination of organic food. Thus even if a 100% organic diet was readily achievable some exposure is still likely and research needs to evaluate the extent to which an organic diet reduces exposure.

The BMT confirmed that consuming a largely organic diet reduces levels of urinary DAPs which are non-selective markers of OP pesticide exposure. Overall the consumption of organic food for 7 days resulted in a statistically significant reduction in urinary OP metabolites. The mean total DAP results in the organic phase were 89% lower than in the

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301 Refer to 6.1.2 What are the Health Concerns for Pesticide Exposure?
302 Refer to 6.3.4 Non-dietary Sources of Pesticide Exposure
303 Refer to 6.3.1 Accidental Contamination of Produce with Pesticides
conventional phase and total dimethyl DAPs were 96% lower. Although the mean total diethyl DAP levels were around half in the organic compared to the conventional phase, this difference was not statistically significant.\textsuperscript{304}

It is important to note that DAPs are non-selective biomarkers so it is not possible to use their presence to attribute exposure to specific pesticides within the OP class, nor can they be considered surrogate markers for exposure to other pesticides or as indicators of improved health. Thus, while the findings of the BMT suggest that organic food consumption leads to reduced OP pesticide exposure, they do not provide direct evidence that organic diets lead to improved health. Future research needs to be conducted to investigate correlations between the amount of organic food consumed, the level of urinary pesticide metabolites and any related health and wellness outcomes.

\textbf{11.3.2 Are commercially available testing methods sufficiently sensitive to detect dietary differences in pesticide exposure?}

One of the difficulties associated with studies of dietary exposure to pesticides is that testing methods often lack the required sensitivity. Commercial laboratories that measure DAPs are geared to identifying unacceptable sources of occupational exposure which are orders of magnitude higher than the population exposure levels through diet.

The importance of test sensitivity was highlighted in a comparison of the results obtained using the low LODs of the chosen laboratory compared to the high published LODs of a second laboratory, as well as the moderate LODs (20% of the published LODs) that were offered by the second laboratory. Only the LODs actually used in the BMT study were sensitive enough to detect metabolites in urine during the organic phase. Had we used the high LODs of the second laboratory there would have been only one detection during the study, in the conventional phase. This may have led to an erroneous assumption that both organic and conventional urine samples were relatively free of the tested metabolites and there was no significant difference between the phases. Even when using the moderate LODs of the second laboratory there would have been only eight detections, all of which would have been in the conventional samples. This too may have led to an incorrect assertion that the organic samples were free of residues rather than being significantly lower.\textsuperscript{305}

\textsuperscript{304} Refer to \textit{10.6.4 Total DAP Results}
\textsuperscript{305} Refer to \textit{10.6.6 Sensitivity of Tests: Are the Testing Methods sufficiently Sensitive to Detect Differences in Pesticide Exposure?}
The results of the BMT indicate that the tests used, were sufficiently sensitive to detect
dietary exposure to OPs with the exception of DEDTP. Previous studies had also reported
analytical concerns or low frequency of detection for this metabolite. 306

Whether testing biomarkers in human tissue, residues on produce, or comparing studies,
test sensitivity and LODs are important considerations as they may vary between studies
making comparison meaningless especially with regard to frequency of detection. The
choice to use of high LODs may introduce an unacceptable risk of bias and lead to false
negative results (type II error) and inaccurate conclusions.

11.4 Associated Issues

11.4.1 Response to Concerns that the Additional Expense of Organic Food will
Negatively Impact Food Behaviours

The price premium is often identified as a key barrier to organic consumption, however
price is not always a deterrent. 307 The OCS confirmed previous studies reporting that
income has little impact on the decision to purchase organic foods or the amount
consumed. 308 It appears to be generally accepted, especially amongst more educated
people who are heavily represented in these surveys, 309 that the additional care and costs
involved in organic production and certification processes warrants a price premium
(Paull, 2007). Respondents in the OCS reported that whether the farmers received a fair
price also played a role in their purchasing decisions. 310

In reality spending on organic food is more about the way the household budget is
prioritised than income levels. In 2010, the average Australian household spent a lot more
on takeaway, fast food and confectionary ($42.27) than fruit and vegetables ($23.30)
(ABS, 2012b). Even significant premiums for organic food could therefore be
counteracted by reducing consumption in other areas, and probably with additional health
benefits.

While concerns are often raised that the added cost of organic produce will result in
decreased consumption of healthy foods like fresh fruit and vegetables, this does not
appear to be the case. Respondents in the OFIS consumed on average 3.0 servings of fruit and 4.6 servings of vegetables daily. These figures are higher than Australian averages. Despite years of public health campaigns in Australia which promote ‘two fruits and five vegetables a day’, not many adults meet this target. In 2007-08 only around 9% of Australian adults ate five or more serves of vegetables and one or more serves of fruit a day; with a further 11% consuming four serves of vegetables and one or more serves of fruit (ABS, 2012b). International studies have also reported higher vegetable intake amongst organic consumers (Hoefkens, et al., 2010).

In the OHWS, respondents reported that the shift to organic food coincided with eating less meat and more freshly prepared foods and this was also the case in the Dutch study (van de Vijver & van Vliet, 2012). In the BMT, participants consumed the same amount of fruit in each phase (3.1 serves) and slightly more vegetables (3.9 vs. 3.6 serves) in the organic than the conventional phase. However, they consumed 36% less animal protein in the organic than the conventional phase (0.9 vs. 1.3 serves) and 24% more vegetable sources of protein (1.2 vs. 1.0). Given that the protein levels were reasonably well maintained, the shift from animal to vegetables sources would generally result in increased fibre and phytonutrients and less saturated fat and cholesterol and thus would be considered positive by nutritionists. There may be a slight reduction in iron and vitamin B12 but not to an extent that would be likely to be clinically significant. Larger scale research would be required to validate these effects but at present it does not appear that the choice to consume organic results in a negative impact on healthy nutrition.

I would suggest that the reduction in animal protein and increase in fresh produce reported by respondents may in part be a reflection of consumers attempting to balance the household food budget by paying more per kilogram for their organic meat but eating less of it. Instead they may increase the ratio of vegetables to meat in their diet, in addition they may purchase certain organic food only when it is in season, when the prices tend to be lower, but when the nutritional value is likely to be higher. To get better prices they may seek out more alternative sources such as farmers’ markets, or they may grow some of their own food. This is likely to mean that the food is consumed closer to harvest which is also likely to increase its nutritional value. So ultimately, the ‘cost barrier’ may indirectly encourage consumers to be more creative in their food choices and this
may have additional benefits for health that are not directly related to the produce being organic.\textsuperscript{311}

Factors other than cost may also influence organic food choices. In the German nun study, as in the BMT, there appeared to be a shift away from animal protein (K. Huber, 2005, cited in Meier-Ploeger, 2005), but in this case the food appeared to have been provided so cost was not a factor. One theory is that organic fresh produce is more enjoyable, possibly due to improved taste driven by increased levels of secondary metabolites,\textsuperscript{312} and is thus consumed in relatively greater amounts displacing the proportion of meat.

The nuns also reported improved appetite during the organic phase (K. Huber, 2005, cited in Rembialkowska, et al., 2008). It has been my observation as a practitioner that poor appetite doesn’t necessarily result in reduced food consumption. Rather, food preferences may be distorted so that a person with a poor appetite may not hunger after a bowl of salad but will happily consume a bag of high fat/ sugar/ salt snack foods. It may be that more intense flavours stimulate digestion and this may also be the case with organic foods. This is supported by reports that consumers feel more satiated by organic produce in the OHWS and Dutch study (van de Vijver & van Vliet, 2012). Improved satiety may be the result of subtle differences in nutrient levels or the bioavailability of nutrients, secondary metabolites or natural enzymes that support digestion. A number of reviews have indicated that organic food has more dry matter (Lairon, 2010; Rembialkowska, 2007), so on a plate the same amount of food may have a greater concentration of nutrients. These issues are worthy of exploration in future research.

In naturopathic and other traditional systems of medicine it is believed that food has a ‘life force’ or energy pattern and that satiation is not just based on the physical matter in food, but also on an intake of this ‘energy’. The closer to harvesting that food is consumed the more likely this energy is to be retained.\textsuperscript{313} These things are not simple to assess but it is important to remain mindful that there may be effects that exceed the current boundaries of scientific enquiry.

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\textsuperscript{311} This is a line of enquiry worthy of further investigation as at present cost, and its potential effect on food intake, is one of the more commonly cited reasons not to consume organic food.

\textsuperscript{312} Refer to 5.2.1 Process: Organic and Conventional Farming Practices: Secondary metabolites

\textsuperscript{313} To my knowledge there is no Australian data that differentiates between organic and conventional produce with regard to the length of time from harvest to consumption. However the different shopping patterns, especially of high end organic consumers who appear more likely to frequent farmers markets and grocers for their fresh produce rather than supermarkets is likely to result in shorter times.
There were also factors reported in the OCS that may have the potential to adversely affect nutrition when organic choices are not readily available. Many of the OCS respondents said there were certain foods they would not eat unless they were organic, in particular certain fruits and vegetables, and this may limit variety in the diet. Those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic varieties and this may result in nutrient loss.\(^{314}\)

Studies have shown that urinary OP metabolites in children increase with increased consumption of fruit and vegetables (Bradman, et al., 2011). While this may be of particular concern in this vulnerable population group, the effect is also likely to occur in adults. Thus it may be more important for those who adhere to the ‘two fruits and five vegetables a day’ recommendation to consider organic options.

### 11.4.2 Other Factors that may Contribute to Health Benefits for Organic Consumers

Due to the dearth of direct evidence of positive health effects from organic food consumption, differences in process and product attributes are often used to explain potential benefits. This includes positive attributes (e.g. nutrients and secondary metabolites)\(^{315}\) as well as negative ones (pesticides\(^{316}\) and other agricultural or food production inputs).\(^{317}\) However, there are many other factors that impact on health and the decision to eat organic food including: the choice of foods, food processing and preparation, health and environmental beliefs, barriers such as cost and availability, engagement in health promoting activities, avoidance of non-dietary sources of chemicals or having a more positive outlook. Thus the health and wellness effects of an organic diet cannot be attributed to product attributes alone.

The move to an organic diet may also be part of a larger decision to prioritise health. For instance amongst OHWS respondents many reported that the move to organic food coincided with other changes that may have had an impact on their health such as increasing exercise, introducing stress management techniques such as meditation or yoga, and reducing chemical use in the household and in personal care products.\(^{318}\) Many respondents in the OCS also said they opt for natural alternatives to pesticides whenever possible and were never or only rarely exposed to residential, personal and commercial

\(^{314}\) Refer to 8.7.6 Food Preparation Behaviours

\(^{315}\) Refer to Chapter 5. The Nutritional Pathway

\(^{316}\) Refer to Chapter 6. The Pesticide Pathway

\(^{317}\) Refer to 2.3 The Product

\(^{318}\) Refer to 11.4.2 Other Factors that may Contribute to Health Benefits for Organic Consumers
pesticides.\textsuperscript{319} Organic consumers in a Polish study reported exercising more and choosing better ways to manage stress. They evaluated their living environments more positively and their nutritional patterns were more in line with the recommendations of nutritionists (Rembialkowska, et al., 2008).\textsuperscript{320} All of these factors may have contributed to their reported health benefits. Future research may also consider additional lifestyle choices. For instance, in addition to engaging in stress management techniques, do organic consumers actively seek to reduce their exposure to stressors, both emotional and physical? Do they engage in less risk taking behaviours? Do they consume less alcohol or smoke less than non-organic consumers?

Respondents in the OCS also reported other factors that influenced their purchase decisions such as; whether the food was in season, the distance it travelled, the amount of processing, the amount of packaging, where the food was grown, the working conditions for producers and the nature of the seller.\textsuperscript{321} These factors have implications for the nutritional value at the point of consumption, the presence of other contaminants that may contribute to the cocktail effect of chemicals, and the psychological benefits experienced by consumers.

11.4.3 Psychological Benefits Associated with Organic Diets

While psychological benefits rated low in the OHWS there may have been some confusion about what this question was asking as many respondents made comments that indicated that they had positive psychological associations with organic food. For example one respondent wrote:

“Being someone who loves food, eating food that tastes real has made a huge difference in our enjoyment of the meals we prepare, as well as easing our social conscious as we’re doing our bit for the earth, as well as making us feel better about ourselves”

This ‘feel good factor’ was also noted in the Dutch study which the authors described as a sense of ‘doing good for the world’ (van de Vijver & van Vliet, 2012). It has been proposed that consumers may associate purchasing organic food with purchasing good health (Grossman, 1972) or investing in the long term future and health of the planet and its inhabitants (Williams & Hammitt, 2000).\textsuperscript{322}

\textsuperscript{319} Refer to 8.7.7 Non-dietary Sources of Pesticide Exposure
\textsuperscript{320} Refer to 4.6 Self-reported Health
\textsuperscript{321} Refer to 8.7.4 Beliefs: Other beliefs
\textsuperscript{322} Refer to 9.6.9 Psychological Effects of Organic Diets
A television interviewer once quipped to me that “the reason people buy organic food is so they can tell people they buy organic food” (A. Lehman, personal communication, September 4, 2012). This is not a trivial point as there are surely psychological benefits for a consumer purchasing a product that they believe reflects their values, and expresses those values to others. This may be described as ‘conshumanism’, or ‘putting your money where your mouth is’.

Although the focus of the OHWS was on health related beliefs, a number of respondents made a point of commenting that there were other reasons they purchased organic food, for example:

“Only part of the reason I buy organic is health, I also do it for environmental, social responsibility and ethical reasons.”

In addition a large number of respondents in the OCS reported that their purchase decisions were influenced by environmental concerns and whether the farmers received a fair price and conditions. The organic farm workers in one study were happier than their conventional counterparts, and although this was attributed to the increase in the variety of tasks performed by this group (Cross, et al., 2008), it may also be an example of a psychological benefit derived from being part of something that is perceived to be more environmentally and socially responsible.

OHWS respondents rated particularly highly on the PWI-A in the domain of community connectedness and this was reflected in the following respondent’s comment:

“I feel connected to where my food comes from. I love to take organic food as gifts and I enjoy buying it to serve to friends. I also feel buying organic is an investment in all futures… I feel positive and empowered. I also feel part of a community a movement ... That must be healthy ...”

The wellness benefits of this ‘feel-good factor’ should not be underestimated. A number of OHWS respondents acknowledged the perceived improvement in their wellness may have been influenced by this psychological benefit, for instance:

“How much of this is a placebo affect I could not say, but there is something psychologically benefiting from eating organic and feeling good about that, and this seems to transfer to physical wellbeing.”

\[323\] Refer to 8.7.4 Beliefs: Other beliefs
\[324\] Refer to 4.7 Studies in Farm Workers
It is generally accepted that beliefs influence behaviour and health. The much maligned ‘placebo effect’ is often taken to mean that any effect is ‘just in the head’. Yet what it really tells us is that the mind and the body are interconnected and the mind can have a powerful influence on health, both positive and negative. For instance, in studies of herbal supplements participants who believe in the effects of the herb have a better response to both the active and placebo treatment (Barrett, et al., 2011). The influence of the mind on physiological processes has long been accepted by traditional systems of medicine and has more recently been acknowledged by western science through the exploration of fields such as psychoneuroimmunology and psychoneuroendocrinology.325

Food-induced emotions also have a psychological impact on our wellness and are believed to be evoked by cognitive associations, yet only a fraction of the sensory information from food-induced emotions makes its way into our consciousness (Geier, Hermann, Mittag & Buchecker, 2012).

**11.4.4 Broadening the Scope of Research**

The principles and practices of organic agriculture have a great deal in common with the wellness movement (and the traditional systems of medicine from which it has drawn). Both are fundamentally wholistic in nature, working with rather than suppressing natural cycles and recognising the importance of inter-relationships. In organic agriculture for instance the health of the soil is fundamental to the quality of crops and livestock. Natural systems are valued and supported. There is a sense of community and timelessness; an acknowledgement that the choices made will have an impact on others, not only now but into the future.

Whereas wellness and organic agriculture are inherently wholistic, the way they are evaluated in research is generally not. The current dominance of reductionism and mechanism in health research encourages biological determinism and allows researchers to ignore the context of the phenomena they observe (Fehr, 2004). Thus the scientific model will break an issue down to its smallest answerable parts and attempt to derive meaning about the whole based on the data generated. So while it may aim to address an important question, it often answers a more trivial one of debatable significance. This has been described as ‘the academic tradition of knowing more and more about less and less,

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325 Psychoneuroimmunology and psychoneuroendocrinology involve the transdisciplinary study of the interaction between psychological processes and the nervous and immune systems/ endocrine systems.
until you know everything about nothing’ (Pinker, 2000, p. ix). In an endeavour to maintain scientific rigour, clinical relevance can sometimes be lost.

Despite the breadth of the 1948 WHO definition, the narrower working definition of the term ‘health’, that it is the absence of disease, is often utilised in health research. An example of this is the FSA report (Dangour, et al., 2010), which interpreted relevant health outcomes as effects on defined diseases and thus concluded that evidence for health effects from organic food was lacking (M. Huber, et al., 2012). Much of the current research favours a reductionist approach considering only specific product attributes or functional biomarkers. For instance, the majority of studies cited in reviews seek to understand the health benefits of organic foods merely through the individual nutrients they contain, but this tells us little about what happens in the actual consumer.

Measuring ‘health’ status at a ‘person’ level is generally thought to require reliable physiological biomarkers that will readily evaluate a reduction in disease (M. Huber, et al., 2012). But assessing wellness using these markers may not be particularly useful, as the processes that are involved in disease progression are not necessarily the same as those that promote wellness and there can be considerable inter-individual variability in the levels that are ‘normal’ for any individual, and this may vary over the lifespan (van Ommen, Keijer, Heil & Kaput, 2009). Currently the availability of objective markers that demonstrate improved ‘wellness’, even at a simply physiological level, are limited. Certainly there are biomarkers that would make a useful contribution to the health discussion; and Machteld Huber and colleagues have suggested that markers of oxidative, cardiovascular, immunological and psychological stress may be of value, but they also recognise that these can only describe a small part of the health phenomenon (M. Huber, et al., 2012).

If we look at the value of organic food only under the narrow microscope of nutritionism or focus only on biomarkers we can lose sight of the big picture and the actual outcome we are interested in… health! Evaluating organic diets from a wholistic wellness perspective is more likely to capture the full potential of organic diets to positively impact wellness and will be more meaningful to consumers.

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326 Or in the words of British songwriter Paul Weller… “The more I see, the more I know. The more I know, the less I understand” (Weller, 1995).

327 Refer to Chapter 3, Health and Wellness Defined

328 Refer to 5.3 The Problem with Nutritionism
The wholistic perspective recognises that everything is related, even when the relationships have not necessarily been clearly defined. It allows for the possibility of ‘as yet unknown factors’. It is accepted that at best we can only ever approach full understanding and that the individual elements are not necessarily static. As such it may be better assessed using general systems theory which recognises that real systems are open to, and interact with, their environments. So rather than reducing an entity to its individual parts, systems theory focuses on the arrangement and relationships between the parts which connect them as a whole (von Bertalanffy, 1969).

A wholistic approach would consider not only what’s in the food (all nutrients and secondary metabolites, not just the ones that have been identified); but also what’s not in the food (pesticides, antibiotics, hormones, GMOs, food additives etc). It would recognise the different food choices and food preparation behaviours and the concomitant health-promoting dietary and lifestyle factors that may coexist with an organic diet. It may utilise wellness ‘biomarkers’ and outcomes, but would also look at other indicators of wellness such as a greater sense of connection with the community, and the psychological benefits derived from purchasing a product that the consumer believes expresses their values.

A recent Portuguese review asked that the organic discussion be contextualised within a broad spectrum of health promotion to include associations that are held with organic farming such as support for small farming, biodiversity, and local sustainable development (Sousa, et al., 2012). A wholistic perspective would therefore consider the role of the food production system and its impact on the environment, society and other species (both in Australia and in more vulnerable communities) and the possible ramifications of any disruptions.

To fully understand whether organic diets promote better health and wellness we need to consider the bigger picture. While many of the pieces of the puzzle may currently be missing, it is essential that we view each piece as part of a greater system that contributes to human health and wellness through the inter-relationships between the pieces. It is not within the scope of this thesis to be able to fill in all of the pieces of this puzzle nor to describe all of the potential inter-relationships but I hope I have elucidated a few pieces.
Chapter 12. Conclusion

This thesis brings together the available evidence for the health effects of organic diets, identifies where there are gaps in the literature and highlights the inherent difficulties associated with research in this field. It explores in detail two of the key pathways, pesticides and nutrients, that may help to explain the health effects of organic food consumption; and highlights the complexity involved in attempting to use product attributes to predict health benefits for consumers.

The results of my research (Figure 12.1) support the hypotheses that organic consumers believe that organic diets are healthier, and that an organic diet is able to reduce OP pesticide exposure in Australian adults.

The OCS and OHWS updated and expanded upon what was previously known about the socio-demographic characteristics of Australian organic consumers. While these studies used self-selected cohorts and cannot claim to be representative samples of organic consumers there were striking similarities between them, and consistencies with other studies, both in Australia and abroad. Respondents were predominantly female, highly

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Figure 12.1. Some of my contributions to the puzzle.329

Appendix 1. Full page image.
educated and in a healthy weight range, but income did not appear to have a direct effect on the amount of organic food consumed.

When considering the health effects of organic food consumption it is important to describe what is meant by an 'organic diet'. The survey results suggest that dedicated organic consumers in Australia commonly consume more than 65% organic produce but a totally organic diet is rare. This research provides a first attempt at quantifying the level of organic food consumed according to different food categories using the OFIS instrument. Future research into health effects of organic diets will benefit from determining realistic criteria for organic consumption and quantifying consumption by select food categories. This will allow subgroup analysis and confirmation that there is dietary consistency across phases in cross-over studies.

The surveys also explored differences in consumption across food categories and added new knowledge such as food preparation behaviours and the influence of health related beliefs on the consumption of different organic food categories. Organic fruit and vegetables had the highest uptake and animal flesh products the lowest. Many consumers did not eat various food categories unless they were organic and those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic produce. Beliefs about the health effects of organic food were not consistent across all food categories and consumers who believed that a specific organic food category was better for health, were more likely to consume the organic version most of the time (i.e. >65% of the time they ate the food); and eat it at least 2-3 times/week.

Beliefs are important because they effect behaviour and also outcomes. Dedicated organic consumers believe that organic diets are healthier and express substantial concerns about the effects of pesticides on human health and the environment. Their decision to purchase organic food appears to be driven more by risk aversion (especially to pesticides), than nutritional superiority. Beliefs about the preventative effects of organic diets echo current research on organic diets (allergic conditions) and pesticides (cancer, and behavioural and developmental problems in children).

More than 75% of OHWS respondents believed that they had experienced personal health benefits as a result of moving to an organic diet. Several of the wellness outcomes reported warrant future investigation, for instance; resistance to and recovery from illness, improved physical energy, and weight management related to improved satiety.
The results of the surveys suggest that organic diets provide psychological benefits that extend beyond health beliefs and include environmental, social and other factors. Concomitant health-promoting dietary and lifestyle factors also appear to coexist with an organic diet and barriers such as cost and availability may indirectly encourage beneficial food choices. These factors are likely to have contributed to the health benefits reported by consumers and assessing the full scope of wellness effects from organic diets should not ignore these contextual issues.

The results of the biomonitoring trial confirmed that a largely organic diet (>80%) for one week significantly reduced exposure to OP pesticides in Australian adults. The average reduction in total DAP metabolites was 89% (p<.05). There was a significant 96% reduction in urinary dimethyl DAPs and a 49% reduction in diethyl DAPs which was not significant. The commercially available tests used in this trial were sufficiently sensitive to detect differences in dietary exposure to OP pesticides with the exception of DEDTP. This study highlighted the need to carefully consider the sensitivity of tests in future trials, as those with high LODs may lead to false negative results (type II error). Given the increasing body of research on adverse effects from low level exposure to these chemicals, a reduction in OP exposure is likely to be a desirable outcome. Whether the reduction in exposure will result in direct health effects requires further, more detailed research.

While the results of the biomonitoring trial provide valuable information, it is important that the exploration of the health effects of organic diets is not limited to investigating only pesticide effects (or nutritional comparisons). Any benefits are likely to be explained by the combined effect of multiple factors rather than a single premise. A wholistic approach needs to be embraced to capture the full potential of organic diets to positively impact wellness and this should also recognise: other differences in conventional food production inputs and practices, changes in food choices, food preparation behaviours, psychological factors and concomitant health-promoting dietary and lifestyle factors that may be associated with organic diets.

From a wholistic perspective the potential benefits of organic diets appear to outweigh any additional expense for dedicated organic consumers. However, much work still needs to be done to elucidate whether and to what extent organic diets affect specific health outcomes and any dose-response effects so that consumers can make more informed decisions. I hope that the findings presented in this thesis have filled in a few pieces of the puzzle and make the way forward a little clearer.
References


Kissel, J. C., Curl, C. L., Kedan, G., Lu, C., Griffith, W., Barr, D. B., et al. (2005). Comparison of organophosphorus pesticide metabolite levels in single and


Appendices

Refer to attached document.

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Appendix 3. Organic Food Intake Survey Documents

Appendix 4. Organic Health and Wellness Survey Documents

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Appendix 1. Full Page Images

Figure 1.1. Elements of the various projects contributing to this thesis.

OCS
Organic Consumption Survey (N=318)

- The surveys updated and expanded upon previous research. Respondents were predominantly female, tertiary educated and in a healthy weight range.

OFIS
Organic Food Intake Survey (Pilot N=17)

- Many dedicated organic consumers, consume a diet consisting of mostly (>85%) organic produce but a 100% organic diet is rare. There is higher uptake of organic fruit and vegetables than other food categories.

OHWS
Organic Health & Wellness Survey (N=643)

- More than 75% of respondents perceived their overall health to be better since moving to an organic diet, including better resistance, energy and satiety. Psychological benefits and other lifestyle changes are likely to play a role.

BMT
Biomonitoring Trial (N=13)

- In Australian adults a largely organic diet (>80%) for 7 days significantly reduced exposure to organophosphate pesticides. The average reduction in total DAP metabolites was 89% (p<.05).
**Figure 5.1.** Biological rationale for why organic diets might improve health and wellness.

- **Process**
  - Organic values
  - Focus on soil health
  - Synthetic chemicals (inc pesticides) not generally used in production
- **Product**
  - More nutrients in food
  - No/low residues in food
- **Person**
  - Improved nutritional status
  - No/low residues in the person
- **Outcome**
  - Health benefits
  - Harm mitigation
Figure 6.1. Biological rationale for why conventional diets might cause harm to human health.
**Figure 6.2.** Why it’s difficult to say whether pesticides cause harm to human health (and if organic diets can mitigate such harm).

- **Pesticides used in food production**
  - Accidental contamination during production, transport or storage
  - Non dietary sources of pesticide exposure
  - Dermal absorption
  - Respiratory inhalation
  - Accidental ingestion
  - Exposure to other chemicals

- **Food choice**
  - Food preparation

- **Pesticide residues in the person**
  - Interaction with other chemicals

- **Pesticides circulate in the body**
  - Dose response unclear

- **Pesticides target body tissue**
  - Effects of timing unclear
  - Other factors that may increase risk

- **Individual susceptibility**
  - Potential for harm

- **Inter/ intra-individual differences in absorption**

- **Inter/ intra-individual differences in metabolism / excretion**
Figure 9.3. Health beliefs influencing purchasing behaviour.
Figure 9.4. Beliefs about organic food consumption preventing disease
Figure 9.6. Comparison between OHWS respondents and Australian averages for the different domains of the PWI-A.
Figure 9.8. Perceived wellness effects reported by respondents.
Figure 9.9. OHWS respondents reported reactions to conventional food (by body system).
Figure 10.2. Design of biomonitoring trial.

- **Pre-study**
  - Undertake diet for 7 days
  - Complete OFIS to confirm organic or conventional food intake

- **Day 1-7**
  - Undertake diet for 7 days
  - Complete OFIS to confirm organic or conventional food intake

- **Day 8**
  - Urine analysed for DAP metabolites

- **Day 1-7**
  - Undertake diet for 7 days
  - Complete OFIS to confirm organic or conventional food intake

- **Day 8**
  - Spot urine sample (first morning void)
  - Complete CEFBeS

- **Spot urine sample (first morning void)**
  - Complete CEFBeS
Figure 12.1. Some of my contributions to the puzzle.

OCS
Organic Consumption Survey (N=318)

Updated and expanded upon previous research. Respondents were predominantly female, tertiary educated and in a healthy weight range.

OFIS
Organic Food Intake Survey (Pilot N=17)

Many dedicated organic consumers, consumed a diet consisting of mostly (>65%) organic produce but a 100% organic diet is rare. Higher uptake of organic fruit and vegetables than other food categories.

OHWS
Organic Health & Wellness Survey (N=404)

More than 75% of respondents perceived their overall health to be better since moving to an organic diet, including better resistance, energy and satiety. Psychological benefits and other lifestyle changes likely to play a role.

BMT
Biomonitoring Trial (N=13)

In Australian adults a largely organic diet (>80%) for 7 days significantly reduced exposure to organophosphate pesticides. The average reduction in total DAP metabolites was 89% (p<.05).
Appendix 2. Organic Consumption Survey

Documents

OCS Project Information Statement

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT
PROJECT INFORMATION STATEMENT

Project Title:
- “Behaviours and beliefs of Australian organic consumers – Organic Consumption Survey (OCS)”

Investigators:
- Ms Liza Oates (PhD candidate, School of Health Sciences, liza.oates@rmit.edu.au)
- Dr Marc Cohen (Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University, marc.cohen@rmit.edu.au, 9925 7440)

You are invited to participate in a research project being conducted by RMIT University.

This information sheet describes detailed information about the project in straightforward language, or ‘plain English’. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project before you decide whether or not to take part in it.

Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators. You may also wish to discuss the project with a relative or friend. Feel free to do this.

Once you understand what the project is about and if you agree to take part in it, you will be asked to proceed to the survey. Your consent to participate in this project will be implied if you choose to complete and submit the survey. By submitting the survey you indicate that you understand the information and that you give your consent to participate in the research project.

Who is involved in this research project?
This project is being conducted by Ms Liza Oates (B HSc [Naturopathy], GradCert Evidence-based Comp Med) under the supervision of Professor Marc Cohen (Professor of Complementary Medicine, School of Health Sciences, RMIT University) as part of a PhD program in the School of Health Sciences at RMIT University. The project has been approved by the RMIT Human Research Ethics Committee.

Why have you been approached?
You have been approached because you have registered your interest in this project and indicated that you consider yourself to be an ‘organic consumer’. If you know of other
people who may be interested in participating, please encourage them to seek more information from www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Prof Marc Cohen on 03 9925 7440.

What is the project about?
The purpose of this project is to identify the behaviours and beliefs of people who consume organic foods. This information will be collected as part of an ongoing trial to determine whether organic consumers have different levels of certain agricultural chemicals in their bodies than people who consume conventional (non-organic) foods. The information from this survey will be used to ensure that the ongoing trial is relevant to and reflective of Australian organic consumers. It is anticipated that approximately 300 people will participate in the project.

The findings of this research and the ongoing trial will enable consumers to make a more informed decision about whether to incur the additional costs of purchasing organic food in order to reduce their overall exposure to chemicals. It may also potentially provide the organic industry with a scientific basis on which to make claims. If you are also interested in being involved in the ongoing trial please register your interest at www.tobeconfirmed.com.au.

If I agree to participate, what will I be required to do?
You will be asked to read this statement before proceeding to the online ‘Organic Consumption Survey’ (OCS). Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your beliefs and behaviours regarding organic foods. You will also be asked questions about other chemicals that you may be exposed to and for general health information. You will not be asked for your name, address or any other personal identifying information. It is anticipated that this survey will take approximately 20-30 minutes to complete.

If you would like to view a copy of the survey before agreeing to participate it can be located on the study website at: www.rmit.edu.au/wellness/OrganicResearch.

What are the risks or disadvantages associated with participation?
If you are concerned about your responses to any of the survey questions or if you find participation in the project distressing, you should contact the investigator (Liza Oates) as soon as convenient. Liza will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary. You can suspend or end your participation in the project at any time if any distress occurs.

What are the benefits associated with participation?
The information collected in this survey will ensure that the ongoing trial is more scientifically rigorous and reflects the characteristics of Australian organic consumers so that the final results will be more relevant. The results of the ongoing trials may assist you in making a more informed choice about whether incurring the additional expense of organic food might be of personal benefit to you. This project may also lead to future research assessing whether various detoxification programs may assist in eliminating such chemicals.

What will happen to the information I provide?
It is anticipated that the results of the project will be published on the study website and in a respected scientific journal. In any publication, information will be provided in such a way that you cannot be identified. The data published will be in a form that gives group values and in no way identifies any specific individuals in the project.
Any survey information collected will be coded, and will not be stored with any details that can be used to directly identify you. Only the investigators will have access to the coding system which will be password protected. Only investigators will have the password.

Responses to the survey will be stored on a host server that is used by the primary investigator (Liza Oates). Once data collection and analysis are completed the data will be imported to the RMIT (SEH Research Unit) server where it will be stored securely for a period of five (5) years before being destroyed. The data on the host server will then be deleted and expunged.

Any hardcopy documents will be kept in a locked cabinet to which only the investigators will have the key. Once the project is complete and results have been published these copies will be destroyed.

In accordance with the Freedom of Information Act 1982 (Vic), you have the right to access and to request correction of information held about you by RMIT University.

**What are my rights as a participant?**
You have the right to have any questions answered at any time. Continue to the survey only after you have had a chance to ask your questions and have received satisfactory answers.

Participation in any research project is voluntary. You are entitled to withdraw your participation at any time, without prejudice. In this event you may request to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not cause any risk to you.

You will not be paid for your participation in this trial. However, you may wish to take advantage of discount vouchers or prize incentives offered to participants.

This project will be carried out according to the *National Statement on Ethical Conduct in Human Research* (2007) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

The ethical aspects of this research project have been approved by the Human Research Ethics Committee of RMIT University.

**Whom should I contact if I have any questions?**
You can seek more information about the project from [www.rmit.edu.au/wellness/OrganicResearch](http://www.rmit.edu.au/wellness/OrganicResearch) or by emailing liza.oates@rmit.edu.au or calling Prof Marc Cohen on 03 9925 7440.

**What other issues should I be aware of before deciding whether to participate?**

**Security of the website and data**
Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

This project will use an external site to create, collect and analyse data collected in a survey format. The site we are using is [www.surveymonkey.com](http://www.surveymonkey.com). If you agree to
participate in this survey, the responses you provide to the survey will be stored on a host server that is used by the investigator (Liza Oates). Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for a period of five (5) years. The data on the host server will then be deleted and expunged.

Your Consent
Because of the nature of data collection, we are not obtaining written informed consent from you. Instead, we assume that you have given consent by your completion and return of the materials. Your consent to participate in the ‘Organic Consumption Survey’ will be assumed if you submit the completed survey.

Thank you for taking the time to read this document carefully. If you have any questions you would like to ask before you commence you can contact the researchers via the study website at: www.rmit.edu.au/wellness/OrganicResearch (Contact Us) or by emailing liza.oates@rmit.edu.au or calling Prof Marc Cohen on 03 9925 7440.

Yours sincerely,

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School of Health Sciences, RMIT University

Further information is available from the Ethics Executive Officer, RMIT Human Research Ethics Committee on 9925 2251.
Ethics approval (OCC & OFIS)

Phone: 9925 2251
Fax: 9925 2387
peter.burke@rmit.edu.au

10 September 2009

Ms Liza Oates
20 Scott Street
ELWOOD VIC 3184

Dear Liza

Project No 28/09: Behaviours and beliefs of Australian organic consumers

I am pleased to advise that this project was approved by the Human Research Ethics Committee at its meeting on 26 August for the period from 10 September 2009 until 31 December 2010. The project has been classified as level 3 as it involves higher risks to the participants than discomfort or inconvenience.

Responsibilities of primary investigator
It is important to emphasise that primary investigators are responsible for ensuring that the project proceeds according to the proposal approved by the Human Research Ethics Committee. The Committee’s approval of the project is not absolute. New and unforeseen ethical issues may arise. A researcher should continue to consider the ethical dimensions of the research as the project progresses.

Adverse events or unexpected outcomes
As the primary investigator you have a significant responsibility to monitor the research and to take prompt steps to deal with any unexpected outcomes. You must notify the Committee immediately of any serious or unexpected adverse effects on participants, or unforeseen events, which may affect the ethical acceptability of your project. Any complaints about the project received by the researcher must be referred immediately to the Ethics Officer.

Reporting
Approval to continue a project is conditional on the submission of annual reports (see attached sample form). A final report should also be provided at the conclusion of the project. If your work is completed within twelve months a final report only is required. Report forms are available from the Human Research Ethics Committee web site: (http://www.rmit.edu.au/research/hrec_apply).
Please note that failure to submit reports will mean that a project is no longer approved, and/or that approval will be withheld from future projects.

Conditions of approval
The Human Research Ethics Committee may apply additional conditions of approval beyond the submission of annual/final reports. It is requested that if the researcher wishes to recruit more than 300 survey participants that they will first contact the Human Research Ethics Committee.

Conflicts of interest
When reporting the research, the researcher should again disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation that bears on the research. Conflicts of interest can arise after a project has been approved, and where they do they must be reported as soon as possible.

Amendments
If, as you proceed with your investigation you find reason to amend your research method, you should advise the Human Research Ethics Committee and seek approval for the proposed changes. If you decide to discontinue your research before its planned completion you must also advise the Committee of this and of the circumstances. Depending on the type of amendment — whether it is minor or major — will determine how long the review process for an amendment will take.

Storage of Data
All data should normally be stored on University Network systems. These systems provide high levels of manageable security and data integrity, can provide secure remote access, are backed on a regular basis and can provide Disaster Recover processes should a large scale incident occur. The use of portable devices such as CDs and memory sticks is valid for archiving, data transport where necessary and some works in progress. The authoritative copy of all current data should reside on appropriate network systems; and the principal investigator is responsible for the retention and storage of the original data pertaining to the project for a minimum period of five years.

If you anticipate any problems in meeting this requirement please contact me to discuss an alternative secure data storage arrangement.

All reports or communication regarding this project is to be forwarded to the Ethics Officer.

On behalf of the Human Research Ethics Committee I wish you well with your research.

Yours sincerely

Peter Burke
Ethics Officer
RMIT Human Research Ethics Committee

cc: Prof Marc Cohen
Survey Design

According to the literature a number of factors should be considered when designing surveys.

Surveys should:

- Be convenient to access and complete
- Have a short meaningful title
- Look professional
- Include a short well-written cover letter, in a friendly tone
- Provide clear concise instructions
- Allow frequent space for comments
- Leave ‘white space’ which makes the survey look easier, increasing the response rate
- Ideally be anonymous as this is likely to elicit more honest responses
- Commence with a few interesting but non-threatening items to encourage the participant to continue
- Place the most important questions in the first half of the survey
- Place general questions before more specific ones
- Group items in coherent categories so that items flow smoothly from one to the next
- Use a variety of question types to prevent participants from falling into ‘response sets’
- Emphasise crucial words using italics, bold or underlining

Questions should:

- Be interesting and meaningful to keep the participants interest
- Be as brief and simple as possible using direct language and avoiding unfamiliar words or abbreviations
- Avoid asking participants to calculate figures or complex equations
- Ask for an answer on only one dimension ie don’t group questions e.g. have you undertaken a detoxification diet or taken medication in the last 3 months?... The answer may be yes to one and no to the other.
- Accommodate all possible responses
- Be unambiguous and answers mutually exclusive (if only one answer is requested)
- Produce variability in response for instance: I consume A) 100% organic, B) some organic and some conventional, C) 100% conventional. It is likely that the majority of participants would choose B but this will not be useful for analysis.
- Avoid questions which ask participants to rank more than 5 items
- Avoid presuppositions e.g. ‘What percentage of the meat you consume is organic?’ presupposes that the person eats meat. A response of 0% suggests that they eat only conventional meat but they may be organic consuming vegetarians.
- Avoid assuming the participant knows the answer to the question e.g. what percentage of your diet comes from imported ingredients? A ‘don’t know’ response could be included but in reality few people would be able to accurately answer this question.
• Avoid implying a desired answer e.g. ‘Wouldn’t you prefer to eat organic food if it were cheaper and more readily available?’
• Avoid emotionally loaded or vaguely defined words e.g. most, a clear mandate etc
• Avoid branching questions where a response is dependent on an answer to a previous question as these often cause confusion.
• Avoid having a middle option for attitudinal scores, as they may encourage participants to not fully consider the question
• ‘Don’t know’ option should only be included for factual questions or it may encourage participants to not fully consider the question
OCS Survey

Thank you for your interest in the ‘Organic Consumption Survey’. Your contribution is important.

The purpose of this survey is to identify the behaviours and beliefs of people who consume organic foods. This information will be collected as part of an ongoing trial to determine whether organic consumers have different levels of certain agricultural chemicals in their bodies than people who consume conventional (non-organic) foods. The information from this survey will be used to ensure that the ongoing trial is relevant to and reflective of Australian organic consumers.

Before you decide whether to participate in the survey you will be asked to confirm the following questions (below).

- I consider myself to be a regular ‘organic consumer’
- I am over 18 years of age.
- I have read and understood the ‘Project Information Statement’. A copy of the ‘Project Information Statement’ can be accessed via the study website.

Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your beliefs and behaviours regarding organic foods. You will also be asked questions about other chemicals that you may be exposed to and for general health information. You will not be asked for your name, address or any other personal identifying information.

It is anticipated that this survey will take approximately 20-30 minutes to complete. Questions with an ‘*’ require an answer, however if you prefer not to answer other questions you may skip them, although we would ask you to complete as many as you feel comfortable with. A copy of the survey can be accessed via the study website. A full ‘Privacy Statement’ is also available on the study website.

At the end of the survey you will also be invited to complete an optional 3-day ‘Organic Food Intake Survey (OFIS)’ to assess exactly what percentage of organic food you consume. If you wish to participate in the OFIS survey you will be asked to register your email address in order to receive more information and electronic delivery of the OFIS survey forms.

Because of the nature of data collection, we are not obtaining written informed consent from you. Your consent to participate in this survey will be assumed if you submit the completed survey. Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects. If you have any questions you would like to ask before you commence you can contact the researchers via the study website.

Thank you for your time and effort,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University
Organic Consumption Survey

1. I consider myself to be a regular ‘organic consumer’ (i.e. I make a deliberate choice to consume at least some organic foods on a weekly basis).
   Please note: This survey is intended to be completed by regular organic consumers.
   ○ Yes
   ○ No

2. I am over 18 years of age.
   Please note: This survey is intended to be completed by persons over 18 years of age
   ○ Yes
   ○ No

3. I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Organic Consumption Survey’.
   Please note: * A copy of the ‘Project Information Statement’ can be accessed via the study website. You should read this statement before proceeding
   ○ Yes, I agree to participate
   ○ No, I do not agree to participate

2. Organic Food Consumption and Purchasing Behaviour

For the following questions please indicate your answer using the following definitions as a guide:

Definitions:
- **Certified Organic** – food may be considered ‘certified organic’ if one of the recognised ‘certified organic’ labels is visible on the product or at the point of sale. A list of these images is available below.
- **Non-certified organic** - no ‘certified organic’ label is visible on the product or at the point of sale but the food has been home grown without chemicals or has been purchased from a farmer’s market, farm gate or local food initiative where non-certified organic food is traded on a ‘trust’ basis.

Note: occasional ‘certified organic’ seafood products can be purchased but they tend to be rare. Wild caught seafood may be considered ‘non-certified organic’, however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.
**Organic Consumption Survey**

**Certification logos**

*You may also see:*

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**4. Please estimate the following (using the definitions above)**

<table>
<thead>
<tr>
<th></th>
<th>Almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>Almost all (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over the past year what proportion of the food you ate was prepared from organic food (either certified or non-certified)?</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Over the past year what proportion of the food you ate was prepared from 'certified organic' food?</td>
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</tr>
</tbody>
</table>

**Comments**

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### Organic Consumption Survey

**5. How often do you eat each of the following?**

*(Please include both certified and non-certified organic products. If you are unsure whether the product is organic do not include it)*

<table>
<thead>
<tr>
<th>Item</th>
<th>Most if not all days</th>
<th>At least 2 to 3 times a week</th>
<th>At least once a week</th>
<th>Every 2 to 3 weeks</th>
<th>About once a month</th>
<th>Less often</th>
<th>Never eat organic</th>
<th>Don’t eat this food</th>
<th>Can’t say</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any type of organic food</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Organic meat</td>
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<tr>
<td>Organic poultry (chicken, turkey, duck etc)</td>
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<tr>
<td>Organic or wild-caught seafood (fish, squid, oysters, shellfish etc)</td>
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<tr>
<td>Fresh organic fruit and vegetables</td>
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<td></td>
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<tr>
<td>Organic eggs</td>
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<td></td>
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<tr>
<td>Organic dairy products (milk, cheese, yoghurt etc)</td>
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<tr>
<td>Organic grains (wheat, oats, rice etc)</td>
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<tr>
<td>Organic legumes (lentils, chickpeas, red kidney beans etc)</td>
<td></td>
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<tr>
<td>Pre-packaged organic foods (e.g. canned, frozen, boxed, bagged etc)</td>
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</tbody>
</table>

Comments: [ ]
**6. In a typical month what proportion of your organic (certified or non-certified) meat, poultry or seafood would you purchase/source from the following?**

*Note: occasional ‘certified organic’ seafood products can be purchased, wild caught seafood may be considered ‘non-certified organic’ however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.*

<table>
<thead>
<tr>
<th>Source</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
<th>Don’t eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td></td>
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<tr>
<td>Small supermarket/local store</td>
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<td></td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
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<td></td>
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<tr>
<td>Butcher</td>
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<td></td>
<td></td>
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<tr>
<td>Fishmonger</td>
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<td></td>
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<tr>
<td>Health/wholefood store</td>
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<tr>
<td>Delivery service (e.g. online)</td>
<td></td>
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</tr>
<tr>
<td>Farmer’s market</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roadside/farm-gate stall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own/other’s garden</td>
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<tr>
<td>Other (please specify)</td>
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</tbody>
</table>

(Please specify) Comments

**7. In a typical month what proportion of your organic (certified or non-certified) fresh fruit and vegetables would you purchase/source from the following?**

<table>
<thead>
<tr>
<th>Source</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
<th>Don’t eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Small supermarket/local store</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Health/wholefood store</td>
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<tr>
<td>Delivery service (e.g. online)</td>
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<tr>
<td>Farmer’s market</td>
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<tr>
<td>Roadside/farm-gate stall</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Own/other’s garden</td>
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<tr>
<td>Other (please specify)</td>
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</tr>
</tbody>
</table>

(Please specify) Comments
Organic Consumption Survey

8. In a typical month what proportion of your other organic produce including eggs, dairy, grains, legumes and pre-packaged foods (certified or non-certified) would you purchase/source from the following?

<table>
<thead>
<tr>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small supermarket/local store</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health/wholefood store</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td></td>
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</tr>
<tr>
<td>Farmer’s market</td>
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<tr>
<td>Roadside/farm-gate stall</td>
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<tr>
<td>Own/other’s garden</td>
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<td></td>
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<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Please specify) Comments

9. What proportion of the household* food shopping are you responsible for?

* If you live in a group household as a single/couple/family you do not need to take into account other members of the group household, just the ones you would purchase food for

<table>
<thead>
<tr>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
</tr>
</thead>
</table>

Comments

10. Estimate the percentage of your weekly food bill that is spent on organic food products (certified and/or non-certified)?

Type a rough percentage (0-100) in the box below.

%

3. Attitudes to Organic Food
**Organic Consumption Survey**

**11. What is your level of agreement with the following statements?**

<table>
<thead>
<tr>
<th>Statement</th>
<th>strongly disagree</th>
<th>disagree</th>
<th>unsure/neutral</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The amounts of pesticide residues remaining on conventionally farmed produce are not likely to be harmful to my health.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In Australia standards enforced by certifying bodies ensure that organic foods generally have no pesticide residues.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In Australia conventionally farmed foods are well regulated by government bodies ensuring minimal pesticide residues remain on foods.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In Australia government bodies ensure that organic food imported from overseas adheres to Australian standards.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In Australia government bodies ensure that conventional food imported from overseas adheres to Australian standards.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Organic foods are better for the environment than conventionally grown foods.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>In Australia the regulation of agricultural chemicals used on conventional farms adequately protects the environment from damage.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Organic yields are too low to provide enough food to meet the demands of a growing population.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Comments:

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**12. How strongly do the following sources of information influence your beliefs about organic foods?**

<table>
<thead>
<tr>
<th>Source</th>
<th>No Influence</th>
<th>Weak Influence</th>
<th>Moderate Influence</th>
<th>Strong Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes sense/ seems logical</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Personal experience</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Family/ friends</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Information from organic food manufacturers</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Information from organic certifying bodies</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Scientific evidence</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
</tr>
</tbody>
</table>

Other (please specify): Comments

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1
### Organic Consumption Survey

**13. Which of the following factors would increase your consumption of organic foods?**

<table>
<thead>
<tr>
<th>Factor</th>
<th>No Influence</th>
<th>Slight Increase</th>
<th>Moderate Increase</th>
<th>Large Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>More evidence that current levels of pesticide residues on conventional food are harmful to health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More evidence that eating organic food reduces exposure to pesticide residues compared to eating conventionally farmed food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More evidence that organic farming practices are better for the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More evidence that organic farming practices can provide enough food to meet the demands of a growing population</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If organic food was less expensive (no more than 20% more expensive than conventional food)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If organic food was more available in convenient locations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If there were a single nationally accredited 'certified organic' logo that I could trust to prove what’s organic and what’s not</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments: [Insert comments]

---

**14. What other factors do you consider when deciding whether to purchase organic food?**

<table>
<thead>
<tr>
<th>Factor</th>
<th>No Influence</th>
<th>Weak Influence</th>
<th>Moderate Influence</th>
<th>Strong Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether it is in season</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where the food was grown/manufactured (local vs imported)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The distance the food has travelled (food miles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whether the farmers received a fair price and labour conditions (Fair Trade)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The amount of processing involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The amount of packaging involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of the seller (e.g. farmer's market, supermarket)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other (please specify)/ Comments: [Insert comments]
Organic Consumption Survey

15. Are there specific foods you select because of their organic status?
   ○ No
   ○ Yes (Why?… please specify below)

Comments

16. Do you have any health related concerns (including medical conditions, allergies, intolerances etc) that affect your decision to consume organic foods?
   ○ No
   ○ Yes (please specify below)

Comments

4. Factors Affecting Chemical Exposure and Metabolism

As previously mentioned the purpose of this study is in part to assist us in designing the best possible trial to compare toxin levels in people who consume organic and conventional foods. The following questions will enable us to identify factors that may affect the results of the trial.

*17. To the best of your knowledge, how often have you been exposed to the following substances.
(Please do not include products that you specifically choose because you believe them to be free from synthetic chemicals.)

<table>
<thead>
<tr>
<th></th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Seasonally (in the past 2 months)</th>
<th>Rarely or Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Insecticides</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Personal Insect repelents</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Commercial fumigation</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>(home, workplace etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden pesticides</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>(home, public parks etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet applications (e.g. flea treatments)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Other (please specify any other products/ environments you avoid to limit pesticide exposure)

 Comments

### Organic Consumption Survey

18. Have you undertaken a ‘detoxification diet’ in the past 2 years?
- [ ] No
- [ ] Yes (please specify below)

If ‘yes’ please briefly describe when, how long the diet lasted and the basic characteristics of the diet.

---

19. Please include the following so that we can calculate your body mass index (BMI).

- Height (in cm)
- Weight (in kg)

---

20. Please estimate how often you would do the following when preparing conventional food.

<table>
<thead>
<tr>
<th>Task</th>
<th>Don’t eat</th>
<th>Almost never (0-10%)</th>
<th>Occasionally (10-35%)</th>
<th>About half the time (35-65%)</th>
<th>Most of the time (65-90%)</th>
<th>Almost all of the time (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing fruit with edible skins</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Peeling edible skins (fruit)</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Washing or scrubbing vegetables</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Peeling edible skins (vegetables)</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Rinsing grains before or after cooking</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Rinsing legumes before or after cooking</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>Removing excess fat from meat</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

---


Organic Consumption Survey

21. Please estimate how often you would do the following when preparing organic food.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Don't eat</th>
<th>Almost never (0-10%)</th>
<th>Occasionally (10-35%)</th>
<th>About half the time (35-65%)</th>
<th>Most of the time (65-90%)</th>
<th>Almost all of the time (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing fruit with edible skins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peeling edible skins (fruit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rinsing legumes before or after cooking</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Removing excess fat from meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments

5. Basic Demographics

You are reminded that this survey is completely anonymous and this information will only be used for the purposes stated in the Project Information Statement.

A copy of the 'Project Information Statement' can be accessed via the study website.

22. Gender

○ Female
○ Male

23. Are you (and your partner) planning on conceiving a child in the next 12 months?

○ Yes
○ No

24. FEMALES ONLY

Do either of the following apply to you?

- I am currently pregnant
- I am currently breastfeeding
Organic Consumption Survey

*25. Age range.
- 0-17 years
- 18-24 years
- 25-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65 years or older

26. Country of Birth
- Australia
- Other (please specify)

27. Employment status
You may check more than one box if necessary
- Employed full-time
- Employed part-time/ casual
- Unemployed
- Student
- Home Duties
- Retired
- Other (please specify)/ Comments

28. Please include the number of children living at home (full or part-time)?
- Number of children under 5 years
- Number of children under 12 years
- Number of children under 18 years
**Organic Consumption Survey**

**29. Household /Personal Income**
(If you live in a group household as a single/couple/family you do not need to include the income of other members of the group household)

- Negative income
- Nil Income
- $1 - $149/week ($1 - $7,799/year)
- $150 - $249/week ($7,800 - $12,999/year)
- $250 - $399/week ($13,000 - $20,799/year)
- $400 - $599/week ($20,800 - $31,199/year)
- $600 - $799/week ($31,200 - $41,599/year)
- $800 - $999/week ($41,600 - $51,999/year)
- $1,000 - $1,299/week ($52,000 - $67,099/year)
- $1,300 - $1,599/week ($67,600 - $83,199/year)
- $1,600 - $1,999/week ($83,200 - $103,999/year)
- $2,000 or more/week ($104,000 or more/year)
- I'd rather not say

Comments

**30. Highest level of primary or secondary school education**

- No formal schooling
- Primary school only
- Secondary school (to 10th Grade)
- Secondary school (to 12th Grade or beyond)

Comments

**31. Highest qualification completed**

- No formal schooling or qualifications
- School only (Primary or secondary)
- Trade certificate (Certificate I, II, III, IV or nfd)
- Diploma/Advanced Diploma
- Tertiary (Undergraduate) e.g. Bachelor Degree
- Tertiary (Postgraduate) e.g. Graduate Diploma, or Graduate Certificate, Masters, PhD

Comments
Organic Consumption Survey

32. Highest level of science education
- No formal science education
- Primary school science only
- Secondary school science (to 10th Grade)
- Secondary school science (to 12th Grade)
- Trade certificate (Certificate I, II, III, IV or nfd)
- Diploma/Advanced Diploma
- Tertiary (Undergraduate) e.g. Bachelor Degree
- Tertiary (Postgraduate) e.g. Graduate Diploma, or Graduate Certificate, Masters, PhD

Comments

*33. What is your postcode?
Postcode:

6. Please take a moment to help us improve this survey.

34. How long did it take you to complete this survey?
Number of minutes

35. Where did you hear about this survey?
- Advertisement on the web
- Advertising flyer/poster
- Newspaper/magazine ad
- Newspaper/magazine article
- Radio
- Television
- Friend/colleague
- Other

Please specify which website/newspaper/radio station/retail outlet etc
Organic Consumption Survey

36. Thank you for taking the time and effort to complete this survey. Your responses will assist us in designing a trial to measure toxin levels in people who consume organic versus conventional foods.

Please feel free to include below any other comments you would like to make before you complete the survey.

7. Thank you

Thank you for taking the time and effort to complete this survey. This information will assist us in designing a groundbreaking trial to determine whether organic consumers have different levels of certain agricultural chemicals in their bodies than people who consume conventional (non-organic) foods. The information from this survey will be used to ensure that the ongoing trial is relevant to and reflective of Australian organic consumers.

Participate in the ‘Organic Food Intake Survey’
At this point we would like to invite you to be involved in a further survey to assess exactly what percentage of organic produce you consume. In this 3 day ‘Organic Food Intake Survey (OFIS)’ you will be asked to record what you eat and drink, including the approximate amounts and whether the items are organic or conventional, for a three day period.

If you wish to participate in the OFIS survey please visit the study website. You will be able to download the forms directly from the website or register your email address to have them emailed to you.

Receive Updates
If you would like to read the results of this survey when they become available or be kept informed about future studies you can visit the study website or register your email address to receive email updates by emailing news@organicresearch.net.

Once again, thank you for your time and interest in this project.

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor; Professor of Complementary Medicine,
School of Health Sciences, RMIT University
Appendix 3. Organic Food Intake Survey Documents

OFIS Project Information Statement

(invitation to participate in a research project
project information statement)

Project Title:
- “Behaviours and beliefs of Australian organic consumers - Organic Food Intake Survey (OFIS)”

Investigators:
- Ms Liza Oates (PhD candidate, School of Health Sciences, liza.oates@rmit.edu.au)
- Dr Marc Cohen (Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University, marc.cohen@rmit.edu.au, 9925 7440)

You are invited to participate in a research project being conducted by RMIT University.

This information sheet describes detailed information about the project in straightforward language, or ‘plain English’. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project before you decide whether or not to take part in it.

Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators. You may also wish to discuss the project with a relative or friend. Feel free to do this.

Once you understand what the project is about and if you agree to take part in it, you will be asked to proceed to the survey. Your consent to participate in this project will be implied if you choose to complete and submit the survey. By submitting the survey you indicate that you understand the information and that you give your consent to participate in the research project.

Who is involved in this research project?
This project is being conducted by Ms Liza Oates (B HSc [Naturopathy], GradCert Evidence-based Comp Med) under the supervision of Professor Marc Cohen (Professor of Complementary Medicine, School of Health Sciences, RMIT University) as part of a PhD program in the School of Health Sciences at RMIT University. The project has been approved by the RMIT Human Research Ethics Committee.

Why have you been approached?
You have been approached because you previously completed the ‘Organic Consumption Survey’ and have registered your interest in this project and indicated that you consider yourself to be an ‘organic consumer’. If you know of other people who may be interested in participating, please encourage them to seek more information from
What is the project about?
The purpose of this survey is to assess what percentage of organic food you consume. This information will be collected as part of an ongoing trial to determine whether organic consumers have different levels of certain agricultural chemicals in their bodies than people who consume conventional (non-organic) foods. The information collected will be used to ensure that the ongoing trial can clearly distinguish organic consumers from non-organic consumers when testing body levels of agricultural chemicals. This will help to ensure that the research is scientifically robust and relevant to Australian organic consumers.

The findings of this research and the ongoing trial will enable consumers to make a more informed decision about whether to incur the additional costs of purchasing organic food in order to reduce their overall exposure to chemicals. It may also potentially provide the organic industry with a scientific basis on which to make claims. If you are also interested in being involved in the ongoing trial please register your interest by emailing bmt@organicresearch.net.

If I agree to participate, what will I be required to do?
The 3 day ‘Organic Food Intake Survey’ (OFIS) will assess what percentage of organic produce you consume. You will be asked to record what you eat and drink, including the approximate amounts and whether the items are organic or conventional (non-organic), over a three day period.

If you wish to participate in the OFIS survey you can download the forms directly from the website at: www.rmit.edu.au/wellness/OrganicResearch or from the final page of the Organic Consumption Survey (OCS) and return the completed forms via email to liza.oates@rmit.edu.au.

Alternatively you can register your email address by emailing ofis@organicresearch.net and we will email the forms to you. If you choose this option you will be asked to register and validate your email address for electronic delivery of the ‘Organic Food Intake Survey’ forms. This means that we will send you a validation email with a link you must click in order to complete your registration. By doing this, you are helping us avoid nuisance registrations and to protect the integrity of the data.

Upon electronic return your survey forms will be coded to protect your identity and your email address and any identifying details will be deleted. At the end of the survey period all remaining email addresses linked to unreturned surveys will be deleted. At no point will email addresses be available to a third party, and no information will be collected or stored with any details that can be used for identification.

If you would like to view a copy of the survey before agreeing to participate it can be located on the study website at: www.rmit.edu.au/wellness/OrganicResearch.

What are the risks or disadvantages associated with participation?
If you are concerned about your responses to any of the survey questions or if you find participation in the project distressing, you should contact the investigator (Liza Oates) as soon as convenient. Liza will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary. You can suspend or end your participation in the project at any time if any distress occurs.
What are the benefits associated with participation?
The information collected in this survey will ensure that the ongoing trial is more scientifically rigorous and reflects the characteristics of Australian organic consumers so that the final results will be more relevant. The results of the ongoing trials may assist you in making a more informed choice about whether incurring the additional expense of organic food might be of personal benefit to you. This project may also lead to future research assessing whether various detoxification programs may assist in eliminating such chemicals.

What will happen to the information I provide?
It is anticipated that the results of the project will be published on the study website and in a respected scientific journal. In any publication, information will be provided in such a way that you cannot be identified. The data published will be in a form that gives group values and in no way identifies any specific individuals in the project.

Any survey information collected will be coded, and will not be stored with any details that can be used to directly identify you. Only the investigators will have access to the coding system which will be password protected. Only investigators will have the password.

Responses to the survey will be stored on a host server that is used by the primary investigator (Liza Oates). Once data collection and analysis are completed the data will be imported to the RMIT (SEH Research Unit) server where it will be stored securely for a period of five (5) years before being destroyed. The data on the host server will then be deleted and expunged.

Any hardcopy documents will be kept in a locked cabinet to which only the investigators will have the key. Once the project is complete and results have been published these copies will be destroyed.

In accordance with the Freedom of Information Act 1982 (Vic), you have the right to access and to request correction of information held about you by RMIT University.

What are my rights as a participant?
You have the right to have any questions answered at any time. Continue to the survey only after you have had a chance to ask your questions and have received satisfactory answers.

Participation in any research project is voluntary. You are entitled to withdraw your participation at any time, without prejudice. In this event you may request to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not cause any risk to you.

You will not be paid for your participation in this trial.

This project will be carried out according to the National Statement on Ethical Conduct in Human Research (2007) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

The ethical aspects of this research project have been approved by the Human Research Ethics Committee of RMIT University.

Whom should I contact if I have any questions?
You can seek more information about the project from www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Prof Marc Cohen on 03 9925 7440.

**What other issues should I be aware of before deciding whether to participate?**

**Security of the website and data**

Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

This project will use an external site to create, collect and analyse data collected in a survey format. The site we are using is www.surveymonkey.com. If you agree to participate in this survey, the responses you provide to the survey will be stored on a host server that is used by the investigator (Liza Oates). Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for a period of five (5) years. The data on the host server will then be deleted and expunged.

**Your Consent**

Because of the nature of data collection, we are not obtaining written informed consent from you. Instead, we assume that you have given consent by your completion and return of the materials. Your consent to participate in the ‘Organic Food Intake Survey’ will be assumed if you return the completed survey documents.

Thank you for taking the time to read this document carefully. If you have any questions you would like to ask before you commence you can contact the researchers via the study website at: www.rmit.edu.au/wellness/OrganicResearch (Contact Us) or by emailing liza.oates@rmit.edu.au or calling Prof Marc Cohen on 03 9925 7440.

Yours sincerely,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
BMedSc(Hons)
PhD candidate,
Medicine,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM),
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University

Further information is available from the Ethics Executive Officer, RMIT Human Research Ethics Committee on 9925 2251.

[Box text: Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. Details of the complaints procedure are available at: http://www.rmit.edu.au/governance/complaints/research]
OFIS Instructions for use

Instructions for completing the ‘Food Intake Survey’
You may wish to keep a copy of these instructions handy when completing the food intake forms. If you have any questions you can find additional useful information on the study website: [www.rmit.edu.au/wellness/OrganicResearch](http://www.rmit.edu.au/wellness/OrganicResearch), or you can email the study co-ordinator including ‘Question re OFIS Forms’ in the subject line at: liza.oates@rmit.edu.au.

Food Groups
You will be asked to record information on the foods you have eaten in the past 24 hours by including them under the following ‘food group’ categories. It may help to quickly write down a list of all of the foods you ate during this period before you commence.

1. Grains - Bread, cereals, rice, pasta, noodles
2. Vegetables including legumes (raw or lightly cooked)
3. Fruit
4. Dairy - Milk, yoghurt, cheese
5. Animal protein sources - Meat, fish, poultry, eggs,
6. Plant protein sources - nuts, legumes (dried peas/beans)
7. Extra foods – includes coffee, tea, alcoholic drinks, snack foods etc
8. Water

Description
For each of the food groups please include a brief description and estimate the amount of each of the foods you consumed over the previous 24 hour period. For example:

- 3/4 cup cooked porridge
- 3 slices bread.

You may also include extra information if you feel it helps to explain your reason for including it in one (or more) of the four categories (certified organic, likely organic, likely conventional, unknown). For example:

- 3 slices bread (from farmer’s market)
- ½ cup cooked rice (cooked by friend)
- 1 cup mixed vegetable soup (with chicken) 70% of vegies certified organic 30% likely conventional
- 1 large apple (mum’s organic garden)

Serving Size
The ‘office use only column’ will be completed by the researcher to estimate the standard serving size. Please try to estimate the portion size (in your description) as accurately as you can to assist this process. Each food group is accompanied in the left hand column by examples of serving sizes for that group.
Organic or Conventional

- Please put a ‘X’ in the appropriate column to indicate whether the food you have described is: certified organic, likely organic, likely conventional, or unknown. Explanations of these categories are below.
- Please note that it is very important that you don’t check ‘unknown’ unless you believe there is a reasonable chance that the food might have been organic. In most cases if you are unsure you should check ‘likely conventional’.
- It is possible to check more than one column for the same food if it contains both organic and conventional items. For example: 1 cup mixed vegetable soup (with chicken) 70% of veggies certified organic 30% likely conventional.

- **Certified Organic** – one of the following recognised ‘certified organic’ labels is visible on the product or at the point of sale.

![Certified Organic Logos]

Other logos you may see include:

- **Likely Organic** – no ‘certified organic’ label is visible on the product or at the point of sale but the food has been purchased from a farmer’s market, farm gate or local food initiative where non-certified ‘organic’ food is traded on a ‘trust’ basis. Alternately the food may have been home grown with a specific intent to avoid the use of any man-made/synthetic chemicals e.g. insecticides, weed killers, fertilisers etc.

- **Likely Conventional** – there is no ‘certified organic’ label visible on the product or at the point of sale and no reason to believe it is organic. For example food purchased from a supermarket or market stall where no ‘organic’ claims have been made. This may also include take-away and restaurant foods where no claims have been made. Commercially prepared food can be assumed to be ‘likely conventional’ unless specific organic claims have been made.

- **Unknown** – Only use this category if you believe that there is a likelihood that the food was organic but you have no way of determining either way. For example, food
prepared by another person, such as a friend, who would be likely to use organic food but would have no commercial interest in saying either way.

Handy Tips:
Before you begin it may be useful to make a quick note of everything you ate for the previous 24 hours. The following may help to trigger your memory:
Did you eat anything…?
- When you first woke up
- Breakfast time
- Between breakfast and lunch
- Lunch time
- Between lunch and dinner
- Dinner
- After dinner
- During the night
- Any snacks you haven't already mentioned
- Any drinks you haven't already mentioned
OFIS Worksheet (Example)

Please complete the following:

Participant #: __________

Dates completed:
Day 1: Day of the week: Thursday Date: 3/11/2011
Day 2: Day of the week: Friday Date: 4/11/2011
Day 3: Day of the week: Saturday Date: 5/11/2011
Day 4: Day of the week: Sunday Date: 6/11/2011
Day 5: Day of the week: Monday Date: 7/11/2011
Day 6: Day of the week: Tuesday Date: 8/11/2011
Day 7: Day of the week: Wednesday Date: 9/11/2011

Urine sample collected:
Day #:8 Day of the week: Thursday Date: 10/11/2011

Please place a ‘X’ in the box to indicate whether the food was ‘Certified organic’, ‘Likely organic’, ‘Likely conventional’ or ‘Unknown’. Please see ‘Instructions for OFIS’ and ‘OFIS Worksheet (example)’ for more detail.

Day 1:

<table>
<thead>
<tr>
<th>Food Groups EXAMPLE ONLY</th>
<th>Description (Type and estimated amount of each food)</th>
<th>Certified Organic</th>
<th>Likely Organic</th>
<th>Likely Conventional</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Grains - Bread, cereals, rice, pasta, noodles</td>
<td>¾ cup cooked porridge</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 slices bread (from farmer’s market)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 vitawheat crackers</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>½ cup cooked rice (cooked by friend)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Foods in this group come from grains like wheat, oats, rice, rye, barley, millet and corn. These grains can be eaten whole, made into breakfast cereals or ground into flour to make grain foods like bread, pasta and noodles. One serve means:
- 2 slices of bread
- 1 medium bread roll
- 1 cup cooked rice,
### 2. Vegetables, legumes (raw or lightly cooked)

Vegetables come from many different parts of the plant including the leaves, root, tubers, flowers, stems, seeds and shoots. Also include mushrooms and legumes that can be eaten raw or lightly cooked (e.g. green beans, snow peas) that are usually eaten as vegetables.

One serve means:
- 75 grams or ½ cup cooked vegetables (including snowpeas, mushrooms etc)
- 1 cup salad vegetables
- ½ cup vegetable juice
- 1 cup vegetable soup
- 1 medium potato

| Office use only | 1 cup mixed vegetable soup (with chicken) | X | X |
| # | ~70% of vegies organic 30% not | | |
| # | 1 cup cooked mixed vegetables (in curry, cooked by friend) | | X |

### 3. Fruit

One serve means:
- 1 medium piece, e.g. apple, banana, orange, pear
- 2 small pieces, e.g. apricots, kiwi fruit, plums
- 1 cup diced pieces or canned fruit
- ½ cup fruit juice
- 4 dried prunes, apricot halves
- 1 ½ tablespoons

<p>| Office use only | 1 medium banana (on porridge) | X |
| # | 1 glass orange juice | X |
| # | 1 large apple (mum's organic garden) | X |</p>
<table>
<thead>
<tr>
<th>Foods</th>
<th>One Serve Means</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Dairy - Milk, yoghurt, cheese</td>
<td>250 ml (1 cup) fresh, long-life or reconstituted milk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>½ cup evaporated milk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40g cheese (2 slices)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>½ cup cottage cheese, ricotta</td>
<td></td>
</tr>
<tr>
<td></td>
<td>¼ round camembert, brie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200g (1 small tub) yoghurt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250 ml (1 cup) custard</td>
<td></td>
</tr>
<tr>
<td>Office use only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Animal protein sources - Meat, fish, poultry, eggs</td>
<td>65-100 g cooked meat or chicken e.g.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>½ cup lean mince</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 small chops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 slices roast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small piece of steak</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80-100g cooked fish fillet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80-100g (small tin) of canned fish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 egg</td>
<td></td>
</tr>
<tr>
<td>Office use only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Plant protein sources - nuts, legumes</td>
<td>Large handful of almonds ~ ¼ cup (from organic grocer but bought from bulk section and I can’t remember if I saw a logo or not)</td>
<td>X</td>
</tr>
<tr>
<td>Plant protein sources include nuts, legumes (dried peas/beans requiring significant cooking e.g. lentils, chickpeas, red kidney beans) and soy products</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tofu (in curry, cooked by friend)</td>
<td>X</td>
</tr>
</tbody>
</table>
One serve means:
- ½ cup cooked beans, lentils, chickpeas, split peas or canned beans
- 1/3 cup peanuts, almonds or other nuts
- ¼ cup seeds e.g. sunflower, sesame seeds
- 250ml (1 cup) soy milk
- 80-100g tofu

Office use only

7. Extra foods
Foods that don’t fit into the above food groups for example:
- Coffee, tea, herbal tea etc
- Alcoholic beverages
- Soft drinks, cordials etc
- Sauces, gravies
- Condiments, chutneys
- Sweet biscuits, Cake
- Chocolate
- Meat pies or pasties
- Hot chips
- Ice cream
- Lollies
- Fats such as mayonnaise, butter, margarine, oil

<table>
<thead>
<tr>
<th>Extra foods</th>
<th>3 cups of earl grey tea</th>
<th>2 pieces Lindt chilli chocolate</th>
<th>Butter on bread ~2tsp</th>
<th>2 handfuls ‘light &amp; tangy’ chips</th>
<th>Curry sauce (in curry, cooked by friend) ~ ¼ cup</th>
<th>1 large glass white wine</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 cups of earl grey tea</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 pieces Lindt chilli chocolate</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter on bread ~2tsp</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 handfuls ‘light &amp; tangy’ chips</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curry sauce (in curry, cooked by friend) ~ ¼ cup</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 large glass white wine</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Office use only

Please place a ‘X’ in the box to indicate your choice. See OFIS Worksheet (example)
8. Water
Please include the number of glasses of water you consumed from each of the following sources. You may use up to one decimal place (e.g. 1.5 glasses). Include water used to make other beverages such as tea, coffee, cordial etc but not pre-made drinks such as soft drink or juice.

_____ glass/es (250ml) Tap water
_____ glass/es (250ml) Bottled water
__5__ glass/es (250ml) Filtered water
_____ glass/es (250ml) Tank water

Please estimate how accurate you believe your answers to be.
__90+_____%

Please estimate how well you believe that this survey reflects your typical level of organic food consumption.
__70_____%

Comments:
I was pretty diligent about recording everything I ate so I don’t think I left anything out. Today was a bit unusual as a friend cooked dinner and I didn’t ask if she’d used any organic ingredients. There were other people present so I didn’t want to make her feel uncomfortable by putting her on the spot. I know the tofu was organic because I saw the packet and it’s the same brand I use. I suspect the other ingredients may also have been organic as she’s pretty health conscious but I’m not sure.

ETC.......
## Comparison of food intake survey methods

<table>
<thead>
<tr>
<th>Instrument/ Tool</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food record/ Diet Diary</strong></td>
<td>the respondent records the foods and beverages and the amounts of each consumed over one or more days. The amounts consumed may be measured or estimated</td>
<td>Intake quantified, Doesn’t rely on memory for recall of foods eaten</td>
<td>High investigator cost, High respondent burden, Extensive respondent training and motivation, Required to describe foods, amounts consumed, preparation methods etc, Many days needed to capture individual's usual intake, Affects eating behaviour, Intake often underreported, Reports of intake decrease with time due to respondent fatigue, Attrition increases with number of daily records requested, May lead to nonrepresentative sample and subsequent nonresponse bias</td>
</tr>
<tr>
<td><strong>Prospective checklist</strong></td>
<td>Filled in concurrently at the time of intake or at the end of the day</td>
<td>Less burden on respondents</td>
<td>Less burden on investigators</td>
</tr>
<tr>
<td><strong>24-hour dietary recall</strong></td>
<td>the respondent is asked to remember and report all the foods and beverages consumed in the preceding 24 hours or in the preceding day. The recall typically is conducted by interview, in person or by telephone</td>
<td>Intake quantified, Appropriate for most populations, thus less potential for nonresponse bias, Easier to complete so relatively low respondent burden, Does not affect eating behaviour</td>
<td>High investigator cost and training required, Many days needed to capture individual’s usual intake, Intake often underreported</td>
</tr>
<tr>
<td><strong>Food frequency questionnaire</strong></td>
<td>Asks respondents to report their usual individual intake asked</td>
<td>Usual individual intake asked</td>
<td>Not quantifiably precise, Difficult cognitive task for</td>
</tr>
<tr>
<td>Method</td>
<td>Usual frequency of consumption of each food</td>
<td>Information on total diet obtained</td>
<td>Respondent Intake often misreported</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Brief instruments</td>
<td>Usual individual intake often asked</td>
<td>Low investigator cost</td>
<td>Low investigator cost</td>
</tr>
<tr>
<td></td>
<td>Low respondent burden</td>
<td>Does not affect eating behaviour</td>
<td>Does not affect eating behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usual individual intake asked</td>
<td>Not quantifiably precise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information on total diet obtained</td>
<td>Difficult cognitive task for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can have low investigator cost</td>
<td>respondent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not affect eating behaviour</td>
<td>Assessment limited to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>foods</td>
<td>small number of factors</td>
</tr>
<tr>
<td>Diet history</td>
<td>Asks respondents to report about past diet</td>
<td>Usual individual intake asked</td>
<td>Intake often misreported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information on total diet obtained</td>
<td>Can have high investigator burden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can have low investigator cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does not affect eating behaviour</td>
<td></td>
</tr>
</tbody>
</table>

{Thompson, 2001 #309}{Walonick, 2004 #311}
Website Content (OCS/ OFIS)

Organic Food Research
Background to the Project
In a recent Australian survey 74% of respondents agreed with the statement ‘Organic food is healthier than conventionally grown food because it has no pesticide residues’. While Australian researchers have demonstrated that Victorian certified organic produce has fewer pesticide residues than conventional food crops, whether this results in less accumulation of agricultural chemicals in people who consume organic produce is unclear.

Recent studies of children in the United States have demonstrated that substituting conventional fruits and vegetables with organic ones for a 5-day period, results in a reduction in levels of organophosphate pesticide metabolites to non-detectable or close to non-detectable levels and pyrethroid insecticides reduced by approximately 50%. This confirms a previous report that consumption of organic fruits, vegetables and juice can reduce children’s exposure levels from ‘uncertain risk’ to ‘negligible risk’. Whether these results can be extended to adult populations and other agricultural contaminants has yet to be explored.

Bio-monitoring trial (BMT)
The School of Health Sciences at RMIT University is currently developing a project entitled ‘Biological monitoring of toxicants in urban living adult consumers of organic and conventional food’ (BMT). This groundbreaking research will investigate whether adult consumers of organic food have differing levels of certain agricultural chemicals in their bodies than those who consume conventional (non-organic) foods.

As part of the development of this project two surveys have been created, the ‘Organic Consumption Survey’ (OCS) and ‘Organic Food Intake Survey’ (OFIS). The results of these surveys will help to ensure that the ongoing research is scientifically robust and relevant to Australian organic consumers.

It is anticipated that the findings of the ongoing project will assist consumers in making a more informed decision about whether to incur the additional costs of purchasing organic food in order to reduce their overall exposure to chemicals.

Organic Consumption Survey (OCS)
The purpose of the ‘Organic Consumption Survey’ (OCS) is to identify the behaviours and beliefs of people who consume organic foods. This information will be collected as part of an ongoing bio-monitoring trial to determine whether organic consumers have different levels of certain agricultural chemicals in their bodies than people who consume conventional (non-organic) foods.

The information from this survey will be used to ensure that the ongoing trial is relevant to and reflective of Australian organic consumers.

It is anticipated that this survey will take approximately 20-30 minutes to complete. The survey will ask basic questions about you and your beliefs and behaviours regarding organic foods. You will also be asked questions about other chemicals that you may be exposed to and for general health information. You will not be asked for your name, address or any other personal identifying information.

- Read or print the OCS Project Information Statement (link)
- Take the ‘Organic Consumption Survey’ (OCS) (link to Survey Monkey survey)

Organic Food Intake Survey (OFIS)
As it is difficult for adult consumers to maintain a 100% organic diet, participants who complete the ‘Organic Consumption Survey’ (OCS) will be invited to participate in an
additional 3 day ‘Organic Food Intake Survey’ (OFIS). The purpose of this survey is to assess what percentage of organic food you consume.

You will be asked to record what you eat and drink, including the approximate amounts and whether the items are organic or conventional (non-organic), over a three day period. You can view a copy of the ‘Organic Food Intake Survey’ questions (link).

The information collected will be used to ensure that the ongoing trial can clearly distinguish organic consumers from non-organic consumers when testing body levels of agricultural chemicals. This will help to ensure that the research is scientifically robust and relevant to Australian organic consumers.

You will be asked to register and validate your email address for electronic delivery of the ‘Organic Food Intake Survey’ forms. This means that we will send you a validation email with a link you must click in order to complete your registration. By doing this, you are helping us avoid nuisance registrations and to protect the integrity of the data.

Upon electronic return your survey forms will be coded to protect your identity and your email address and any identifying details will be deleted. At the end of the survey period all remaining email addresses linked to unreturned surveys will be deleted. At no point will email addresses be made available to a third party, and no information will be collected or stored with any details that can be used for identification. To find out more read the Privacy Statement (link).

- Read or print the OFIS Project Information Statement (link)
- Register your interest in participating in the ‘Organic Food Intake Survey’ (OFIS) (link to register)

Additional Information
- Join our mailing list (link)
Appendix 4. Organic Health and Wellness Survey

Documents

OHWS Project Information Statement

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT
PROJECT INFORMATION STATEMENT

Project Title:
- “Health & Wellness Perceptions in Australian Organic Consumers – Organic Health & Wellbeing Survey (OHWS)”

Investigators:
- Ms Liza Oates, B HSc [Naturopathy], GradCert Evidence-based Comp Med (PhD candidate, School of Health Sciences, liza.oates@rmit.edu.au)
- Dr Marc Cohen, MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons), FAMAC, FICAEP (Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University, marc.cohen@rmit.edu.au, 9925 7440)

You are invited to participate in a research project being conducted by RMIT University.

This information sheet describes detailed information about the project in straightforward language, or ‘plain English’. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project before you decide whether or not to take part in it.

Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators. You may also wish to discuss the project with a relative or friend. Feel free to do this.

Once you understand what the project is about and if you agree to take part in it, you will be asked to proceed to the survey. Your consent to participate in this project will be implied if you choose to complete and submit the survey. By submitting the survey you indicate that you understand the information and that you give your consent to participate in the research project.

Who is involved in this research project?
This project is being conducted by Ms Liza Oates under the supervision of Professor Marc Cohen as part of a PhD program in the School of Health Sciences at RMIT University. The project has been approved by the RMIT Human Research Ethics Committee (College Human Ethics Advisory Network).

Why have you been approached?
You have been approached because you have indicated that you consider yourself to be an ‘organic consumer’. If you know of other people who may be interested in participating, please encourage them to seek more information from the study website.
www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.

**What is the project about?**
The purpose of this survey is to explore the health experiences of people who consume organic foods on a regular basis. The information collected will be used to direct future research.

This survey is intended to be completed by people who consume organic foods on most if not all days. The questions will generally refer to the period since you started eating organic food (or made a choice to increase your intake from only eating organic food occasionally to eating it regularly).

**If I agree to participate, what will I be required to do?**
You will be asked to read this statement before proceeding to the online ‘Organic Health & Wellness Survey’ (OHWS) at www.surveymonkey/s/OHWS. Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your personal health experiences as a result of consuming organic foods. In some sections, parents of children under 18 years (who are not eligible to complete the survey themselves) may also include health effects that they have observed in their own children. You will not be asked for your name, address or any other personal identifying information. A full ‘Privacy Statement’ is available on the study website.

It is anticipated that this survey will take approximately 15-20 minutes to complete.

**What are the risks or disadvantages associated with participation?**
There are minimal risks to completing this survey. However if you are concerned by any of the questions or find participating in the project in any way distressing, you should contact the investigator (Liza Oates) as soon as convenient. Liza will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary. You can suspend or end your participation in the project at any time if any distress occurs.

**What are the benefits associated with participation?**
This research paves the way for future research on the health effects of consuming an organic diet. The purpose is to explore the perceptions of people who consider themselves to be 'organic consumers' in order to ensure that such research is meaningful. The results of the OHWS will allow for the design of more clinically relevant research in the future.

The results of the ongoing research being carried out by the research team may assist you in making a more informed choice about whether incurring the additional expense of organic food might be of personal benefit to you.

**What will happen to the information I provide?**
It is anticipated that the results of the project will be published on the study website www.rmit.edu.au/wellness/OrganicResearch and in a respected scientific journal. In any publication, information will be provided in such a way that you cannot be identified.

No personal identifying information will be collected so no survey information will be stored with any details that can be used to directly identify you.

Responses to the survey will be stored on a host server that is used by the primary investigator (Liza Oates). Once data collection and analysis are completed the data will be imported to the RMIT (SEH Research Unit) server where it will be stored securely for a
period of five (5) years before being destroyed. The data on the host server will then be deleted and expunged.

In accordance with the Freedom of Information Act 1982 (Vic), you have the right to access and to request correction of information held about you by RMIT University.

What are my rights as a participant?
You have the right to have any questions answered at any time. Continue to the survey only after you have had a chance to ask your questions and have received satisfactory answers.

Participation in any research project is voluntary. You are entitled to withdraw your participation at any time, without prejudice. In this event you may request to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not cause any risk to you.

This project will be carried out according to the National Statement on Ethical Conduct in Human Research (2007) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

The ethical aspects of this research project have been approved by the Human Research Ethics Committee (College Human Ethics Advisory Network) of RMIT University.

Whom should I contact if I have any questions?
You can seek more information about the project from www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.

What other issues should I be aware of before deciding whether to participate?
Security of the website and data
Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

This project will use an external site to create, collect and analyse data collected in a survey format. The site we are using is www.surveymonkey.com. If you agree to participate in this survey, the responses you provide to the survey will be stored on a host server that is used by the investigator (Liza Oates). Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for a period of five (5) years. The data on the host server will then be deleted and expunged.

Your Consent
Because of the nature of data collection, we are not obtaining written informed consent from you. Your consent to participate in this survey will be assumed if you submit the completed survey.

Thank you for taking the time to read this document carefully. If you have any questions you would like to ask before you commence you can contact the investigators via the study website at: www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.
Yours sincerely,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
BMEdSc(Hons)
PhD candidate,
Medicine,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM),

Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University

Further information is available from the Ethics Executive Officer, RMIT Human Research Ethics Committee on 9925 2251.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001.
Details of the complaints procedure are available at: http://www.rmit.edu.au/governance/complaints/research
OHWS Ethics Approval

22nd September 2011

Liza Oates
20 Scott Street
Elwood VIC 3184

Dear Liza,

ASEHAPP 53 – OATES Health & Wellness Perceptions in Australian Organic Consumers

Thank you for submitting your amended application for review.

I am pleased to inform you that the CHEAN has approved your application for a period of 3 Months to December 2011 and your research may now proceed.

The CHEAN would like to remind you that:

All data should be stored on University Network systems. These systems provide high levels of manageable security and data integrity, can provide secure remote access, are backed up on a regular basis and can provide Disaster Recover processes should a large scale incident occur. The use of portable devices such as CDs and memory sticks is valid for archiving; data transport where necessary and for some works in progress. The authoritative copy of all current data should reside on appropriate network systems; and the Principal Investigator is responsible for the retention and storage of the original data pertaining to the project for a minimum period of five years.

Annual reports are due during December for all research projects that have been approved by the College Human Ethics Advisory Network (CHEAN).

The necessary form can be found at: http://www.rmit.edu.au/governance/committees/hrec

Yours faithfully,

Linda Jones
Acting Chair, Science Engineering & Health
College Human Ethics Advisory Network

Cc: CHEAN Member: Vernon Coffey School of Health Sciences RMIT University
Supervisor/s: Marc Cohen School of Health Sciences RMIT University
OHWS Survey

Thank you for your interest in the ‘Organic Consumer’s Health & Wellness Survey’. This survey is intended to be completed by people who consume organic foods on most if not all days. The questions will generally refer to the period since you started eating organic food (or made a choice to increase your intake from only eating organic occasionally to eating it regularly).

The purpose of this survey is to explore the health experiences of people who consume organic foods on a regular basis. The information collected will be used to direct future research.

Before you decide whether to participate in the survey you will be asked to confirm the following questions (below).

- I consider myself to be a regular ‘organic consumer’
- I am over 18 years of age.
- I have read and understood the ‘Project Information Statement’.* A copy of the ‘Project Information Statement’ can be accessed via the study website.

Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your personal health experiences as a result of consuming organic foods. In relevant sections, parents of children under 18 years (who are not eligible to complete the survey themselves) may also include health effects that they have observed in their own children. Throughout the survey there will also be opportunities for you to make additional comments should you wish to do so. You will not be asked for your name, address or any other personal identifying information. A full ‘Privacy Statement’ is available on the study website.

It is anticipated that this survey will take approximately 15-20 minutes to complete. Questions with an * require an answer in order proceed but we would be grateful if you would complete as many questions as you can.

The ethical aspects of this research project have been approved by the College Human Ethics Advisory Network of RMIT University. Because of the nature of data collection, we are not obtaining written informed consent from you. Your consent to participate in this survey will be assumed if you submit the completed survey. Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

There are minimal risks to completing this questionnaire. However if you are concerned by any of the questions or find participating in the project in any way distressing, you should contact the researcher via the study website as soon as convenient to confidentially discuss your concerns. If you have any other questions you would like to ask before you commence please feel free to contact the researcher.

Thank you for your time and effort, your contribution is important.

Liza Gates  
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PhD candidate,  
School of Health Sciences, RMIT University

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MBBS(Hons), FRACEM(Elec Eng), PhD (TCM), BMedSc(Hons)  
Project Supervisor, Professor of Complementary Medicine,  
School of Health Sciences, RMIT University

*1. I consider myself to be a regular ‘organic consumer’ (i.e. I make a deliberate choice to consume at least some organic foods on most days).

- Yes
- No
Organic Health and Wellness Survey

2. I am over 18 years of age.
   Please note: This survey is intended to be completed by persons over 18 years of age
   ○ Yes
   ○ No

3. I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Organic Health & Wellness Survey’.
   Please note: A copy of the ‘Project Information Statement’ can be accessed via the study website. You should read this statement before proceeding
   ○ Yes, I agree to participate
   ○ No, I do not agree to participate

There are many reasons people choose to consume organic food including; environmental, social, ethical etc. This survey will focus on your beliefs about and experience with organic foods in relation to their impact on health and wellness. The term ‘health’ should be interpreted as more than the presence or absence of specific diseases or complaints, but should also include more subtle effects on your sense of wellbeing.

The questions will generally refer to the period since you started eating organic food (or made a choice to increase your intake from only eating organic occasionally to eating it regularly)

4. Approximately how long is it since you started eating organic foods (or made a choice to increase your intake from only eating organic occasionally to eating it regularly)?
   
   years
   months

5. Did any of the following influence your decision to eat (more) organic food?
   Multiple answers allowed. These questions will be explored in more detail later in the survey.
   - General wellbeing of you or your family (i.e. improved health and wellness)
   - Prevention of illness
   - Treatment of specific health concerns of you or your family
   - No, my reasons for choosing organic were related to factors other than health
6. Did any of the following influence your decision to eat (more) organic food? *Multiple answers allowed.*

- [ ] pregnancy
- [ ] child birth
- [ ] care for infants/children
- [ ] No, my reasons for choosing organic were not related to the above

Comment:

7. How much does your agreement with each of the following statements influence your decision to consume organic food?

"*Organic food is healthier because...*"

<table>
<thead>
<tr>
<th>Statement</th>
<th>I don't agree</th>
<th>No Influence</th>
<th>Weak Influence</th>
<th>Moderate Influence</th>
<th>Strong Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is produced without pesticides (insecticides, herbicides etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is produced without synthetic fertilisers</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>It is produced without hormones</td>
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<td></td>
<td></td>
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<tr>
<td>It is produced without antibiotics or other veterinary medicines</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>It is produced without artificial additives (colours, flavours etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is produced without genetically modified organisms (GMO)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>It contains more essential nutrients (vitamins, minerals etc)</td>
<td></td>
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<tr>
<td>It contains additional compounds that may impart health benefits (e.g. phytochemicals which are antioxidant, anticancer etc)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>I get a psychological benefit from choosing organic foods</td>
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</tr>
</tbody>
</table>

Comment:

The following questions relate to your general sense of health and wellbeing.
**Organic Health and Wellness Survey**

8. Have you noticed a change in any of the following since you began eating (more) organic food?

*One answer per row.*

<table>
<thead>
<tr>
<th>Aspect</th>
<th>A lot worse</th>
<th>A little worse</th>
<th>About the same</th>
<th>A little better</th>
<th>A lot better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness/ability to exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mental alertness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mood stability (depression, anxiety)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioural stability (anger, aggression, hyperactivity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to/recovery from illness</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Ability to cope with stressful situations</td>
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<tr>
<td>Weight</td>
<td></td>
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<tr>
<td>Sleep</td>
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<tr>
<td>Condition of skin / hair / nails</td>
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<tr>
<td>Sense of satiety (satisfied feeling after eating)</td>
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</tbody>
</table>

Comments

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9. Which of the following statements best describes you?

*Since moving to (more) organic food I have noticed that my overall health is...”

- a lot worse.
- a little worse.
- about the same (I haven’t noticed any changes, either positive or negative).
- about the same (some symptoms have improved and some have worsened).
- a little better.
- a lot better.

Comments
Organic Health and Wellness Survey

10. To what extent do you believe moving to (more) organic food influenced this (if any) change in your health?
   - No influence
   - Weak influence
   - Moderate influence
   - Strong influence

Comment

11. Did you make any other dietary or lifestyle changes around the time you started eating (more) organic food or have any other factors occurred that may have had an impact on your health?
   - No
   - Yes (please describe briefly)

12. To what extent do you believe these factors influenced the change (if any) in your health?
   - Not applicable, no other factors have influenced my health
   - No influence
   - Weak influence
   - Moderate influence
   - Strong influence

Comment
**Organic Health and Wellness Survey**

*13. The following question asks how satisfied you feel, on a scale from zero to 10. Zero means you feel completely dissatisfied. 10 means you feel completely satisfied. And the middle of the scale is 5, which means you feel neutral, neither satisfied nor dissatisfied."
One answer per row.

**How satisfied are you with...?**

<table>
<thead>
<tr>
<th>Completely dissatisfied</th>
<th>Neutral</th>
<th>Completely satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>your standard of living</td>
<td></td>
<td></td>
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<tr>
<td>your health</td>
<td></td>
<td></td>
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<tr>
<td>what you are achieving in life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>your personal relationships</td>
<td></td>
<td></td>
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<tr>
<td>how safe you feel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>feeling part of your community</td>
<td></td>
<td></td>
</tr>
<tr>
<td>your future security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>your spirituality or religion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. The following question asks you to rate your overall sense of ‘wellness’ on a scale from minus five (-5) to plus five (+5).
On this scale -5 is extreme or disabling illness, zero (0) is neutral (i.e. the absence of illness but without a sense of ‘wellness’), and +5 is an extreme sense of wellness.
One answer per row

**How would you rate your overall sense of wellness prior to moving to (more) organic food AND how would you rate it now?**

<table>
<thead>
<tr>
<th>Extreme illness</th>
<th>Absence of illness</th>
<th>Extreme wellness</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>-1</td>
<td>+4</td>
</tr>
<tr>
<td>-4</td>
<td>0</td>
<td>+3</td>
</tr>
<tr>
<td>-3</td>
<td>+1</td>
<td>+2</td>
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<tr>
<td>-2</td>
<td>+2</td>
<td>+1</td>
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<tr>
<td>-1</td>
<td>+3</td>
<td>0</td>
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<tr>
<td>0</td>
<td>+4</td>
<td>-1</td>
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<tr>
<td>+1</td>
<td>+5</td>
<td>-2</td>
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<td>+2</td>
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<td>+3</td>
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<td>-4</td>
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<tr>
<td>+4</td>
<td></td>
<td>-5</td>
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</tbody>
</table>

Prior to moving to (more) organic food

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
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<tbody>
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</table>

The following questions ask about the extent to which you believe consuming organic food can assist in preventing illness.
### Organic Health and Wellness Survey

15. How much do you agree or disagree with the following statements?

"Consuming organic food reduces the risk of developing..."

<table>
<thead>
<tr>
<th>Condition</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Unsure/Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular disease</td>
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<tr>
<td>Asthma</td>
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<tr>
<td>Developmental problems in children</td>
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<tr>
<td>Problems with fertility</td>
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<tr>
<td>Allergic conditions e.g. eczema, hay fever</td>
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<tr>
<td>Liver disease e.g. cirrhosis</td>
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<tr>
<td>Psychiatric conditions e.g. depression, anxiety</td>
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<tr>
<td>Auto-Immune diseases e.g. rheumatoid arthritis, Crohn's Disease</td>
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<tr>
<td>Infection</td>
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<tr>
<td>Cancer</td>
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<tr>
<td>Obesity</td>
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<tr>
<td>Diabetes</td>
<td></td>
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<tr>
<td>Fatigue syndromes e.g. chronic fatigue syndrome, fibromyalgia</td>
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<tr>
<td>Behavioural disorders e.g. ADHD</td>
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</tbody>
</table>

Are there any other conditions (or specific conditions within the above categories e.g. bowel cancer) that you believe organic food can assist in preventing?
Organic Health and Wellness Survey

16. Have you experienced a problem with any of the following that you believe is associated with consuming conventional food?

- Reproductive – e.g. impaired fertility, polycystic ovaries
- Cardiovascular – e.g. high blood pressure/ hypertension, high cholesterol, palpitations
- Skin – e.g. acne, psoriasis, skin allergies
- Musculoskeletal – e.g. muscle pain, joint pain
- Respiratory – e.g. asthma, hayfever, sinusitis, excess mucus, respiratory allergies
- Endocrine – e.g. high/ low blood sugar (hyper/ hypoglycaemia), thyroid disease
- Immune – e.g. auto-immune conditions, repeated infections, cancer
- Other – e.g. insomnia, fatigue, headache, migraine
- Gastrointestinal – e.g. (gut) discomfort, pain, bowel issues

Comment

The following questions may be answered for yourself, or if you are a parent, for your own child/ children.

The purpose of these questions is to explore whether you have experienced any changes in your health (either positive or negative) as a result of moving to (more) organic food.

It is understood that many people will experience some symptoms/ conditions from time to time. You do not need to report on occasional symptoms unless there has been a noticeable change in the frequency or severity of symptoms since you moved to (more) organic food e.g. occasional headache. You also do not need to report on symptoms/ conditions that can be clearly explained by factors other than diet e.g. muscle pain as a result of an injury.

If you answer 'yes' you will be guided through a series of questions to obtain more information about the effects that you have noticed in yourself or your child/ children.

*17. Have you (or your child/ children under 18 years) experienced any ongoing* health problems that you believe have changed as a result of moving to (more) organic food?

* You do not need to report on occasional symptoms or symptoms which you believe are related to factors other than diet.

- Yes
- No
Organic Health and Wellness Survey

18. Please briefly describe the condition/symptoms.

19. How has the condition/symptom(s) changed since moving to (more) organic food?
- A lot worse
- A little bit worse
- About the same (some symptoms have improved and some have worsened)
- A little better
- A lot better

Comment

20. Who experiences or experienced the symptom?

If more than one person experiences the symptom please report on the person with the most pronounced symptoms and include a comment at the end of the section about the other's.

- Myself
- My child

21. How old is the child in question?

Years __________________________

Months __________________________

22. Is the child female or male?

- Female
- Male

23. Over the past year what proportion of the child's food intake was prepared from organic food (either certified or non-certified)?

- Almost none (0-10%)
- A little (10-35%)
- About half (35-65%)
- Most (65-90%)
- Almost all (90-100%)
Organic Health and Wellness Survey

24. At what point was organic food introduced to this child?
   - Organic food was introduced before the child was conceived
   - Organic food was introduced during pregnancy
   - Organic food was introduced when the child was... (age in years and/or months)

25. Please briefly describe the changes you have noticed in the condition/symptoms.

26. Were you aware prior to moving to (more) organic food that it may have an impact on your (your child’s) symptoms?
   - Yes
   - No

27. How long had you (your child) experienced the symptoms prior to moving to (more) organic food?
   - Symptoms started after moving to (more) organic food
   - Less than one month before
   - Few months before
   - Six months to one year before
   - 1 to 2 years before
   - 2 to 5 years before
   - 5 to 10 years before
   - More than 10 years before
   - Comment
**Organic Health and Wellness Survey**

28. How long after moving to (more) organic food did you notice a change in symptoms?

- [ ] within days
- [ ] less than one month
- [ ] a few months
- [ ] six months to one year
- [ ] 1 to 2 years
- [ ] over 2 years

Comment

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29. Have you discussed the symptoms with a doctor, specialist or other health professional?

- [ ] Yes
- [ ] No

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30. Have any of the following factors occurred that might have contributed to the change in your (your child’s) condition?

If **NO** - please mark 'not applicable'.
If **YES** - please indicate the degree to which you believe that it may have made the condition better or worse?

<table>
<thead>
<tr>
<th></th>
<th>Not applicable</th>
<th>A lot worse</th>
<th>A little worse</th>
<th>No effect</th>
<th>A little better</th>
<th>A lot better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commenced a medication</td>
<td></td>
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</tr>
<tr>
<td>(pharmaceutical, natural etc) to treat the condition</td>
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</tr>
<tr>
<td>Made other dietary changes to treat the condition</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Made lifestyle changes to treat the condition</td>
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<tr>
<td>New exposure or event that may affect the condition e.g. chemical exposure, stressful event, other illness etc (describe below)</td>
<td></td>
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</tr>
</tbody>
</table>

Comment
Organic Health and Wellness Survey

31. Have any changes in symptoms been confirmed by a doctor, specialist or other health professional?
- YES - the doctor, specialist or other health professional has confirmed that there have been changes
- NO - the doctor, specialist or other health professional does not agree that there have been any changes
- NO - the symptoms got better so I didn't bother discussing with the doctor, specialist or other health professional
- NO - the symptoms got worse but I haven't discussed with the doctor, specialist or other health professional

Comment

32. Please include any additional comments, including observations about yourself or any other children who experience these symptoms.

33. Have you (your child) experienced any other symptoms or conditions that you feel have been made better or worse by eating (more) organic food?
- Yes
- No

34. Please describe any other changes (if any) that you have noticed since moving to (more) organic food.

The remaining questions relate to the person completing the survey.

Please indicate your answers using the following definitions as a guide:
Organic Health and Wellness Survey

**Definitions:**
- **Certified Organic** – food may be considered ‘certified organic’ if one of the recognised ‘certified organic’ labels is visible on the product or at the point of sale. A list of these images is available below.
- **Non-certified Organic/Likely Organic** – no ‘certified organic’ label is visible on the product or at the point of sale but the food has been home grown without chemicals or has been purchased from a farmer’s market, farm gate or local food initiative where non-certified organic food is traded on a ‘trust’ basis.

**Note:** occasional ‘certified organic’ seafood products can be purchased but they tend to be rare. Wild caught seafood may be considered ‘non-certified organic’, however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.

### Certification logos

![Certification logos](image)

### Questions

**35. Over the past year what proportion of the food you ate was prepared from organic food (either certified or non-certified)?**

- [ ] Almost none (0-10%)
- [ ] A little (10-35%)
- [ ] About half (35-65%)
- [ ] Most (65-90%)
- [ ] Almost all (90-100%)

**36. Over the past year what proportion of the food you ate was prepared from certified organic food?**

- [ ] Almost none (0-10%)
- [ ] A little (10-35%)
- [ ] About half (35-65%)
- [ ] Most (65-90%)
- [ ] Almost all (90-100%)
### Organic Health and Wellness Survey

37. Estimate the percentage of your weekly food bill that is spent on organic food products (certified and/or non-certified)?
Type a rough percentage (0-100) in the box below.

%  

38. How often do you eat the following organic foods?
(One answer per row. Please include both certified and non-certified organic products. If you are unsure whether the product is organic do not include it)

<table>
<thead>
<tr>
<th>Item</th>
<th>Most if not all days</th>
<th>At least 2 to 3 times a week</th>
<th>At least once a week</th>
<th>Every 2 to 3 weeks</th>
<th>About once a month</th>
<th>Less often</th>
<th>Don't eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic grains (wheat, oats, rice etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh organic fruit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh organic vegetables</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Organic dairy products (milk, cheese, yogurt etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic meat</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic poultry (chicken, turkey, duck etc)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic or seafood (fish, squid, oysters, shellfish etc)</td>
<td></td>
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<tr>
<td>Organic eggs</td>
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</tr>
<tr>
<td>Organic legumes (lima, chickpeas, red kidney beans etc)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Organic nuts and seeds</td>
<td></td>
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<tr>
<td>Organic vegetarian meat alternatives (including tofu, vegetarian sausages etc)</td>
<td></td>
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<tr>
<td>Pre-packaged organic foods (e.g. canned, frozen, boxed, bagged etc)</td>
<td></td>
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<tr>
<td>Ready made organic foods (e.g. ready made meals)</td>
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<tr>
<td>Other foods snacks, confectionary, condiments etc</td>
<td></td>
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</tbody>
</table>

Comments
### Organic Health and Wellness Survey

39. **How much** (what percentage) of the following foods do you eat as organic? (One answer per row. Please include both certified and non-certified organic products. If you are unsure whether the product is organic do not include it)

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>Almost all (90-100%)</th>
<th>Don’t eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains (wheat, oats, rice etc)</td>
<td></td>
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<tr>
<td>Fresh fruit</td>
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<td></td>
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<tr>
<td>Fresh vegetables</td>
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<td></td>
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<tr>
<td>Dairy products (milk, cheese, yoghurt etc)</td>
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<tr>
<td>Red meat</td>
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<tr>
<td>Poultry (chicken, turkey, duck etc)</td>
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<tr>
<td>Seafoods/ fish (fish, squid, oysters, snail etc; include wild caught seafood)</td>
<td></td>
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<td></td>
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<tr>
<td>Eggs</td>
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<tr>
<td>Legumes (lentils, chickpeas, red kidney beans etc)</td>
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<tr>
<td>Nuts and seeds</td>
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<td>Vegetarian meat alternatives (including tofu, vegetarian sausages etc)</td>
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<td>Pre-packaged foods (e.g. canned, frozen, boxed, bagged etc)</td>
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<tr>
<td>Ready made foods (e.g. ready made meals)</td>
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<tr>
<td>Other foods (snacks, confectionary, condiments etc)</td>
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</tbody>
</table>

Comments
Organic Health and Wellness Survey

40. Are there specific organic foods you select because you believe they are better for health?
Multiple answers allowed.

- Grains
- Fruit
- Vegetables
- Dairy
- Red meat
- Poultry
- Fish/seafood
- Eggs
- Legumes
- Nuts & seeds
- Meat substitutes
- Other

Comments: (You can specify specific foods within the above groups e.g. specific fruits, grains etc.)

You are reminded that this survey is completely anonymous and this information will only be used for the purposes stated in the Project Information Statement.
A copy of the 'Project Information Statement' can be accessed via the study website.

* 41. Gender

- Female
- Male

* 42. Age (in years).

  years

43. Please include the following so that we can calculate your body mass index (BMI).

- Height (in cm)
- Weight (in kg)

44. Country of Birth

- Australia
- Other (please specify)
Organic Health and Wellness Survey

*45. Highest qualification completed
- No formal schooling or qualifications
- School only (Primary or secondary)
- Trade certificate (Certificate I, II, III, IV or NVQ)
- Diploma or Advanced Diploma
- Tertiary (Undergraduate) e.g. Bachelor Degree
- Tertiary (Postgraduate) e.g. Graduate Certificate, Graduate Diploma, Masters, PhD

Comments

46. Complete this statement.

I would describe the area I live in as...

- Inner-urban
- Suburban
- Semi-rural
- Rural

*47. What is your postcode?

Postcode:

Please take a moment to help us improve this survey.

48. How long did it take you to complete this survey?

Number of minutes
Organic Health and Wellness Survey

49. Where did you hear about this survey?
Multiple answers allowed.

- Advertisement on the web
- Advertising flyer/poster
- Newspaper/magazine ad
- Newspaper/magazine article
- Radio
- Television
- Friend/colleague
- Other

Please specify which website/newspaper/radio station/retail outlet etc

50. Thank you for taking the time and effort to complete this survey.

Please feel free to include below any other comments you would like to make before you complete the survey.

Thank you for taking the time and effort to complete this survey.

If you would like to read the results of this survey when they become available or be kept informed about future studies you can visit the study website or register your email address to receive email updates by emailing news@organiserearch.net.

Once again, thank you.

Liza Gates
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University
Website Content (OHWS)

Organic Food Research
Background to the Project

In the Organic Consumption Survey over 95% of organic consumers agreed with the statement 'organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues'. While Australian researchers have demonstrated that Victorian certified organic produce has fewer pesticide residues than conventional food crops, whether this results in less accumulation of pesticides in people who consume organic produce is unclear.

Recent studies of children in the United States have demonstrated that substituting conventional fruits and vegetables with organic ones for a five-day period, results in a reduction in levels of organophosphate pesticide metabolites to non-detectable or close to non-detectable levels and pyrethroid insecticides reduced by approximately 50%. This confirms a previous report that consumption of organic fruits, vegetables and juice can reduce children's exposure levels from 'uncertain risk' to 'negligible risk'. Whether these results can be extended to adult populations and other agricultural contaminants has yet to be explored.

‘Organic Health & Wellness Survey’
OPENS FRIDAY 14th OCTOBER

The purpose of the ‘Organic Health & Wellness Survey’ is to explore the health experiences of people who consume organic foods on a regular basis. The information collected will be used to direct future research.

This survey is intended to be completed by people who consume organic foods on most if not all days. The questions will generally refer to the period since you started eating organic food (or made a choice to increase your intake from only eating organic occasionally to eating it regularly).

Before you decide whether to participate in the survey you will be asked to confirm the following.

- I consider myself to be a regular ‘organic consumer’.
- I am over 18 years of age.
- I have read and understood the ‘Project Information Statement’.

If you have not done so already you can view a copy of the ‘Project Information Statement’ (PDF 55KB 3p).

It is anticipated that this survey will take approximately 15-20 minutes to complete. Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your personal health experiences as a result of consuming organic foods. In relevant sections, parents of children under 18 years (who are not eligible to complete the survey themselves) may also include health effects that they have observed in their own children. You will not
be asked for your name, address or any other personal identifying information. To find out more read the Privacy Statement (PDF 20KB 2p).

To complete the survey please take the Organic Health and Wellness Survey.

**Bio-monitoring trial (BMT)**

*Please contact the study co-ordinator if you are interested in participating in this study.*

The Department of Health Sciences at RMIT University is conducting a study to identify whether there is a difference in urinary pesticide residues in response to consumption of organic and conventional (non-organic) foods. It will also look at whether the tests that are commercially available in Australia are sensitive enough to pick up dietary differences in organic intake. Urine samples will be collected from participants on two occasions and analysed for pesticide residues (in particular for metabolites of organophosphate).

Eligible participants will be asked to undertake two different diets, each for a 7 day period. In phase 1 participants will be asked to complete a food intake survey for 7 days whilst following an organic diet. At the end of this period participants will be asked to provide a urine sample, to be analysed for pesticide residues, and complete an online survey known as the ‘Chemical Exposure and Food Behaviour Survey’. This process will then be repeated with the participants consuming a conventional diet for a 7-day period. The order of the diets may be reversed for some participants.

Participants will be provided with copies of all necessary documents as well as any equipment and written instructions required for the collection, storage and transportation of urine samples. The primary researcher will be available to answer questions if required. All documents and specimens will be coded to protect the participants’ identity.

Participants who complete the study will be able to obtain copies of their personal test results free of charge at the end of the study period.

If you are interested in learning more about this project please read the ‘Project Information Statement’ (link).

The project is supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd. The project has been approved by the RMIT Human Research Ethics Committee.

If you have any questions or would like to express your interest in participating please contact the study co-ordinator: liza.oates@rmit.edu.au or 0412 310 390. Please provide your contact details (email and phone number) and a suitable time to contact you. These details will not be passed on to any third parties.

**Previous Research (Key Findings)**

*Organic Consumption Survey (OCS)*
The Organic Consumption Survey (OCS) was conducted in Australia in 2010. The purpose was to identify the behaviours and beliefs of people who consume organic foods. Three hundred and eighteen usable surveys were submitted. The majority of participants were female (80.3%), 25-55 years old (80.3%), from urban areas (61.2%), born in Australia (68.9%) and were in a healthy weight range (55.5%). As with previous reports income did not appear to have a strong impact on organic uptake. The median household income amongst organic consumers surveyed was AU$1,000–1,299/week (AU$52,000–67,599/year) with a marked increase up to but only a slight increase beyond AU$400–599/week (AU$20,800–31,199/year). Nearly two thirds of OCS participants held a tertiary degree qualification with over a third holding postgraduate degrees. In general the demographic characteristics of participants did not appear to differ with the level of organic consumption.

Based on self-reports, the percentage of people in the OCS that consumed most or all (i.e. >65%) organic food in the previous 12 months was 37.4% for certified organic food and 60.4% when ‘likely’ organic foods were also included. The majority (56.3%) of participants were able to achieve 65% organic food intake including a minimum of 35% certified organic food.

Organic fruit and vegetables had the highest uptake by organic consumers and animal flesh products the lowest. The average estimated weekly expenditure on organic food (either certified or ‘likely’) was 69.3% of the weekly food budget. Many of the organic consumers surveyed did not eat various food groups unless they were organic. Those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit and vegetables.

The vast majority agreed with the statements: ‘organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ (95.4%); and ‘organic foods are better for the environment than conventionally grown foods’ (97%). Very few agreed that ‘in Australia the regulation of agricultural chemicals used on conventional farms adequately protects the environment from damage’ (2%) or that ‘the amounts of pesticide residues remaining on conventionally farmed produce are not likely to be harmful to my health’ (5.6%).

Around a quarter (24.7%) said that health related concerns influenced their decision to consume organic foods and 76.9% said that scientific evidence had a moderate or strong influence on their beliefs about organic food.

The majority of people said they would eat more organic food if: it was ‘more available in convenient locations’ (70.4%); if it was ‘less expensive (no more than 20% premium)’ (65.4%); or if there was ‘more evidence that eating organic food reduces exposure to pesticide residues compared to eating conventionally farmed food’ (57.7%). Cost and convenience appeared to become less important in those with high consumption of organic food.
Other factors that influenced purchasing decisions included: where the food was grown (90.5%), the amount of processing (89.4%), the amount of packaging (87.5%), whether the food was in season (86.2%), the nature of the seller (80.4%), whether the farmers received a fair price and conditions (79.9%) and the distance it had travelled (79.1%).

Clearer definitions of organic consumers should allow for more rigorous research evaluating the purported health benefits of organic foods in the future. The information from this survey will be used to ensure that the ongoing ‘Health and Wellness Survey’ and biomonitoring trial are relevant to and reflective of Australian organic consumers.

If you would like you can view a copy of the ‘Organic Consumption Survey’ questions (PDF, 211KB, 18p).

Organic Food Intake Survey (OFIS)

As it is difficult for adult consumers to maintain a 100% organic diet, participants were invited to pilot a three-day 'Organic Food Intake Survey' (OFIS). The purpose of this survey was to assess the percentage of organic food consumed. Nineteen participants returned the surveys providing a total of 58 sampling days.

Based on self-reports, the percentage of people in the OFIS that consumed more than 65% organic food in the previous 12 months was 52.6% for certified organic food and 73.6% when ‘likely’ organic foods were also included. On the whole the ‘actual’ levels of organic consumption (based on quantification of serving sizes by food group) were slightly higher than the initial self-reported estimates of the participants, although these differences were not statistically significant. The average estimated weekly expenditure on organic food (either certified or ‘likely’) was 74.3% amongst participants in the OFIS. The majority (63%) were able to achieve 65% organic food intake including a minimum of 35% certified organic food.

Overall the percentage of servings that came from organic food was lowest for animal protein (56.8%) and highest for fruit (80.1%) and vegetables (83.2%). Interestingly both animal protein (16.6%) and vegetables (19.0%) had the highest contribution from 'likely' organic sources. Comments from participants suggested these were largely from vegetables grown in their own garden or eggs from their own chickens. Some participants also included food purchased from farmer’s markets where they had discussed the production methods with the farmers.

If you would like you can view a copy of the ‘Organic Food Intake Survey’ questions (DOC, 356KB, 13p).

Additional information

Register your interest in joining our mailing list

If you have any questions please email Liza Oates.
Publications and Presentations


Funding Sources

- Liza Oates is supported by an Australian Postgraduate Award scholarship
- RMIT University provides assistance with statistical, IT and marketing support
- The organic industry provides in kind assistance with promoting the projects to prospective participants
- The biomonitoring trial is supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd.

The Researchers would like to thank

- Professor Charlie Xue and the staff of the School of Health Sciences
- Dr Anthony Bedford and Adrian Schembri (School of Mathematical and Geospatial Sciences)
- Cathy Leahy (School of Health Sciences)
- Professor Neil Mann (School of Applied Science)
- Gosia Kaszubska, Milena Nicola and Nick Besley (College of SEH Marketing and Communications)
Appendix 5. Biomonitoring Trial Documents

BMT Project Information Statement

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT
PROJECT INFORMATION STATEMENT

Project Title:
"Intrapersonal variation in pesticide residues in response to an organic diet – a biomonitoring trial (BMT)"

Investigators:
- Ms Liza Oates, B HSc [Naturopathy], GradCert Evidence-based Comp Med (PhD candidate, School of Health Sciences, liza.oates@rmit.edu.au 0412 310 390)
- Dr Marc Cohen, MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons), FAMAC, FICAE (Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University, marc.cohen@rmit.edu.au, 9925 7440)

You are invited to participate in a research project being conducted by RMIT University.

This information sheet describes detailed information about the project in straightforward language, or ‘plain English’. Its purpose is to explain to you as openly and clearly as possible all the procedures involved in this project before you decide whether or not to take part in it.

Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators. You may also wish to discuss the project with a relative or friend. Feel free to do this.

Once you understand what the project is about and if you agree to take part in it, you will be asked to sign this form. You will be given a copy for your records.

Who is involved in this research project?
The project is being conducted by Ms Liza Oates under the supervision of Professor Marc Cohen as part of a PhD program in the School of Health Sciences at RMIT University, which is supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd. The project has been approved by the RMIT Human Research Ethics Committee.

Why have you been approached?
You have been approached because you have registered your interest in this project and indicated that you consider yourself to be an ‘organic consumer’. If you know of other people who may be interested in participating, please encourage them to seek more information from www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.

What is the project about?
The purpose of this study is to see if consuming organic food (compared to conventional or non-organic food) results in a reduction in the levels of pesticide residues in your urine.
It will also look at whether the tests that are commercially available in Australia are sensitive enough to pick up dietary differences in organic intake. This information will be collected as part of an ongoing trial investigating the health effects of an organic diet. The information collected will be used to direct future research in the area.

**If I agree to participate, what will I be required to do?**

Once you have registered your interest by contacting the study investigators you will receive a phone call and you will be asked questions to determine whether you are eligible to participate in the study. At this point you should also take the opportunity to have any of your own questions answered.

During the study participants will be asked to follow two different diets for 7 days at a time. The two diets will be a conventional (non-organic) diet and an organic diet. During the conventional diet you will be asked to consume only conventional foods (as close to 100% as possible). During the organic diet you will be asked to consume only organic foods. It is accepted that a small amount of conventional food may be unavoidably or unknowingly included in the organic diet period and vice versa. During each of the diet periods we will ask you to complete a food intake survey (known as the OFIS).

In the OFIS you will be asked to record what you eat and drink, including the approximate amounts and whether the items are ‘certified organic’, ‘likely organic’ or conventional (non-organic). Where possible you should try to consume similar foods to your usual diet during each of the diet periods. At the end of the diet period you will be asked to submit the OFIS forms to the investigators via email (liza.oates@rmit.edu.au). The investigators may then contact you to clarify any of your responses. At no point will your email address or any other contact details be available to a third party, and no information will be collected or stored with any details that can be used for identification by a third party.

Prior to commencing and following each of the 7-day diet periods you will also be asked to complete a short online survey known as the ‘Chemical Exposure and Food Behaviour Survey’ (CEFBS). This will record basic details including factors that may affect your test results. At this time we will also ask you to provide a sample of your urine (your first urination for the day) which will be tested for pesticide residues. You will be asked to pack the urine sample with an ice pack in a small esky and call a courier to collect the sample so that it can be delivered to the laboratory as a matter of urgency. If there is likely to be a delay between collecting your urine sample and the courier picking up the sample you may be required to keep the sample refrigerated for a short period of time.

You will be provided with clear instructions and any equipment needed for the collection and transport of your urine samples. The costs of all equipment, tests and transportation will be covered by the project.

You will be provided with a participant code number which will be used on your urine sample and any survey documents. You should keep a record of this number so that you can obtain a copy of your test results at the end of the study period.

If you would like to see the surveys before agreeing to participate you can view or download a copy of the OFIS and/ or CEFBS survey forms from the study website at: www.rmit.edu.au/wellness/OrganicResearch or request a copy by emailing liza.oates@rmit.edu.au.

**Who is the project being funded by?**

This project is supported by a private philanthropic gift from Bharat Mitra, founder of Organic India.
What are the risks or disadvantages associated with participation?
At present there is no clear evidence that the consumption of conventional food (as consumed by the majority of the population) poses direct health risks. However, it is not possible to guarantee that future research may show otherwise. As any risks are likely to be higher during certain developmental periods pregnant and lactating women and children will not be eligible for this study. As risks may also theoretically be higher for older adults or those with medical conditions or taking medications that may affect the way the body deals with pesticides, such participants will also not be eligible for the current study.

If you have any concerns, you should contact the investigator (Liza Oates) as soon as convenient. Liza will discuss your concerns with you confidentially. Participation is entirely voluntary and you can suspend or end your participation in the project at any time.

What are the benefits associated with participation?
If desired, participants will be able to obtain a copy of their individual test results free of charge. Test results will be accompanied by a written report explaining the results so that they can be discussed with your healthcare practitioner. This information may assist participants in making a more informed choice about incurring the additional expense of organic food.

This project may also lead to future research into the potential health benefits of organic diets and the ability of various detoxification programs to eliminate such pesticides.

What will happen to the information I provide?
It is anticipated that the results of the project will be published on the study website www.rmit.edu.au/wellness/OrganicResearch and in a respected scientific journal. In any publication, information will be provided in such a way that you cannot be identified.

Any survey information collected will be coded using your participant number, and will not be stored with any details that can be used to directly identify you. Only the investigators will have access to the coding system which will be password protected. Only investigators will have the password.

Responses to the surveys will be stored on a host server that is used by the primary investigator (Liza Oates). Once data collection and analysis are completed the data will be imported to the RMIT (SEH Research Unit) server where it will be stored securely for a minimum period of twenty five (25) years before being destroyed. The data on the host server will then be deleted and expunged.

Any hardcopy documents will be kept in a locked cabinet to which only the investigators will have the key. Once the project is complete and results have been published these copies will be destroyed.

In accordance with the Freedom of Information Act 1982 (Vic), you have the right to access and to request correction of information held about you by RMIT University.

What are my rights as a participant?
You have the right to have any questions answered at any time. You should provide your written consent, by signing this document, only after you have had a chance to ask your questions and have received satisfactory answers.

Participation in any research project is voluntary. You are entitled to withdraw your participation at any time, without prejudice. In this event you may request to have any
unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not cause any risk to you.

You will not be paid for your participation in this trial. The costs of collecting, transporting and analysing your urine samples will be covered by the project. Unfortunately, we cannot cover food costs at this time.

This project will be carried out according to the National Statement on Ethical Conduct in Human Research (2007) produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies.

The ethical aspects of this research project have been approved by the Human Research Ethics Committee of RMIT University.

**Whom should I contact if I have any questions?**
You can seek more information about the project from www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.

**What other issues should I be aware of before deciding whether to participate?**

*Security of the website and data*
Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects.

This project will use an external site to create, collect and analyse data collected in a survey format. The site we are using is www.surveymonkey.com. If you agree to participate in this survey, the responses you provide to the survey will be stored on a host server that is used by the investigator (Liza Oates). Once we have completed our data collection and analysis, we will import the data we collect to the RMIT server where it will be stored securely for a minimum period of twenty five (25) years. The data on the host server will then be deleted and expunged.

Thank you for taking the time to read this document carefully. If you have any questions you would like to ask before you agree to participate you can contact the investigators via the study website at: www.rmit.edu.au/wellness/OrganicResearch or by emailing liza.oates@rmit.edu.au or calling Liza Oates on 0412 310 390.

Yours sincerely,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
BMedSc(Hons)

Liza Oates

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM),
HEALTH, WELLNESS AND ORGANIC DIETS

PhD candidate, Medicine, School of Health Sciences, RMIT University
Project Supervisor: Professor of Complementary Medicine, School of Health Sciences, RMIT University

Further information is available from the Ethics Executive Officer, RMIT Human Research Ethics Committee on 9925 2251.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. Details of the complaints procedure are available at: http://www.rmit.edu.au/governance/complaints/research
BMT Consent Form

**Participant Code:**

*Please keep this copy for your records*

**PARTICIPANT’S CONSENT**

1. I have had the project explained to me, and I have read the information sheet.

2. I agree to participate in the research project as described. I agree to undertake the specified diets, complete the necessary survey forms and provide urine samples during the three 7-day diet phases of this study. I agree to have my de-identified urine samples stored for up to 5 years to allow for the possibility of further testing/retesting, before being disposed of according to University policy.

3. I acknowledge that:
   
   (a) I understand that my participation is voluntary and that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied (unless follow-up is needed for safety).
   
   (b) The project is for the purpose of research. It may not be of direct benefit to me.
   
   (c) The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.
   
   (d) The security of the research data will be protected during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided on the study website. Any information which will identify me will not be used.

4. I confirm that:
   
   (a) I am between 18 and 65 years of age.
   
   (b) I am not currently pregnant, breastfeeding or trying to conceive.
   
   (c) I have/will disclose all medical conditions and medications to the investigators.
   
   (d) I feel confident that I will be able to read and understand all of the necessary documents and complete all of the necessary survey forms to complete the study.
   
   (e) I am willing to and feel confident that I will be able to follow the different diets.

**Participant’s Consent**

Participant: ___________________________ Date: ______________

(Signature)

**Witness:**

Witness: ___________________________ Date: ______________

(Signature)
Any complaints about your participation in this project may be directed to the Ethics Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251. Details of the complaints procedure are available at: http://www.rmit.edu.au/governance/complaints/research

Ethics approval BMT
**Notice of Approval**

**Date:** 7 November 2011  
**Project number:** 59/11  
**Project title:** *Intrapersonal variation in pesticide residues in response to an organic diet*  
**Risk classification:** More than low risk  
**Investigator:** Liza Gates  
**Approved:** From: 7 November 2011 To: 31 December 2012

**Terms of approval:**

1. **Responsibilities of investigator**  
   It is the responsibility of the above investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by HREC. Approval is only valid whilst investigator holds a position at RMIT University.

2. **Amendments**  
   Approval must be sought from HREC to amend any aspect of a project including approved documents. To apply for an amendment use the request for amendment form, which is available on the HREC website and submitted to the HREC secretary. Amendments must not be implemented without first gaining approval from HREC.

3. **Adverse events**  
   You should notify HREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. **Plain Language Statement (PLS)**  
   The PLS and any other material used to recruit and inform participants of the project must include the RMIT university logo. The PLS must contain a complaints clause including the above project number.

5. **Annual reports**  
   Continued approval of this project is dependent on the submission of an annual report.

6. **Final report**  
   A final report must be provided at the conclusion of the project. HREC must be notified if the project is discontinued before the expected date of completion.

7. **Monitoring**  
   Projects may be subject to an audit or any other form of monitoring by HREC at any time.

8. **Retention and storage of data**  
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

In any future correspondence please quote the project number and project title above.

**A/Prof Barbara Polus**  
Chairperson  
RMIT HREC

*cc: Dr Peter Burke (Ethics Officer/HREC secretary), Prof Marc Cohen (supervisor).*
BMT Letter to participants

Dear XXX,

Thank you for your participation in the study known as ‘Intrapersonal variation in pesticide residues in response to an organic diet’.

Your participant number is: XXXXXXX

Please keep a record of this number as you will be asked to use this number instead of your name on any documents or samples. This is to ensure that your identity is protected so please keep this number secure. At the end of the study period you will need this number in order to obtain copies of your individual test results.

We appreciate the time and commitment involved in participating in such a study. This information will assist us in identifying if there is a difference in urinary pesticide residues (i.e. the amount of detectable pesticide residues in urine samples) in response to consumption of organic and conventional (non-organic) foods. This study is part of an ongoing trial investigating the health effects of an organic diet. The information collected will be used to direct future research in the area.

As part of this study you have been asked to undertake two different diets for 7 days at a time. The two diets are a conventional (non-organic) diet and an organic diet. During the conventional diet phase we would ask you to consume only conventional foods (as close to 100% as possible). During the organic diet we would ask you to consume only organic foods. Where possible you should attempt to consume similar foods during the diet phases. If you have any questions please contact the researcher at liza.oates@rmit.edu.au or 0412 310 390.

We would ask you to undertake the different diet phases in the following order:
1. Conventional diet
2. Organic diet

Please let me know if this will be problematic for you.

Completing the OFIS

It is accepted that a small amount of conventional food may be unavoidably or unknowingly included in the organic diet phase and vice versa. In order to record all relevant details of your food intake we would ask you to complete the Food Intake Survey (OFIS) documents attached on each of the 7 days and for each of the diet phases. The documents are marked accordingly.

The purpose of this survey is to assess what percentage of organic or conventional food you consume. You will be asked to record what you eat and drink, including the approximate amounts and whether the items are ‘certified organic’, ‘likely organic’ or conventional (non-organic). The information collected will be used to ensure that the results are as accurate as possible. Should the amount of organic of conventional food you consume fall below a certain threshold we may need to ask you to repeat the diet phase before testing your urine.

You will already have provided written consent for your participation in this study. Because of the nature of data collection, we are not obtaining separate written informed consent from you for the surveys. Your consent to participate in the survey aspects of this study will be assumed if you return the completed survey documents. If you have any
questions you would like to ask before you commence you can contact the researchers via liza.oates@rmit.edu.au or 0412 310 390.

You may be sent a reminder email if you have not returned the survey forms. Upon electronic return of the OFIS survey forms, you may be contacted by the researchers for clarification about the food items you have listed. The survey forms are coded to protect your identity and your email address will be deleted at the end of the study. At no point will email addresses be available to a third party, and no information will be collected or stored with any details that can be used for identification.

The attached document (Instructions for OFIS) explains how to complete the survey forms. If you have any questions you can contact the researcher via: liza.oates@rmit.edu.au or 0412 310 390.

Once you have completed the forms please email them to liza.oates@rmit.edu.au and include ‘Returned OFIS Forms’ in the subject line.

Collecting your urine sample

On day 8, after you have undertaken the diet for at least 7 days and completed the OFIS documents for these days you should collect your first morning urine sample.

You will have been provided with equipment for the following. Please read the collection instructions (attached) the night before so that you are clear about the procedure. Pay specific attention to what to do if you need to go to the bathroom during the night.

Please select the following container depending on whether you have completed the usual, organic or conventional phase of the study.

- Conventional diet (Container J)
- Organic diet (Container S)

Complete the following items on the label prior to collection.
- Date of collection:
- Time of collection:

Please keep a record of these dates/times as you will be asked for them again when you complete the CEFBS.

Please follow the instructions for how to collect your urine sample which are attached (note that these differ for males and females).

Ensure that all labels are visible and have not become smudged.

Make sure the lid is tightly secured and pack the urine sample in a plastic bag and place it in the esky with a frozen ice pack (provided).

Please contact Liza on 0412 310 390 to arrange pickup. If there is likely to be a delay between collecting your urine sample and the courier picking up the sample you may be required to keep the sample frozen for a short period of time.

Note: The first morning urine sample (also called an 8-hour specimen) should be collected when you first wake up, having emptied your bladder before going to sleep. Since the urine can be collected over any eight-hour period, this method still applies for people who have atypical work/sleep schedules. Any urine that is voided from the bladder during the eight-hour pre-collection period (i.e. during sleep hours) should be collected and
refrigerated, and then pooled with the first morning sample so that a true 8-hour specimen is obtained.

**Complete the CEFBS**

Before you embark on the study you should complete the following survey

CEFBS – Baseline [www.surveymonkey.com/s/CEFBSbaseline](http://www.surveymonkey.com/s/CEFBSbaseline)

As soon as possible after urine collection please complete the CEFBS for the diet phase you have just completed.

- Conventional Diet [www.surveymonkey.com/s/CEFBSconventional](http://www.surveymonkey.com/s/CEFBSconventional)

**Checklist**

Please ensure that you have completed the following for each of the diet phases.

**During the 7 day diet phase:**

- Undertake the diet (conventional or organic) for 7 consecutive days
- If you are in the organic phase try to avoid consuming any conventional food as much as possible
- If you are in the conventional phase try to avoid consuming any organic food as much as possible
- Try to maintain a diet that is similar to your usual diet, for instance similar amounts of fruit and vegetables, meat, dairy, grains etc. The food does not need to be exactly the same but try not to vary too much from what you would normally eat.
- At the end of each day record everything you have consumed on the OFIS forms.

**At the end of each 7-day diet phase:**

- Email the 7 completed OFIS forms to liza.oates@rmit.edu.au
- Collect your urine sample (on day 8) using the equipment provided. Ensure that you use the correctly labelled container (S/ J) and that your participant code is visible on the specimen container.
- Pack the urine sample with an ice pack in the small esky (provided)
- Call the courier as soon as possible to organise collection (If there is likely to be a delay between collecting your urine sample and the courier picking up the sample you may need to keep the sample refrigerated for a short period of time).
- Go to Survey Monkey and complete the relevant CEFBS survey. There are two separate surveys depending on which diet phase you have just completed.
  - Conventional Diet [www.surveymonkey.com/s/CEFBSconventional](http://www.surveymonkey.com/s/CEFBSconventional)

Thank you again for your time and effort,

**Liza Oates**

B HSc (Nat), GradCert Evid-based CompMed
BMSc(Hons)
PhD candidate,
Medicine,
School of Health Sciences, RMIT University

**Professor Marc Cohen**

MBBS(Hons), PhD(Elec Eng), PhD (TCM),
Project Supervisor: Professor of Complementary
School of Health Sciences, RMIT University
Cover letter for Food Survey (OFIS for use in BMT)

Thank you for your interest in the ‘Intrapersonal variation in pesticide residues in response to an organic diet’ study. We appreciate the time and commitment involved in participating in such a project. This information will assist us in ensuring the results of this study are as rigorous as possible. The purpose of this survey is to assess what percentage of the food you consume is organic or conventional (non-organic). You will be asked to record what you eat and drink, including the approximate amounts and whether the items are organic or conventional (non-organic), over a three day period.

Your consent
You will already have provided written consent for your participation in this study. Because of the nature of data collection, we are not obtaining separate written informed consent from you for the surveys. Your consent to participate in the survey aspects of this study will be assumed if you return the completed survey documents. If you have any questions you would like to ask before you commence you can contact the researchers via liza.oates@rmit.edu.au or 0412 310 390.

What will we do with your email address?
You may be sent a reminder email if you have not returned the survey forms. Upon electronic return of the OFIS survey forms, you may be contacted by the researchers for clarification about the food items you have listed. The survey forms are coded to protect your identity and your email address will be deleted at the end of the study. At no point will email addresses be available to a third party, and no information will be collected or stored with any details that can be used for identification.

What to do when you’ve completed the forms
Once you have completed the forms please save them as a normal word document on your computer but do not include any identifying information in the file name. We would then ask for you to attach the file to an email and return the forms to the study co-ordinator at liza.oates@rmit.edu.au. Please include ‘Returned OFIS Forms’ in the subject line. If you require any assistance with this visit the study website or contact the study co-ordinator (see below).

Finding more information and contacting us
The following page explains how to complete the survey forms. If you have any questions you can find additional useful information on the study website: www.rmit.edu.au/wellness/OrganicResearch, or you can email the study co-ordinator liza.oates@rmit.edu.au or 0412 310 390. We will endeavour to respond to any questions as soon as possible.

Thank you for your time and effort,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
BMedSci(Hons)

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM)
BMT Screening Questionnaire

1. Do I have your verbal consent to ask you some questions to determine whether you might be eligible for inclusion in this study?
   - Yes
   - No (DO NOT PROCEED)

2. Your answers are completely anonymous and won’t be passed on to any other parties
   Have you read the ‘Project Information Statement’? (if not can I ask you to read it now, before we proceed)
   - Yes
   - No (DO NOT PROCEED UNTIL YES)

3. Do you have any questions you would like to ask about the study?

4. How old are you?
   (<18 OR >65 DO NOT PROCEED)
   Years

5. Roughly what percentage of your diet would you say is generally from organic foods? (if prompting required use the following options:
   (<35% or >90% DO NOT PROCEED)
   - almost none [0-10%]
   - a little [10-35%]
   - about half [35-65%]
   - most [65-90%]
   - almost all [90-100%]

Percent
Screening Questionnaire

6. Complete this statement.

I would describe the area I live in as...

- Inner-urban
- Suburban
- Semi-rural (REQUEST DETAIL ABOUT LIKELY AGRICULTURAL PESTICIDE EXPOSURE)
- Rural (DO NOT PROCEED)

Comments

7. Gender

- Female
- Male (SKIP TO Q10)

8. Are you currently pregnant?

- No
- Yes (DO NOT PROCEED)

9. Are you currently breastfeeding?

- No
- Yes (DO NOT PROCEED)

10. Are you or your partner planning on conceiving in the near future? If so how long?

- No
- Yes (but not for at least 4 months)
- Yes (within the next 4 months) (DO NOT PROCEED)

11. Do you smoke?

- No
- Yes (DO NOT PROCEED)

12. Do you have any known health conditions? Please describe?

Screening Questionnaire

14. Are there any other medications you take from time to time (e.g. antihistamines as required)?

15. To the best of your knowledge what is the likelihood that you might be exposed to pesticides from any of the following sources during the course of the study?

<table>
<thead>
<tr>
<th>Source</th>
<th>Not at all likely</th>
<th>Small possibility</th>
<th>Moderate possibility</th>
<th>High possibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal insect repellents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial fumigation (home, workplace etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden pesticides (home, public parks etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet applications (e.g. flea treatments)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. Do you feel confident that you will be able to read and understand all of the necessary documents and complete all of the necessary survey forms to complete this study?

- Yes
- Unsure (Would you like to receive a copy of the food intake survey to complete for a few days?)
- No (DO NOT PROCEED)

17. Do you feel confident that you will be able to adhere to the different diets?

- Yes
- No (DO NOT PROCEED)

Comments

18. Do you have any other questions you would like to ask?
Screening Questionnaire

19. If you are happy to be enrolled in this study would you kindly sign the consent form attached to the ‘project information statement’ and return it via mail as soon as possible.

☐ Yes, I agree to participate and will return the consent form as soon as possible.  ☐ No, I don’t think this study will be suitable for me. (DO NOT PROCEED)

Comments:

20. What email address would you prefer to have electronic documents sent to?

Email Address:

21. What is the best telephone number to contact you on if required.

Phone Number:

22. If accepted for this study what postal address would you like to have documents and equipment to assist with urine collection sent to?

Name:
Address 1:
Address 2:
Suburb/Town:
State:
Postal Code:

23. Participant code:

Female: 1/ Male 2

Age next birthday e.g. 43yo = 44

First 2 numbers of postcode e.g. 31

Order of enrolment e.g. 03

So a female 43 y.o. female who lives in Elwood (3184) and who was enrolled third would be: 1443103

Participant code:
Screening Questionnaire

24. Which phase will this participant complete first?

1C 2C 30 40 5C 60 70 8C 9O 10C 11O 12C 13C 140 150 16C

☐ Organic
☐ Conventional

25. Thank you. I will now email you a participant code which you should keep a record of in a secure place.
You will need this code to access your personal test results at the conclusion of the study.
I will also email you some important documents.
These include the consent form which we will ask you to sign and return as soon as possible.
Once we have received the consent form we will organise for delivery of any equipment you require for urine collection.
Thank you for participating.
If you have questions at any time please do not hesitate in contacting me.
CEFBeS (Baseline)

1. Welcome to the 'Chemical Exposure and Food Behaviour Survey'

Thank you for participating in this study. Your contribution is important.

The purpose of this survey is to identify non-dietary factors that may affect your exposure to or elimination of pesticides. These include factors that may affect your intake of pesticides from sources other than food, or the way your body processes pesticides. This information is being collected as part of a study investigating the levels of pesticides in a person’s body following a period of eating organic food or conventional food. It will assist us in assessing whether you might be suitable for inclusion in this study.

It is anticipated that this survey will take approximately 10 minutes to complete. A copy of the survey can be accessed via the study website. A full ‘Privacy Statement’ is also available on the study website.

The ethical aspects of this research project have been approved by the Human Research Ethics Committee of RMIT University. Because of the nature of data collection, we are not obtaining separate written informed consent from you. Your consent to participate in this part of the study will be assumed if you submit the completed survey. Users should be aware that the World Wide Web is an insecure public network that gives rise to the potential risk that a user’s transactions are being viewed, intercepted or modified by third parties or that data which the user downloads may contain computer viruses or other defects. If you have any questions you would like to ask before you commence you can contact the researchers via the study website.

Thank you for your time and effort,

Lisa Oates
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University

*1. You will have been issued a participant number by the researcher of this project. Please include the number here.
Participant #: 

*2. I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Chemical Exposure and Food Behaviour Survey’.
Please note: * A copy of the ‘Project Information Statement’ can be accessed via the study website. You should read this statement before proceeding

☐ Yes, I agree to participate
☐ No, I do not agree to participate

2. Organic Food Consumption and Purchasing Behaviour

For the following questions please indicate your answer using the following definitions as a guide:
BMT Baseline

Definitions:

-Certified Organic- food may be considered 'certified organic' if one of the recognised 'certified organic' labels is visible on the product or at the point of sale. A list of these images is available below.

Non-certified organic - no 'certified organic' label is visible on the product or at the point of sale but the food has been home grown without chemicals or has been purchased from a farmer’s market, farm gate or local food initiative where non-certified organic food is traded on a ‘trust’ basis.

Note: occasional ‘certified organic’ seafood products can be purchased but they tend to be rare. Wild caught seafood may be considered non-certified organic, however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.

Certification logos

You may also see:

3. Over the past year what proportion of the food you ate was prepared from organic food (either certified or non-certified)?

- Almost none (0-10%)
- A little (10-35%)
- About half (35-65%)
- Most (65-90%)
- Almost all (90-100%)

4. Over the past year what proportion of the food you ate was prepared from ‘certified organic’ food?

- Almost none (0-10%)
- A little (10-35%)
- About half (35-65%)
- Most (65-90%)
- Almost all (90-100%)
5. Approximately how long is it since you started eating organic foods (or made a choice to increase your intake from only eating organic food occasionally to eating it regularly)?

- **Years**: 
- **Months**: 

6. How often do you eat each of the following? (Please include both certified and non-certified organic products. If you are unsure whether the product is organic do not include it)

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Most of the time</th>
<th>At least 2 to 3 times a week</th>
<th>At least once a week</th>
<th>Every 2 to 3 weeks</th>
<th>About once a month</th>
<th>Less often</th>
<th>Never eat organic</th>
<th>Don't eat this food</th>
<th>Can't say</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic grains (wheat, oats, rice etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fresh organic fruit</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fresh organic vegetables</td>
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<tr>
<td>Organic dairy products (milk, cheese, yoghurt etc)</td>
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<td></td>
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<tr>
<td>Organic meat</td>
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<td></td>
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<tr>
<td>Organic poultry (chicken, turkey, duck etc)</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Organic or wild-caught seafood (fish, squid, oysters, shellfish etc)</td>
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<tr>
<td>Organic eggs</td>
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<td></td>
<td></td>
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<tr>
<td>Organic legumes (lentils, chickpeas, red kidney beans etc)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Organic nuts and seeds</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Organic meat substitutes (including tofu, vegetarian sausages etc)</td>
<td></td>
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<tr>
<td>Pre-packaged organic foods (e.g. canned, frozen, boxed, bagged etc)</td>
<td></td>
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<tr>
<td>Ready made organic foods (e.g. ready made meals)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Other foods (snacks, confectionary, condiments etc)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:

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### BMT Baseline

7. How much (what percentage) of the following foods do you eat as organic? (One answer per row. Please include both certified and non-certified organic products. If you are unsure whether the product is organic do not include it)

<table>
<thead>
<tr>
<th></th>
<th>Almost none (0-10%)</th>
<th>A little (10-30%)</th>
<th>About half (36-65%)</th>
<th>Most (66-90%)</th>
<th>Almost all (90-100%)</th>
<th>Don’t eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains (wheat, oats, rice etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fresh vegetables</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Dairy products (milk, cheese, yoghurt etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Red meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Poultry (chicken, turkey, duck etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Seafood (fish, squid, oysters, shellfish etc; include wok or other seafood)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Eggs</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Legumes (lentils, chickpeas, red kidney beans etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Nuts and seeds</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Meat substitutes (including tofu, vegetarian sausages etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Pre-packaged foods (e.g. canned, frozen, boxed, bagged etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ready made foods (e.g. ready made meals)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other foods (snacks, confectionary, condiments etc)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

### 3. Factors Affecting Chemical Exposure and Metabolism

As previously mentioned the purpose of this study is in part to assist us in designing the best possible trial to compare toxin levels in people who consume organic and conventional foods. The following questions will enable us to identify factors that may affect the results of the trial.
8. To the best of your knowledge, how often have you been exposed to the following substances. (Please do not include products that you specifically choose because you believe them to be free from synthetic chemicals.)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Seasonally (in the past 2 months)</th>
<th>Seasonally (not in the past 2 months)</th>
<th>Rarely or Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal insect repellents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial fumigation (home, workplace etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden pesticides (home, public parks etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet applications (e.g. flea treatments)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin products (including sunscreen, moisturisers, make-up etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair products (including shampoo, conditioner, styling products)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify any other products/environments you avoid to limit pesticide exposure)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Have you undertaken a ‘detoxification diet’ in the past 2 years?

- No
- Yes (please specify below)

If 'yes' please briefly describe when, how long the diet lasted and the basic characteristics of the diet.

10. Please include the following so that we can calculate your body mass index (BMI).

- Height (in cm) 

- Weight (in kg)
**BMT Baseline**

11. **FEMALES ONLY. Have you ever breastfed an infant?**
   - [ ] No
   - [ ] Yes. Please estimate the total period of time (days, weeks, months, years) that you breastfed.
     - [ ]

12. **Please list any medications that you have used in the past 2 months and the reason for use (include medicines taken by mouth, via injection or IV or applied to external parts of the body)**

   - [ ]

### 4. Basic Demographics

You are reminded that this survey is completely anonymous and this information will only be used for the purposes stated in the Project Information Statement. A copy of the "Project Information Statement" can be accessed via the study website.

13. **Gender**
   - [ ] Female
   - [ ] Male

14. **How old are you?**
   - Age (years)
     - [ ]

15. **Complete this statement.**

   *I would describe the area I live in as...*
   - [ ] Inner-urban
   - [ ] Suburban
   - [ ] Semi-rural
   - [ ] Rural

16. **What is your postcode?**

   - Postcode:
     - [ ]

### 5. Thank you

Thank you for taking the time and effort to complete this survey.

*Receive Updates*
CEFBeS (Conventional Phase)

**BMT Conventional Phase**

1. **Welcome to the 'Chemical Exposure and Food Behaviour Survey' (Conventional ...**

Thank you for participating in this study. Your contribution is important.

Please complete this survey when you provide your urine sample for analysis.

It is anticipated that this survey will take approximately 5 minutes to complete.

If you have any questions you would like to ask you can contact the researchers via email at liza.oates@rmit.edu.au.

Thank you for your time and effort.

_Liza Oates_
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

_Professor Marc Cohen_
MBBS(Hons), PhD(Elec Eng), PhD (TCM), EMedSc(Hons)
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University

*1. I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Chemical Exposure and Food Behaviour Survey’.*

*Please note: *A copy of the ‘Project Information Statement’ can be accessed via the study website. You should read this statement before proceeding.*

- [ ] Yes, I agree to participate
- [ ] No, I do not agree to participate

2. **Urine sample**

*2. You will have been issues a participant number by the researcher of this project. Please include the number here.*

Participant number: [ ]

3. **Please enter details of when your urine sample was collected.**

Date of collection: [ ]

Time of collection: [ ]
BMT Conventional Phase

4. Please complete the following with regard to your urine sample.

- Was this the first urine passed after a period of sleep? Yes □ No □
- Has this sample been pooled with urine collected during sleep hours? Yes □ No □

Do you have any comments/concerns regarding the conditions around the collection, storage or transport of your urine sample that we should be aware of?

3. Food consumption and purchasing behaviour

5. Where did you get your fresh fruit and vegetables this week?

<table>
<thead>
<tr>
<th>Store Type</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-36%)</th>
<th>About half (36-66%)</th>
<th>Most (66-100%)</th>
<th>All or almost all (00-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Woolworths, ALDI</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Small supermarket/ local store</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Health/ wholefood store</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Farmer's market</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Roadside farm-gate stall</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Own/ other's garden</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

(Please specify) Comments □
### BMT Conventional Phase

6. Where did you get your meat, poultry or seafood this week?

<table>
<thead>
<tr>
<th>Source</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
<th>Don't eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small supermarket/ local store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Butcher</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fishmonger</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Health/ wholefood store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Roadside/ farm-gate stall</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Own/ other’s garden</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Please specify) Comments

7. Where did you get your other produce this week - including eggs, dairy, grains, legumes and pre-packaged foods?

<table>
<thead>
<tr>
<th>Source</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small supermarket/ local store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Health/ wholefood store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Roadside/ farm-gate stall</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Own/ other’s garden</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Please specify) Comments

### 4. Factors Affecting Chemical Exposure and Metabolism
BMT Conventional Phase

8. Over the past week, please estimate how often you have done the following.

<table>
<thead>
<tr>
<th></th>
<th>Don't eat</th>
<th>Almost never (0-10%)</th>
<th>Occasionally (10-30%)</th>
<th>About half the time (35-65%)</th>
<th>Most of the time (66-90%)</th>
<th>Almost all of the time (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing fruit with edible skins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peeling edible skins (fruit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing or scrubbing vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peeling edible skins (vegetables)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rinsing grains before or after cooking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rinsing legumes before or after cooking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removing excess fat from meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments

9. To the best of your knowledge, have you been exposed to the following substances in the past week.
(Please do not include products that you specifically choose because you believe them to be free from synthetic chemicals.)

<table>
<thead>
<tr>
<th>Substances</th>
<th>Not that I know of</th>
<th>On one occasion</th>
<th>On two to three occasions</th>
<th>Most days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal insect repellents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial fumigation (home, workplace etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden pesticides (home, public parks etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet applications (e.g. flea treatments)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin products (including sunscreen, moisturisers, make-up etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair products (including shampoo, conditioner, styling products)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other chemicals (specify below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments
BMT Conventional Phase

10. Please list any medications that you have used in the past 7 days and the reason for use (include medicines taken by mouth, via injection or IV or applied to external parts of the body)

11. Over the past week please estimate the number of hours you spent...
   - outdoors in parks or gardens
   - outdoors in rural/county areas

5. Thank you

Once again, thank you for your time and interest in this project.

Liza Oates  
B HSc (Natu), GradCert Evid-based CompMed  
PhD candidate,  
School of Health Sciences, RMIT University

Professor Marco Cohen  
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSci(Hons)  
Project Supervisor: Professor of Complementary Medicine,  
School of Health Sciences, RMIT University
CEFBeS (Organic Phase)

BMT Organic Phase

1. Welcome to the 'Chemical Exposure and Food Behaviour Survey' (Organic Phase...)

Thank you for participating in this study. Your contribution is important.

Please complete this survey when you provide your urine sample for analysis.

It is anticipated that this survey will take approximately 5 minutes to complete.

If you have any questions you would like to ask you can contact the researchers via email at liza.oates@rmit.edu.au.

Thank you for your time and effort,

Liza Oates
B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor; Professor of Complementary Medicine,
School of Health Sciences, RMIT University

*1. I have read and understood the ‘Project Information Statement’ and agree to participate in the ‘Chemical Exposure and Food Behaviour Survey’.

Please note: * A copy of the 'Project Information Statement’ can be accessed via the study website. You should read this statement before proceeding

☐ Yes, I agree to participate
☐ No, I do not agree to participate

2. Urine sample

*2. You will have been issued a participant number by the researcher of this project. Please include the number here.

Participant number: __________________________

3. Please enter details of when your urine sample was collected.

Date of collection: __________________________

Time of collection: __________________________
BMT Organic Phase

4. Please complete the following with regard to your urine sample.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was this the first urine passed after a period of sleep?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has this sample been pooled with urine collected during ‘sleep hours’?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have any comments/concerns regarding the conditions around the collection, storage or transport of your urine sample that we should be aware of?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Organic Food Consumption and Purchasing Behaviour

For the following questions please indicate your answer using the following definitions as a guide:

**Definitions:**
- **Certified Organic** – food may be considered ‘certified organic’ if one of the recognised ‘certified organic’ labels is visible on the product or at the point of sale. A list of these images is available below.
- **Non-certified organic** – no ‘certified organic’ label is visible on the product or at the point of sale but the food has been home grown without chemicals or has been purchased from a farmer’s market, farm gate or local food initiative where non-certified organic food is traded on a ‘trust’ basis.
- **Note:** occasional ‘certified organic’ seafood products can be purchased but they tend to be rare. Wild caught seafood may be considered ‘non-certified organic’, however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.

**Certification logos**

![Certification logos](image)

You may also see:
**BMT Organic Phase**

5. Where did you get your organic (certified or non-certified) fresh fruit and vegetables this week?

<table>
<thead>
<tr>
<th>Source of Produce</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small supermarket/local store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Health/wholefood store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Roadside/farmgate stall</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Own/other’s garden</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

(Please specify) Comments

6. Where did you get your organic (certified or non-certified) meat, poultry or seafood this week?

*Note: occasional ‘certified organic’ seafood products can be purchased, wild caught seafood may be considered ‘non-certified organic’ however many seafood products will be farmed and should therefore be considered as ‘conventionally farmed’ not ‘organic’.*

<table>
<thead>
<tr>
<th>Source of Meat/Poultry/Seafood</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
<th>Don’t eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/ Woolworths, ALDI)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small supermarket/local store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Butcher</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fishmonger</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Health/wholefood store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Roadside/farmgate stall</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Own/other’s garden</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

(Please specify) Comments
## BMT Organic Phase

7. Where did you get your other organic produce this week - including eggs, dairy, grains, legumes and pre-packaged foods (certified or non-certified)?

<table>
<thead>
<tr>
<th>Source</th>
<th>None or almost none (0-10%)</th>
<th>A little (10-35%)</th>
<th>About half (35-65%)</th>
<th>Most (65-90%)</th>
<th>All or almost all (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large supermarket chain (e.g. Coles, Safeway/Woolworths, ALDI)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Small supermarket/local store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Grocer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Health/wholefood store</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Delivery service (e.g. online)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Farmer’s market</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Roadside/farm-gate stall</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Own/other’s garden</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

(Please specify)/ Comments

## 4. Factors Affecting Chemical Exposure and Metabolism

8. Over the past week, please estimate how often you have done the following.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Don’t eat (0-10%)</th>
<th>Almost never (10-35%)</th>
<th>Occasionally (35-65%)</th>
<th>About half the time (65-90%)</th>
<th>Most of the time (90-100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing fruit with edible skins</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Peeling edible skins (fruit)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Washing or scrubbing vegetables</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Peeling edible skins (vegetables)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Rinsing grains before or after cooking</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Rinsing legumes before or after cooking</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Removing excess fat from meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Comments
BMT Organic Phase

9. To the best of your knowledge, have you been exposed to the following substances in the past week.
   (Please do not include products that you specifically choose because you believe them to be free from synthetic chemicals.)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Not that I know of</th>
<th>On one occasion</th>
<th>On two to three occasions</th>
<th>Most days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal insect repellents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial fumigation (home, workplace etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garden pesticides (home, public parks etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet applications (e.g. flea treatments)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin products (including sunscreen, moisturisers, make-up etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair products (including shampoo, conditioner, styling products)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other chemicals (specify below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   Comments

10. Please list any medications that you have used in the past 7 days and the reason for use (include medicines taken by mouth, via injection or IV or applied to external parts of the body)

   Comments

11. Over the past week please estimate the number of hours you spent...

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>outdoors in parks or gardens</td>
<td></td>
</tr>
<tr>
<td>outdoors in rural/country areas</td>
<td></td>
</tr>
</tbody>
</table>

5. Thank you

   Once again, thank you for your time and interest in this project.

Liza Oates
BMT Organic Phase

B HSc (Nat), GradCert Evid-based CompMed
PhD candidate,
School of Health Sciences, RMIT University

Professor Marc Cohen
MBBS(Hons), PhD(Elec Eng), PhD (TCM), BMedSc(Hons)
Project Supervisor: Professor of Complementary Medicine,
School of Health Sciences, RMIT University
Instructions for urine collection and transport

Instructions for collecting, storing and transporting your urine samples.

Thank you again for your participation in this study. Enclosed you will find:

- Eskies (foam coolers) x 2. These are marked for either the organic (S) or conventional (J) phase of the trial and the relevant documentation is taped to the outside of the esky.
- Envirofreeze ice sheets. 2 x large, 2 x small. These will need to be activated and frozen (see instructions below). They will assist in keeping your sample cool while in transit.
- Large urine specimen jars x 2. These are marked with a grey line. This indicates the minimum level of urine that should be collected.
- Labels x 2. These are for either the organic (S) or conventional phase (J) of the trial. It is very important that the correct label is attached to your specimen.
- Double sealable plastic bags x2
- Wide packing tape.

What will happen to your urine samples.
To ensure the integrity of your urine sample it should be transported immediately after collection or stored frozen until it can be collected for transport. The sample will be transported to a collection centre in Tullamarine (Victoria) where it will be frozen at -20°C before being transported in a frozen state to the Assure Quality laboratory in Wellington, New Zealand. The chemicals being tested can degrade quickly if the urine sample is not properly stored and this can affect the test results. As the tests being conducted and the logistics to transport the samples are costly we would ask you to keep us informed as to any factors that may adversely affect the timely and appropriate transportation of your samples.

Instructions

Several days prior to collecting your sample (or as soon as you receive your envirofreeze ice sheets).

Activate the envirofreeze ice sheets:

- Immerse envirofreeze sheets in water and scrunch in hands to allow any air bubbles to escape. Water will enter through a one way surface to activate the crystals inside to fully expand. Soak for about 10 minutes until they have fully plumbed out. Freeze for at least 24 hours prior to use.

At least one day prior to collecting your sample.

Organise collection of your sample:

- Contact the study coordinator (Liza Oates liza.oates@rmit.edu.au or 0412 310 390) to advise when you are planning to collect your sample. A weekday is most appropriate as weekend collection may delay the transportation of your sample.
However if it is more practical for you to choose a weekend day you can freeze your sample and have it collected on the Monday morning.

- Please advise the location and a suitable time for collection.
- Liza will make arrangements for a courier to collect your sample and provide you with details in case you need to contact them directly.
- If collection is delayed for some reason, please keep Liza informed.
- Participants outside of the Melbourne metropolitan area should freeze their urine samples prior to collection. The courier will be organised for the day after collection so that the sample will be sufficiently frozen.

The evening before collecting your urine sample

- You should empty your bladder before going to sleep. Since the urine can be collected over any eight-hour period, this method still applies for people who have atypical work/sleep schedules.
- Any urine that is voided from the bladder during the eight-hour pre-collection period (i.e. during sleep hours) should be collected and refrigerated, and then pooled with the first morning sample so that a true 8-hour specimen is obtained. You may wish to have a collection vessel handy in the event that this is required.
- The evening before collecting your urine sample you should aim to drink sufficient fluids so that you will produce at least 200mL (about a cup) of urine in the morning but not so much that you will need to go to the bathroom during the night. Try to avoid excess alcohol, coffee, tea or other diuretic substances that may increase the likelihood of needing to urinate during sleep hours.
- Ensure that you have a urine specimen container conveniently located for use in the morning. It may be useful to set an alarm or leave yourself a reminder somewhere that you will see immediately upon rising.
- If you forget to collect your sample on the arranged day you will need to reschedule the courier, advise the study coordinator and continue the diet phase that you are on for another day, then repeat the process.

On the morning of collection.

Collect urine sample

- The first morning urine sample (also called an 8-hour specimen) should be collected when you first wake up, having emptied your bladder before going to sleep.
- Prepare by opening the container and placing it where it can be reached conveniently.
- Females should sit well back on the toilet and gently part the labia. Uncircumcised males may need to slightly retract the foreskin.
- Place the container under the stream and collect enough urine to nearly fill the container.
- Ensure the urine level is above the minimum line (marked in grey) on the urine specimen container. Keep in mind that fluids expand when frozen so you don’t want to go too far above this line.
- The rest of the urine can be passed into the toilet.
- Replace the opaque plastic inner lid then screw the outer (black) lid on firmly.

Label urine sample

- Remove the label and the Sample Submission Form from the plastic bag on top of the esky.
- Remove and dispose of the yellow sticky label.
• Double check that you have the correct label and esky for the phase of the trial you are completing. Either the organic (S) or conventional (J).
• Complete the following items on the label prior to attaching it to the specimen container. These are highlighted in pink.
  o Date of collection:
  o Time of collection:
  o Please keep a record of these dates / times as you will be asked for them again when you complete the online CEFBS survey after each phase of the trial.
• Tick the box to confirm that this is your first morning urine specimen. Highlighted in pink
• Ensure the outside of the container is dry and firmly attach the label.
• Place a strip of clear tape over the label to ensure that it is securely fastened and to protect it from smudging if exposed to moisture.
• Place specimen container in the double bags and seal both bags.

Freeze sample until courier arrives
• If it is necessary to store urine, please place in a freezer as soon as possible.
• Participants outside of the Melbourne metropolitan area should freeze urine samples prior to collection. Participants within the Melbourne metropolitan area may also need to place their urine samples in a freezer for a short period between the time they are collected in the morning and the time the courier arrives.
• Your home freezer is likely to be around -4°C whereas the commercial freezer that will be used once your urine sample is received will be around -20°C. The sample should be kept as cold as possible until it can be placed in the commercial freezer. Ideally it should be transported as soon as possible (within 24 to 48 hours).

Packing urine sample for transport:
• Double check that you have the correct Sample Submission Form for the phase of the trial you are completing. Either the organic (S) or conventional (J).
• Remove the sample specimen submission form from the plastic bag on the outside of the esky and complete the following item (other information will already have been filled in on your behalf, do not add any personal identifying information).
  o Date / time despatched (top right hand corner) This is highlighted in pink.
• Return the form to the bag ensuring that the delivery address is visible to the courier and seal it.
• Place the larger frozen envirofreeze sheet sideways in the bottom of the esky so that it covers the bottom and the longer sides of the inside of the esky.
• Place the urine specimen container (in the sealed double bags) on top of the ice sheet and then place the smaller frozen ice sheet over the top so that it wraps around the side walls of the container.
• The less airspace in the esky the longer it will stay frozen. If you feel there is too much airspace you can place plastic bags, paper or bubblewrap in the esky to reduce the space. This may be useful at the top and bottom of the specimen container.
• Firmly tape the lid down to ensure that it does not come loose.
Urine Sample Submission Form

Equipment
To assist with urine collection and transportation participants received:
- 250mL opaque urine specimen containers x2
  Livingstone NAT CP unlabelled 147PCS/CTN (S10065-UU)
- Sealable plastic bags x2
- Esky for transport x2
- Ice packs x2
- Labels for each phase including participant number and phase

Specimen Label
The containers were labelled with the following information:
  Researcher's details: Liza Oates, School of Health Sciences, RMIT University, liza.oates@rmit.edu.au, 0412 310 390
  HREC: 59/11
  Tests: Urinary Dialkyl Phosphate Metabolites by GC-MS/MS
  Participant #: XXXXXXX
  Phase of trial: X
  Date of collection:
Time of collection:
First morning specimen: Yes ☑

Testing Methods

Proposed Service Offering
Test specifications are as identified below.

Dialkyl Phosphate Metabolites of Organophosphate Pesticides in Urine by GCMS/MS

<table>
<thead>
<tr>
<th>Dialkyl Phosphate Metabolites of Organophosphate Pesticides by GCMS/MS</th>
<th>Urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis Code</td>
<td>Meth Dev</td>
</tr>
<tr>
<td>TAT</td>
<td>10</td>
</tr>
<tr>
<td>Accreditation Status</td>
<td>Pending</td>
</tr>
<tr>
<td>Method</td>
<td>In House GCMS/MS</td>
</tr>
<tr>
<td>Units</td>
<td>mg/L</td>
</tr>
<tr>
<td>Quantification Limits</td>
<td>Estimated LOD</td>
</tr>
<tr>
<td>Dimethyl phosphate</td>
<td>0.001</td>
</tr>
<tr>
<td>Dimethyl thiophosphate</td>
<td>0.001</td>
</tr>
<tr>
<td>Dimethyl dihydrophosphate</td>
<td>0.001</td>
</tr>
<tr>
<td>Diethyl phosphate</td>
<td>0.001</td>
</tr>
<tr>
<td>Diethyl thiophosphate</td>
<td>0.001</td>
</tr>
<tr>
<td>Diethyl dihydrophosphate</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Accreditation

WC-246 (FDP-01) - 'Determination of Dialkyl Phosphates in Human Urine by Gas Chromatography - Tandem Mass Spectrometry (GC-MS/MS)' accreditation details are:
IANZ Chemical Scope
2.61 Biological Specimens
(b) Residues in Specified Veterinary Specimens GC/MS
BMT Results – Letter to participants

Dear XXX,

Thank you for your participation in “Intrapersonal variation in pesticide residues in response to an organic diet – a biomonitoring trial (BMT)”. 

As you know the purpose of this trial was to see if consuming organic food (compared to conventional or non-organic food) results in a reduction in the levels of pesticide residues in your urine. You provided a urine sample on two separate occasions. On one occasion after following a largely conventional diet for seven days and on another occasion after following a largely organic diet for seven days. On each occasion the urine sample you provided was analysed for six different metabolites of organophosphate pesticides as well as creatinine.

Understanding your results

How much organic food did I consume?
As part of the project we asked you to keep a record of the food and beverages you consumed in the seven days prior to collecting your urine samples. This was used to calculate what percentage of your food servings were organic or conventional during these periods. These figures provide only a rough estimate as ‘extra foods’ which could not be included under the main food group categories (i.e. grains, vegetables, fruit, dairy, animal and vegetable protein) were not included in this calculation. Keep in mind also that these calculations are based on the percentage of your servings not on the weight of volume of the food you consumed.

Dialkylphosphate metabolites of organophosphate pesticides
The metabolites tested, which are known as dialkylphosphates (DAPs), are non-selective metabolites of a variety of organophosphate (OP) pesticides. This means that they cannot clearly identify exposure to a specific pesticide but because they are common to around 80% of the available compounds in the OP class they provide a useful indication of overall exposure.

The names of the metabolites tested are: Dimethylphosphate (DMP), Diethylphosphate (DEP), Dimethyldithiophosphate (DMDT), Diethylthiophosphate (DETP), Dimethylthiophosphate (DMTP) and Diethyldithiophosphatetotal (DEDTP). Measurement was performed using gas chromatography - tandem mass spectrometry.

On your attached laboratory results you will see four columns. The first is the concentration of the metabolite that was detected in your urine sample. It is the amount (or weight) of the metabolite per litre of urine.

The second column is the limit of detection (LOD) for that particular metabolite. This is the minimum amount that the equipment is able to detect. However at these very low limits
even though the equipment can see that something appears to be present but it can’t reliably tell how much is there. The third column is the limit of quantification (LOQ). This is the point at which the equipment can start to reliably determine how much of the metabolite is present in the urine.

If your result is listed as ‘not detectable’ (ND) this means that the particular metabolite was either not present at all, or was so low that the equipment couldn’t see it. As the limits of detection used were extremely low this is an ideal result. If your results are listed as ‘not quantifiable’ (NQ) it means that the equipment seems to have detected something but it is at such low levels that it can’t say with any degree of accuracy how much. In this instance the reading is likely to be somewhere between the LOD and the LOQ. Again this is an extremely low amount and a very good result.

It is important to note that the LOD and LOQ levels are simply indicators of the capacity of the equipment to measure the metabolite, they do not indicate ‘normal’ or ‘safe’ ranges as you may be used to seeing when you get laboratory test results from your doctor. In fact scientists have not yet established what these levels might be.

The final column is your creatinine corrected result. This figure takes into account how concentrated or dilute your urine was when the laboratory conducted the test and is a more reliable indicator of how much of the metabolite was in your body. This measurement is converted to the amount or weight of the metabolite per gram of creatinine.

Creatinine correction of results
Just as you will notice that the colour of your urine may be darker or lighter depending on how much fluid you have consumed or how much you have lost through sweating, a similar thing can happen with the concentration of metabolites. To use an analogy… imagine you have dissolved 20 grams of salt in 100mL water. So you know that the concentration is 20g salt/ 100mL water. Then you add another 100mL of water, so the concentration is now 20 grams of salt in 200mL water or the equivalent of 10g salt/100mL. The concentration appears to have halved but there is actually still the same amount of salt it has simply been diluted by the extra water.

Because a random urine sample was used in this study this means that depending on your hydration status at the time the sample was collected the amount of metabolites in your urine per millilitre may be more concentrated or more dilute. But it is the amount (or weight) of the metabolite that we are interested in. For this reason we also tested the amount of creatinine in your urine. Creatinine is metabolic product of muscle tissue and is a normal constituent in urine. Creatinine correction is used as a way of accounting for this variability in the concentration of your urine so that your results are more accurate and can be more easily compared. Therefore you will notice that your results are referred to as ‘creatinine corrected’.

Exposure to Organophosphate pesticides
Organophosphates are widely used in Australian agriculture and residues are commonly found in Australian food. Studies overseas have shown that the vast majority of the population have at least one DAP present in their urine. As these metabolites are
excreted by the body quite quickly, and diet is considered to be the major route of exposure for most people, this suggests that many people are regularly exposed to these pesticides through their diet.

A recent study in South Australian children tested four of the six DAPs that you were also tested for. The study detected these DAPs in between 53% and 83% of the urine samples. However for some of the DAPs, such as DEP, the actual amounts detected were up to 10 times higher in children who lived in rural areas or on the outskirts of urban areas. This suggests that these children were also exposed to OP pesticides from sources other than their diet.

**Sources of Organophosphates**

Organophosphate pesticides are regularly detected in conventional food. Even though they are not permitted in organic food production there may be rare instances of organic food becoming contaminated with pesticides. For instance this may occur due to spray drift from neighbouring farms, contact with conventional food or vessels that have previously held conventional food during transport or storage, or pest control in warehouses or retail outlets where organic food is exposed.

In addition to any pesticides you may be exposed to through your diet you may also have been exposed to pesticides because of their use in residential and commercial pesticide products. For instance if you have been in buildings that have recently been fumigated or where pesticides have been sprayed; spent time in gardens or parks that have been sprayed; come into contact with pets that have been treated with certain flea treatments; or a person wearing insect repellent. Pesticides may enter the body through the consumption of contaminated food or fluids, but may also be absorbed through the skin or inhaled.

If you happen to have spent time in rural areas during the study period you may also have been exposed to agricultural sources of pesticides which are applied to crops and pastures.

**What do my results mean?**

The presence of one or more metabolites in your urine does not necessarily infer a health risk. At present there are no exposure guidelines in Australia or internationally for urinary DAP metabolites. As such it is not clear what level of these metabolites may indicate an increased health risk.

In interpreting your results what you should look at is the difference in the creatinine corrected results between the conventional phase of the study and the organic phase of the study. In other words did they go down, stay the same, or go up.

I have attached copies of your original reports from the laboratory but have also included a summary of your key results below so that you can see how they compare. This includes:

- what percentage of your servings were from organic or conventional sources during the study periods
the creatinine results that were used to calculate your creatinine corrected DAP results
- each of the six individual DAPs (creatinine corrected)
- your total DAP measurements (this is a calculation based on the combination of all of your results and is a good way to see the overall effect)
- the difference between the conventional and organic phases (for the purpose of these calculations ND is assumed to be one half of the LOD, and NQ is assumed to be the midpoint between the LOD and the LOQ)

**Summary of your results**

You consumed:
- \( X\% \) conventional servings during the conventional phase
- \( X\% \) total organic servings (certified and likely organic) during the organic phase

<table>
<thead>
<tr>
<th></th>
<th>Conventional phase</th>
<th>Organic phase</th>
<th>Difference</th>
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<tr>
<td><strong>Creatinine (mmol/ L)</strong></td>
<td>x</td>
<td>x</td>
<td>-</td>
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<tr>
<td><strong>DAP Metabolites (µg/ g)</strong></td>
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<td>DMP</td>
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<tr>
<td>DEP</td>
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<td>DMDDTP</td>
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<td>DEDTP</td>
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<tr>
<td><strong>Total DAPs</strong></td>
<td>x</td>
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</table>

Again, many thanks for your participation and support with this project. Please feel free to contact me if you have any questions.

Kind regards,

*Liza Oates*
PhD Candidate
School of Health Sciences
RMIT University, Melbourne, Australia
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liza.oates@rmit.edu.au
www.rmit.edu.au/wellness/organicresearch
Website content (BMT)

Organic Food Research

Background to the Project

In the Organic Consumption Survey over 95% of organic consumers agreed with the statement 'organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues'. While Australian researchers have demonstrated that Victorian certified organic produce has fewer pesticide residues than conventional food crops, whether this results in less accumulation of pesticides in people who consume organic produce is unclear.

Recent studies of children in the United States have demonstrated that substituting conventional fruits and vegetables with organic ones for a five-day period, results in a reduction in levels of organophosphate pesticide metabolites to non-detectable or close to non-detectable levels and pyrethroid insecticides reduced by approximately 50%. This confirms a previous report that consumption of organic fruits, vegetables and juice can reduce children's exposure levels from 'uncertain risk' to 'negligible risk'. Whether these results can be extended to adult populations and other agricultural contaminants has yet to be explored.

‘Organic Health & Wellness Survey’ Closes Sunday 18 December

The purpose of the ‘Organic Health & Wellness Survey’ is to explore the health experiences of people who consume organic foods on a regular basis. The information collected will be used to direct future research.

This survey is intended to be completed by people who consume organic foods on most if not all days. The questions will generally refer to the period since you started eating organic food (or made a choice to increase your intake from only eating organic occasionally to eating it regularly).

Before you decide whether to participate in the survey you will be asked to confirm the following.

- I consider myself to be a regular ‘organic consumer’.
- I am over 18 years of age.
- I have read and understood the ‘Project Information Statement’.

If you have not done so already you can view a copy of the Project Information Statement (PDF 56KB 4p)

It is anticipated that this survey will take approximately 15-20 minutes to complete. Once you commence the survey you will be asked a series of questions. These will include basic questions about you and your personal health experiences as a result of consuming organic foods. In relevant sections, parents of children under 18 years (who are not eligible to complete the survey themselves) may also include health effects that they have observed in their own children. You will not
be asked for your name, address or any other personal identifying information. To find out more read the Privacy Statement (PDF 20KB 2p).

To complete the survey please take the Organic Health and Wellness Survey.

Bio-monitoring trial (BMT)

Please contact the study co-ordinator if you are interested in participating in this study.

The Department of Health Sciences at RMIT University is conducting a study to identify whether there is a difference in urinary pesticide residues in response to consumption of organic and conventional (non-organic) foods. It will also look at whether the tests that are commercially available in Australia are sensitive enough to pick up dietary differences in organic intake. Urine samples will be collected from participants on two occasions and analysed for pesticide residues (in particular for metabolites of organophosphate).

Eligible participants will be asked to undertake two different diets, each for a 7 day period. In phase 1 participants will be asked to complete a food intake survey for 7 days whilst following an organic diet. At the end of this period participants will be asked to provide a urine sample, to be analysed for pesticide residues, and complete an online survey known as the ‘Chemical Exposure and Food Behaviour Survey’. This process will then be repeated with the participants consuming a conventional diet for a 7-day period. The order of the diets may be reversed for some participants.

Participants will be provided with copies of all necessary documents as well as any equipment and written instructions required for the collection, storage and transportation of urine samples. The primary researcher will be available to answer questions if required. All documents and specimens will be coded to protect the participants’ identity.

Participants who complete the study will be able to obtain copies of their personal test results free of charge at the end of the study period.

If you are interested in learning more about this project please read the Project Information Statement (PDF 56KB 4p).

The project is supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd. The project has been approved by the RMIT Human Research Ethics Committee.

If you have any questions or would like to express your interest in participating please contact the study co-ordinator: liza.oates@rmit.edu.au or 0412 310 390. Please provide your contact details (email and phone number) and a suitable time to contact you. These details will not be passed on to any third parties.

Previous Research (Key Findings)

Organic Consumption Survey (OCS)
The Organic Consumption Survey (OCS) was conducted in Australia in 2010. The purpose was to identify the behaviours and beliefs of people who consume organic foods. Three hundred and eighteen usable surveys were submitted.

The majority of participants were female (80.3%), 25-55 years old (80.3%), from urban areas (61.2%), born in Australia (68.9%) and were in a healthy weight range (55.5%). As with previous reports income did not appear to have a strong impact on organic uptake. The median household income amongst organic consumers surveyed was AU$1,000–1,299 /week (AU$52,000–67,599 /year) with a marked increase up to but only a slight increase beyond AU$400–599 /week (AU$20,800–31,199 /year). Nearly two thirds of OCS participants held a tertiary degree qualification with over a third holding postgraduate degrees. In general the demographic characteristics of participants did not appear to differ with the level of organic consumption.

Based on self-reports, the percentage of people in the OCS that consumed most or all (i.e. >65%) organic food in the previous 12 months was 37.4% for certified organic food and 60.4% when ‘likely’ organic foods were also included. The majority (56.3%) of participants were able to achieve 65% organic food intake including a minimum of 35% certified organic food.

Organic fruit and vegetables had the highest uptake by organic consumers and animal flesh products the lowest. The average estimated weekly expenditure on organic food (either certified or ‘likely’) was 69.3% of the weekly food budget.

Many of the organic consumers surveyed did not eat various food groups unless they were organic. Those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit and vegetables.

The vast majority agreed with the statements: ‘organic food is healthier to eat than conventionally grown food because it generally contains no pesticide residues’ (95.4%); and ‘organic foods are better for the environment than conventionally grown foods (97%). Very few agreed that ‘in Australia the regulation of agricultural chemicals used on conventional farms adequately protects the environment from damage’ (2%) or that ‘the amounts of pesticide residues remaining on conventionally farmed produce are not likely to be harmful to my health’ (5.6%).

Around a quarter (24.7%) said that health related concerns influenced their decision to consume organic foods and 76.9% said that scientific evidence had a moderate or strong influence on their beliefs about organic food.

The majority of people said they would eat more organic food if: it was ‘more available in convenient locations’ (70.4%); if it was ‘less expensive (no more than 20% premium)’ (65.4%); or if there was ‘more evidence that eating organic food reduces exposure to pesticide residues compared to eating conventionally farmed food’ (57.7%). Cost and convenience appeared to become less important in those with high consumption of organic food.
Other factors that influenced purchasing decisions included: where the food was grown (90.5%), the amount of processing (89.4%), the amount of packaging (87.5%), whether the food was in season (86.2%), the nature of the seller (80.4%), whether the farmers received a fair price and conditions (79.9%) and the distance it had travelled (79.1%).

Clearer definitions of organic consumers should allow for more rigorous research evaluating the purported health benefits of organic foods in the future. The information from this survey will be used to ensure that the ongoing ‘Health and Wellness Survey’ and biomonitoring trial are relevant to and reflective of Australian organic consumers.

If you would like you can view a copy of the ‘Organic Consumption Survey’ questions (PDF, 211KB, 18p).

**Organic Food Intake Survey (OFIS)**

As it is difficult for adult consumers to maintain a 100% organic diet, participants were invited to pilot a three-day ‘Organic Food Intake Survey’ (OFIS). The purpose of this survey was to assess the percentage of organic food consumed. Nineteen participants returned the surveys providing a total of 58 sampling days.

Based on self-reports, the percentage of people in the OFIS that consumed more than 65% organic food in the previous 12 months was 52.6% for certified organic food and 73.6% when ‘likely’ organic foods were also included. On the whole the ‘actual’ levels of organic consumption (based on quantification of serving sizes by food group) were slightly higher than the initial self-reported estimates of the participants, although these differences were not statistically significant. The average estimated weekly expenditure on organic food (either certified or ‘likely’) was 74.3% amongst participants in the OFIS. The majority (63%) were able to achieve 65% organic food intake including a minimum of 35% certified organic food.

Overall the percentage of servings that came from organic food was lowest for animal protein (56.8%) and highest for fruit (80.1%) and vegetables (83.2%). Interestingly both animal protein (16.6%) and vegetables (19.0%) had the highest contribution from ‘likely’ organic sources. Comments from participants suggested these were largely from vegetables grown in their own garden or eggs from their own chickens. Some participants also included food purchased from farmer’s markets where they had discussed the production methods with the farmers.

If you would like you can view a copy of the ‘Organic Food Intake Survey’ questions (DOC, 356KB, 13p).

**Additional information**

Register your interest in joining our mailing list

If you have any questions please email Liza Oates.
Publications and Presentations


Funding Sources

- Liza Oates is supported by an Australian Postgraduate Award scholarship
- RMIT University provides assistance with statistical, IT and marketing support
- The organic industry provides in kind assistance with promoting the projects to prospective participants
- The biomonitoring trial is supported in part by a research restricted donation from Bharat Mitra, co-founder of Organic India Pty Ltd

The Researchers would like to thank

- Professor Charlie Xue and the staff of the School of Health Sciences
- Dr Anthony Bedford and Adrian Schembri (School of Mathematical and Geospatial Sciences)
- Cathy Leahy (School of Health Sciences)
- Professor Neil Mann (School of Applied Science)
- Gosia Kaszubska, Milena Nicola and Nick Besley (College of SEH Marketing and Communications)
Appendix 6. Publications

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Characteristics and consumption patterns of Australian organic consumers. (2012)

Characteristics and consumption patterns of Australian organic consumers‡

Liza Oates,∗∗ Marc Cohen∗ and Lesley Braun†

Abstract

BACKGROUND: Increasingly, Australians are choosing to consume organically produced food, but only a small percentage consume organic food exclusively, and there is little information in the scientific literature that describes their actual level of intake. In order to provide a more meaningful description of Australian organic consumers the ‘Organic Consumption Survey’ and ‘Organic Food Intake Survey’ were conducted online in 2010. The aim was to provide information about the characteristics of regular organic consumers and quantify levels of organic consumption.

RESULTS: The majority of participants (n = 318) were female (60.3%), 25–55 years old (80.1%) living in urban areas (81.2%), born in Australia (68.9%) and were in a healthy weight range (55.3%). Organic fruit and vegetables had the highest uptake by organic consumers and meat products the lowest. The majority of participants consumed at least 65% organic food in their diet, including 35% certified organic food.

CONCLUSION: A better understanding of organic consumers may help to serve the long-term interests of the organic industry and other stakeholders of food marketing. Clearer definitions of organic consumers may also inform research evaluating the purported health benefits of organic foods.

Keywords: organic; organic consumers; organic consumption; dietary survey

INTRODUCTION

There are numerous standards that define organic production practices. These may vary from region to region and between certifying bodies but generally conform to the Principles of Organic Agriculture laid out by the International Federation of Organic Agriculture Movements (IFOAM, http://www.ifoam.org). Food produced with adherence to these standards can generally be defined as organic food and under the proviso that incidental contamination during production, transport, or storage of prohibited chemicals does not exceed certain levels. Logically, it should then follow that a person who consumes organic food is an organic consumer; however, the level of consumption varies greatly and the characteristics and consumption patterns of Australian organic consumers are unclear with only dated or incomplete data available.1–4

Much of the previous Australian research has targeted the wider population and often classified “organic consumers” as those that reported consuming organic food in the previous 12 months. On the whole, these surveys suggest that there is only a small percentage of organic consumers who exclusively purchase organic food.5 According to the 2010 Australian Organic Market Report (AOMR), 61% of households claimed to have purchased some organic food in the previous 12 months but only around 12% reported spending more than 50% of their household food spend on organic options.5 This recent finding confirmed earlier studies, both in Australia and abroad, that suggest organic food is purchased either in significant quantities by a comparatively small number of people, or in small quantities by a substantially larger number of people.5–10

Although consumer consistently cite health reasons as a major determinant for organic food consumption,11 very few studies have investigated the direct health effects of organic diets.12 To evaluate health benefits or harm minimization, organic consumers need to be clearly differentiated from conventional (non-organic) consumers. Ideally, the quantities of organic food consumed as a percentage of the overall diet should be established in order to determine whether a dose-dependent effect occurs. If this is the case then occasional consumption of organic foods (deliberate or incidental) may have little or no health benefits compared to a diet made up of a majority of organic produce.

The current study aims to inform existing knowledge about the characteristics of Australian organic consumers and quantify levels of organic consumption using two electronic surveys. While the results relate to the Australian market, it is anticipated that the findings may also be applicable to other markets for whom demographic and consumption trends are similar.

‡ Supported by the Organic Industries Research and Development Corporation, Western Australia, Australia.4

∗ Research Fellow, School of Health Sciences, Curtin University of Technology, Perth, Western Australia, Australia.

∗∗ Current position: Scientific Officer, Health Measurement, Food Standards Australia New Zealand, Sydney, New South Wales, Australia.

† Lecturer, School of Health Sciences, University of New South Wales, Sydney, New South Wales, Australia.


5. A summary information sheet was presented to people at the International Congress on Organic Food Quality and Health Benefits in Prague, Czech Republic, 18–20 May 2011.

6. School of Health Sciences, Curtin University of Technology, Perth, Western Australia, Australia.
EXPERIMENTAL

In 2010, following ethics approval from RMIT University’s Human Research Ethics Committee, two electronic surveys – the ‘Organic Consumption Survey’ (OCS) and the ‘Organic Food Intake Survey’ (OFIS) – were developed and distributed to self-reported organic consumers in Australia. Both surveys were targeted at regular organic consumers who were likely to be at the high end of consumption trends. Participants were recruited through retail outlets and websites that sell or promote organic produce. Prospective participants were asked to confirm that they were over 18 years of age and considered themselves to be a regular ‘organic consumer’ (i.e. agree with the statement ‘I make a deliberate choice to consume at least some organic foods on a weekly basis’). This statement was used to target the more dedicated organic consumers, rather than those for whom organic consumption was occasional or incidental. Participants’ consumption patterns where then explored further in the surveys.

Organic Consumption Survey

A preliminary set of questions was developed following a review of the previous Australian literature and piloted on a convenience sample of 27 subjects in April and May 2010. Eight of these subjects then repeated the survey at least 2 weeks later to test retest reliability. Based on the results and feedback from the participants some questions were reworded to improve clarity, some were reordered to improve the flow and others were removed to shorten the time required to complete the survey.

Data collection occurred over a 2-month period from mid August to mid October 2010 using the Survey Monkey® online survey tool. The OCS asked participants to estimate their level of organic food consumption over the previous year and respond to questions regarding how much they spent on organic foods and how often they consumed different types of organic food, e.g. meat, dairy, fruit, vegetables. It also collected demographic information and inquired about purchasing behaviour, attitudes to organic food, and other factors that may affect chemical exposure and metabolism.

Organic Food Intake Survey

As self-estimation of organic intake may be prone to over- or underestimation we also developed another survey instrument to more accurately quantify the level of organic intake. The purpose of the OFIS was to assess the percentage of organic food consumed, based on serving sizes.

The OFIS was designed taking into account the strengths and weaknesses of various dietary assessment methods. A preliminary version of the questionnaire was provided to a focus group, which included nutritionists and laypeople, and adjustments were made based on their feedback. A subset of participants from the OCS was recruited to test the 3-day survey in late 2010.

Prior to completing the OFIS, participants were again asked to estimate the percentage of organic food they consumed during the previous year and their weekly expenditure on organic foods; and then to record all food and beverages consumed over a 3-day period and report on the organic status of the food consumed (certified organic, likely organic, likely conventional or unknown). Detailed instructions were provided to clarify the meaning of all survey terms, which included pictures of the various certification logos used in Australia and prompts to improve memory recall. ‘Likely organic’ foods were defined as ‘no “certified organic” label is visible on the product or at the point of sale but the food has been purchased from a farmers’ market, farm gate or local food initiative where non-certified “organic” food is tracked on a “trust” basis. Alternately the food may have been home grown with a specific intent to avoid the use of any synthetic chemicals e.g. insecticides, weed killers, fertilisers etc.’ The OFIS used a modified version of the Australian Guide to Healthy Eating (AGHE) food group categories and serving sizes to provide a simple method of data collection that would allow for quantification of organic intake. The food group categories were: grains; vegetables (including legumes eaten as a vegetable, e.g. snow peas); fruit; dairy; animal protein sources (including eggs); plant protein sources (including legumes eaten as a protein, e.g. lentils); and extra foods. These were described in detail with examples of serving sizes used by the AGHE. At the end of each day participants were asked to estimate how accurate and how typical of their usual daily food intake their responses had been.

Upon return, the OFIS documents were checked by a nutritionist and queries resolved with participants prior to de-identification and data entry. The nutritionist used the AGHE guidelines to determine ‘serving sizes’ based on the information provided by participants.

Group-based data analysis was conducted using SPSS for Windows statistical software (version 18). For participants in the OCS, an ‘Organic Consumption Score’ was created for each individual based on responses to questions about the frequency and quantity of organic food consumed. The quantity and frequency score were both scored out of 5 (between 1 and 5, with 5 indicating the highest quantity or frequency of organic consumption) and added together to give a total score out of 10. The Visual Binning feature in SPSS was used to separate the sample into three equal groups, with each group containing ~32% of the data points. The cut-off points were ‘low’ (<6.93), ‘moderate’ (6.93 – 8.13) or ‘high’ (>8.13).

RESULTS AND DISCUSSION

Three hundred and twenty completed OCS surveys were returned, of which two were excluded as they did not meet the inclusion criteria, leaving 318 usable surveys. Nineteen participants returned the 3-day OFIS, resulting in a total of 57 sampling days.

Characteristics of survey participants

The majority of participants in the OCS were female. 25 – 55 years old, living in urban areas, born in Australia and were in a healthy weight range (Table 1).

Women were more significantly represented than men in the survey participant group. A gender bias towards females is consistent across earlier studies which have shown that female gender and the commonly associated responsibility for feeding children and other family members predicted organic consumption. The female bias was more marked than in previous surveys and may be due to a greater number frequenting the organic retail outlets and websites used for recruitment, or greater interest in the topic.

The majority of participants (80.3%) were between 25 and 55 years old. In previous studies, younger age (<40 years) was shown to be a predictor of a positive attitude to organic food and increasing age (≥60 years), on the other hand, has been shown to be a negative predictor, with less consumption in the older population.
Of the participants in the OCS, 33.4% were overweight or obese (body mass index \(> 25 \text{ kg m}^{-2}\)). This is in contrast to results from the Australian 2007–08 National Health Survey (NHS), which revealed that 61.4% of the Australian population were either overweight or obese. The NHS included 42.1% of adult males and 30.0% of adult females who were classified as overweight and 25.6% of males and 24% of females who were classified as obese, with rates of overweight and obesity increasing with age. Our results suggest that fewer organic consumers are obese compared to the national average, which may indicate better overall health. However, whether this is due to their dietary choices, general lifestyle choices or a combination of these factors remains to be explored. Additionally, whether people with a lower BMI are more likely to consume organic food or whether consuming organic food has an impact on BMI is unclear. This result is likely to be influenced by several confounders, including the high proportion of younger females (<53 years) in the study.

The median household income amongst organic consumers surveyed was AU $1000–1299 per week (AU $32,000–67,999 per year), with a marked increase up to but only a slight increase beyond AU $400–599 per week (AU $20,800–31,199 per year). Although Australian data for the same period were not available, in 2007–08 the median household income was AU $692 and average weekly disposable income was AU $381 per household. As price is considered a barrier to organic consumption it is often assumed that organic consumers are more affluent. However, as with previous Australian reports, income did not appear to have a strong impact on organic uptake in the OCS. In fact, the percentage of respondents with an income over AU $1000 per week was similar for consumers in the low and high consumption groups (21.3% vs. 20.0% respectively).

Increasing education (especially science education) has previously been shown to be a positive predictor for organic consumption and this is supported by the OCS, in which respondents had considerably higher qualifications than the Australian population. Nearly two-thirds of OCS respondents had a tertiary and over a third had a postgraduate qualification, compared to the Australian average of 16.5% with tertiary and 6.2% with postgraduate qualifications.

In general, the demographic characteristics of participants did not appear to differ with the level of organic consumption (low, moderate or high). Previous studies using demographic profiling have highlighted few consistent trends amongst organic consumers, with the exception of female gender. A lack of clear trends related to the level of consumption is therefore not surprising.

Overall consumption patterns
Based on self-reports, the percentage of people in the OCS that consumed most or all (i.e. >65%) organic food in the previous 12 months was 37.4% for certified organic food and 50.4% when ‘likely’ organic foods were also included. These figures were somewhat higher in the subgroup of participants who also participated in the OFS, at 42.1% and 73.6% respectively. In a 2002 survey, less than 7% of participants who reported eating organic food claimed to consume ‘most or all’ of their diet as organic. The OCS and OFS surveys specifically targeted high-and consuming, and the figures may also reflect an increase in awareness and availability of organic food in the years that separated these surveys.

On the whole, the actual levels of organic consumption (based on quantification of serving sizes by food group) were slightly higher over the 3-day recording period of the OFS than the initial self-reported estimates of the participants, although these differences were not statistically significant (\(P > 0.05\)) (Table 2).

In the OFS the ‘actual intake’ was based on a 3-day period, whereas the self-report was based on an estimate of the previous 12 months. Given the small number of participants, the results may have been skewed by individual cases. For instance, one OFS participant reported that they had converted to organic food during the previous 12 months so the self-report was based on the entire 12-month period, while the OFS was completed following their conversion to organic and intake was markedly higher. In addition, although participants in the OFS largely reported that their responses were accurate (\(M = 92.3\%\), 95% CI [90.8, 93.7]) and typical (\(M = 87.5\%\), 95% CI [83.9, 91.1]) of their usual dietary intake, the act of keeping a food diary may influence food intake behaviour as people become more conscious of their food choices. However,
Characteristics and consumption patterns of Australian organic consumers

Table 2. Organic consumption reported in the OFS

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<th>Self-reported</th>
<th>Actuala</th>
<th>Mean differenceb</th>
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<tr>
<td></td>
<td>Mean (%) [95% CI]</td>
<td>Mean (%) [95% CI]</td>
<td>Mean (%) [95% CI]</td>
</tr>
<tr>
<td>Any organic</td>
<td>60.7 [60.1, 79.4]</td>
<td>70.5 [68.0, 84.5]</td>
<td>0.0 [−1.1, 14.2]</td>
</tr>
<tr>
<td>Certified only</td>
<td>58.9 [47.8, 71.1]</td>
<td>63.0 [51.9, 73.6]</td>
<td>4.1 [−5.5, 13.4]</td>
</tr>
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Notes:
a Self-reported consumption is based on the previous 12-month period in both the OCS and the OFS.
b Actual consumption is based on results from the 3-day OFS.
c The mean difference is based on each individual’s actual organic intake minus the self-reported organic intake for each participant.

the tendency for higher-end organic consumers to underestimate their purchase frequency has been previously reported.10

The mean estimated weekly expenditure on organic food (either certified or likely) was 69.3% (SD = 27.5) of the weekly food budget in the OCS and 74.3% (SD = 22.6) in the OFS. As expected, the figures varied depending on the organic consumption score: low (42.41%), moderate (77.06%) and high (88.34%). While these surveys specifically targeted organic consumers, the 2010 AOMR (which targeted the general population) reported that only 5% of participants spent more than 70% of their household food-spend on organic options. These were entirely composed of those placed in the so-called ‘leader’ group, who were considered to have a high level of participation in activities with ‘healthier and more sustainable’ attributes. Of the ‘Leaders’, 31% reported in excess of 70% organic household spend. It is likely that our cohort would have similarities to the Leaders in the AOMR, who are considered to be the primary participants in the organic market at present.8

Consumption by food group

Based on both the quantity and frequency of organic choices, the most popular organic foods were fruit and vegetables and the least popular were meat products (including poultry and fish).

Over the 3-day OFS recording period, one participant did not consume any animal protein, one did not consume any plant protein and two did not consume any dairy. However, amongst participants there were 15 recording days that were free of animal protein, 18 free of plant protein and 12 free of dairy products. Recording days where the food was not consumed were excluded from the analysis. Overall, the percentage of servings that came from organic food was lowest for animal protein and highest for fruit and vegetables (Table 3). Interestingly both animal protein (160%) and vegetables (19.0%) had the highest contribution from likely organic sources. Comments from participants suggested these were largely from vegetables grown in their own garden or eggs from their own chickens. Some participants also included food purchased from farmers’ markets and reported having discussed the production methods with the farmers. Some likely foods were not explained.

While the OFS recorded the relative amount (quantity) of organic food consumed within each food group, the OCS investigated how often organic options were consumed within different food groups (frequency). As per the inclusion criteria all of the participants made a deliberate effort to consume at least some organic food on a weekly basis, 90% of whom consumed it daily. Weekly consumption patterns were again highest for fruit and vegetables (Table 3). A number of participants in the OCS reported that they did not consume animal proteins; meat (27.9%), poultry (23.5%), seafood (20.6%) and eggs (4.8%) but after excluding these participants from the analysis animal proteins still had the lowest frequency of organic consumption.

Higher uptake of organic fruit and vegetables compared to animal products was also reported in the 2010 AOMR, with 57% of participants (general consumers) purchasing organic fresh fruit and vegetables in the previous 12 months, versus 33% for red meat.8 In addition, 45% of participants consumed organic fruits and vegetables at least monthly, while only 39% consumed organic red meat with the same frequency.

Previous results have suggested that consumers may be more sensitive to price increases in absolute terms rather than relative terms.13 Thus they may be more willing to pay a proportionately larger premium for less expensive foods such as fruit and vegetables than for more expensive foods such as animal products. This trend is not unique to Australia.19 In the organic sector fruit and vegetables are considered extremely important as they have the largest share of any product category and are a key gateway product (i.e. the first organic product purchased by many consumers).10

The low level of organic fish consumption was unsurprising given that certified organic sources of fish and seafood are uncommon in Australia. Although the surveys also allowed for ‘wild-caught’ to be included with organic, this is not always labelled, making it difficult for consumers to assess.

Food preparation

Whether food was organic also appeared to have an influence on food preparation behaviours. Many of the organic consumers surveyed did not eat various food groups unless they were organic. Those who did eat conventional fruit and vegetables were around three times more likely to peel them than they would organic fruit (OR 3.505; CI [1.433, 8.867]) and vegetables (OR 3.456; CI [1.61, 7.418]).

To our knowledge, the food preparation behaviours of organic consumers have not previously been reported. The threefold tendency for these organic consumers to peel conventional fruit and vegetables could result in a loss of nutrients located in the skins. This may increase any nutritional differences between organic and conventional produce.20

Describing organic consumers

As previously discussed, health reasons are commonly cited as a major determinant for organic food consumption, but this perception is not strongly supported in the scientific literature.10 One of the benefits of more clearly describing organic consumers is to allow for more rigorous research evaluating the purported
HEALTH, WELLNESS AND ORGANIC DIETS

Table 3. Organic consumption by food group: based on the relative amount in the ORFS and frequency of intake in the OCS.

<table>
<thead>
<tr>
<th>Food group</th>
<th>Days consumed&lt;sup&gt;a&lt;/sup&gt; (%)</th>
<th>Average servings per day ($)</th>
<th>Certified organic&lt;sup&gt;b&lt;/sup&gt; (% of servings)</th>
<th>Any organic&lt;sup&gt;c&lt;/sup&gt; (% of servings) [5% CI]</th>
<th>Organic consumed weekly (% of participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>57 (98.3%)</td>
<td>4.6</td>
<td>64.2</td>
<td>83.2 [75.6, 90.7]</td>
<td>95.6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fruit</td>
<td>52 (89.4%)</td>
<td>3.0</td>
<td>74.2</td>
<td>85.4 [77.7, 93.1]</td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>46 (79.3%)</td>
<td>1.7</td>
<td>60.7</td>
<td>72.7</td>
<td>83.1</td>
</tr>
<tr>
<td>Grains</td>
<td>50 (95.1%)</td>
<td>2.7</td>
<td>60.0</td>
<td>69.0</td>
<td>77.7</td>
</tr>
<tr>
<td>Plant protein sources</td>
<td>40 (69.0%)</td>
<td>1.7</td>
<td>60.5</td>
<td>61.8</td>
<td>67.5&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Animal protein sources</td>
<td>63 (71.4%)</td>
<td>2.0</td>
<td>60.3</td>
<td>56.8&lt;sup&gt;f&lt;/sup&gt; [42.2, 71.3]</td>
<td>67.9</td>
</tr>
</tbody>
</table>

<sup>a</sup> Only the days consumed are included in the analysis.
<sup>b</sup> Number and percentage of the 17 sampling days in the ORFS where the foods were consumed (15 participants over 3 days).
<sup>c</sup> Fruit and vegetables were grouped together in the OCS.
<sup>d</sup> Legumes were the only plant protein recorded in the OCS.
<sup>e</sup> Animal products were grouped together in the ORFS.

health benefits of organic foods. It has been suggested that the lack of research for the health effects (and also for the environmental and sensory benefits) of organic food hampers the segmentation, targeting and positioning of organic foods in the marketplace. In the OCS, only 15% of participants claimed to consume ‘all or almost all (90–100%)’ certified organic food, rising to 22% when ‘likely’ sources were also included. In the ORFS only one of the 19 participants achieved in excess of 90% certified organic, with another two who consumed in excess of 50% when ‘likely’ organic foods were also included.

While it would be reasonable to define an organic consumer as one who makes a deliberate choice to consume organic food whenever there is a reasonable opportunity to do so, this may be interpreted very differently by different people. For research purposes some level of quantification is required to confirm the organic status of prospective participants if meaningful results are to be obtained. These criteria need to be sufficiently rigid to clearly differentiate dedicated organic consumers from those whose intake is only occasional or incidental whilst still being readily achievable by dedicated organic consumers.

Using data collected in the OCS and ORFS, we propose consumption criteria that appear to be achievable and reflective of current trends in Australian consumers and may also be applicable to other similar markets. The majority of participants from the OCS and ORFS self-reported consuming more than 65% organic food and this was confirmed for ORFS participants using the 3-day food intake survey instrument (Table 4). We propose that this figure be used as a minimum intake level to define ‘organic status’ in future research. Given the uncertain nature of ‘likely’ organic foods we would also recommend a minimum level for certified organic foods set at 35% (based on quantification of serving sizes by food group).

In addition to supporting research endeavours, previous reports have highlighted that organic consumers are heterogeneous and that research that better describes organic consumers can serve the long-term interests of the organic industry and other stakeholders of food marketing.

Table 4. Percentage of participants in the OCS and ORFS that would meet eligibility criteria based on self-report in both surveys as well as actual in the ORFS.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>OCS self-report</th>
<th>ORFS self-report</th>
<th>ORFS actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;65% organic certified or likely</td>
<td>60.4</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>&gt;35% certified organic&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60.8</td>
<td>79</td>
<td>70</td>
</tr>
<tr>
<td>Meet both criteria</td>
<td>56.3</td>
<td>74</td>
<td>63</td>
</tr>
</tbody>
</table>

Other limitations of this research

In addition to concerns previously discussed such as the large number of females in the OCS, it should be stressed that the sample was self-selected and therefore not representative. Organic consumers were largely captured through organic outlets and websites and this may have precluded other potential participants.

Several concerns also exist regarding the use of Internet-based surveys. Firstly, coverage bias (the fact that some people do not have access to, or choose not to use the Internet) and lack of familiarity with Internet tools may affect the representativeness of the sample and thus the generalizability of the results. This may potentially result in underrepresentation especially of certain age, ethnic and socioeconomic groups. However, modern Internet-based surveys have been reported to be equivalent to that of conventional interviews.

Prospective methods, such as those used in the ORFS, which ask participants to record foods as they are consumed, are likely to obtain more accurate information on recent intake and position sizes, with less risk of under- or over-reporting. However, with the ORFS they typically only cover 3–4 days’ intake as reliability
began to diminish after several days due to respondent fatigue. As a result, prospective designs may not be representative of ‘usual’ intakes and will not account for seasonal variability.

The use of ‘AGHE serving sizes’ within various food groups rather than other methods may also affect the value of the findings. Various methods can be used to determine portion size: weight (using a scale), volume (using a household measure, e.g. cup, tablespoon), or estimation (using models, pictures or no particular aid). The estimation method used in the OFIS may not be as quantifiable precise but was chosen to reduce respondent burden and in turn reduce the risk of missing or inaccurate data.

CONCLUSIONS

The majority of participants in the OCS were female. 25–55 years old, from urban areas, born in Australia and were in a healthy weight range. However, as with previous reports, a clear demographic profile of organic consumers remains elusive. The surveys specifically high-end organic consumers so consumption patterns in the OCS and OFIS were understandably higher than those generally reported in the literature. Organic fruit and vegetables were particularly popular and many participants reported peeling these items when conventional varieties were consumed.

Better understanding of organic consumers in terms of general characteristics as well as consumption patterns could be useful in providing support for marketing strategies that aim to increase organic consumption. As health reasons are often cited as a major determinant for organic food consumption, research confirming these perceptions may also provide additional impetus for increased consumption.

In order to properly evaluate any direct health benefits or harm minimisation resulting from the consumption of organic foods, organic consumers need to be clearly differentiated from conventional (non-organic) consumers. Based on our findings we suggest that in general minimum intake of 65% organic food and 35% certified organic food would appear to be a reasonable cut-off to confirm ‘organic’ status. These figures appear to be reflective of current practice amongst the high-end Australian organic consumers who completed the OCS and OFIS in 2010.

ACKNOWLEDGEMENTS

The authors wish to thank Dr Neil Mann, Professor of Food Science and Nutrition and statisticians Dr. Adrian Schiemandi and Dr Anthony Bedford of RMIT University for their valuable input.

REFERENCES

Assessing Diet as a Modifiable Risk Factor for Pesticide Exposure. (2011)

Assessing Diet as a Modifiable Risk Factor for Pesticide Exposure

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Received: 18 April 2011; in revised form: 13 May 2011 / Accepted: 17 May 2011 / Published: 25 May 2011

Abstract: The effects of pesticides on the general population, largely as a result of dietary exposure, are unclear. Adopting an organic diet appears to be an obvious solution for reducing dietary pesticide exposure and this is supported by biomonitoring studies in children. However, results of research into the effects of organic diets on pesticide exposure are difficult to interpret in light of the many complexities. Therefore future studies must be carefully designed. While biomonitoring can account for differences in overall exposure it cannot necessarily attribute the source. Due diligence must be given to appropriate selection of participants, target pesticides and analytical methods to ensure that the data generated will be both scientifically rigorous and clinically useful, while minimising the costs and difficulties associated with biomonitoring studies. Study design must also consider confounders such as the unpredictable nature of chemicals and inter- and intra-individual differences in exposure and other factors that might influence susceptibility to disease. Currently the most useful measures are non-specific urinary metabolites that measure a range of organophosphate and synthetic pyrethroid insecticides. These pesticides are in common use, frequently detected in population studies and may provide a broader overview of the impact of an organic diet on pesticide exposure than pesticide-specific metabolites. More population based studies are needed for comparative purposes and improvements in analytical methods are required before many other compounds can be considered for assessment.
1. Introduction

Pesticides are manufactured to be toxic to living organisms, but are not necessarily specific to their target species. They are deliberately released into the environment where their ubiquitous presence may endanger other living species, including humans [1]. It is unsurprising then that numerous published studies suggest a link between pesticide exposure and human health risks such as cancer [2], and adverse genotoxic, neurologic, and reproductive effects [3]. Obvious health risks may be due to acute poisoning or high level occupational exposure, while there is the possibility of more subtle health risks through general exposure via the food chain.

Globally around three million accidental or intentional pesticide poisonings occur each year resulting in around 260,000 deaths [4]. The vast majority occur in developing countries, which use only a fraction (20%) of the world’s agrochemicals [5]. However, these figures do not take into account chronic or cumulative health effects or effects arising from exposure during critical periods of development [6].

1.1. Occupational Exposure to Pesticides

There are numerous examples cited in the scientific literature regarding occupational exposure to pesticides and adverse health outcomes such as various cancers, Parkinson’s and other chronic diseases, as well as potential adverse effects on mental health and reproduction [7-12].

The United States Agricultural Health Study (AHS), a large prospective cohort study of pesticide applicators and their spouses, identified links between various pesticides and cancer incidence (lung, pancreatic, colon and rectal, all lymphohaematopoietic cancers, leukaemia, non-Hodgkin lymphoma, multiple myeloma, breast, bladder, prostate, brain, melanoma and childhood cancers). Outside the AHS, epidemiologic evidence remains limited with respect to many of these associations, but animal toxicity data support the biological plausibility of these relationships [7].

In addition to cancer, pesticides have been associated with a number of other health effects in animals and humans. The AHS has investigated conditions as widespread as Parkinson’s Disease, depression, diabetes, respiratory disorders and other health conditions [7]. Links to Parkinson’s Disease have been supported by experimental studies indicating that high exposure to parquat (herbicide) and maneb (fungicide) may increase the risk in genetically susceptible individuals [8,9] highlighting concerns of potential epigenetic effects (gene-environment interactions). That a number of pesticides directly target the nervous system as their mechanism of toxicity may provide additional concerns. Studies in pesticide workers have also demonstrated effects on neurotransmitters which may be involved in mood regulation [10,11].

The risks of pesticide exposure at occupational levels may be of specific concern during critical developmental periods. Despite safeguards for pregnant farm workers, current measures may not be sufficient to protect the developing foetus from endocrine disrupting agents. For example a Danish
study has reported that sons of women occupationally exposed to pesticides have a statistically significant decrease in penile length and a trend towards reduced testicular volume and serum concentrations of testosterone [12].

There are many uncertainties however, due to the limited number of research studies conducted on specific exposure-outcome relationships and methodological limitations such as crude exposure measurements, small sample sizes, and limited knowledge and control of potential confounders [13]. Furthermore, the sheer number of chemicals and variety of chemical actions involved, and the attribution of some adverse health effects to pesticides that are no longer in current-use in many regions make it extremely difficult to generalise about the health effects of pesticides.

1.2. Other Sources of Pesticide Exposure

While occupational exposure is likely to incur a greater risk, all humans are exposed to pesticides whether they be ingested from food sources, absorbed through the skin or inhaled from polluted air.

Dietary exposure from the ingestion of contaminated food (more so than water or other beverages) is considered to be the primary route of exposure for most pesticides although additional environmental exposure is also likely [14-16]. Food can be contaminated by pesticides used during production, transport or storage. While diet has been shown to be a significant predictor of pesticide exposure in all age groups, specific foods and food choices must also be considered as some foods may have a greater impact on exposure levels [17]. Food consumption patterns will vary among and within individuals for economic, seasonal, regional, cultural, ethical and personal reasons.

Non-dietary pesticide exposure can occur as a result of residential pesticide use (home, garden, pets, personal insect repellents), proximity to agricultural areas, time spent in parks and recreational areas or fumigated buildings, or hand to mouth activity (generally higher in young children). With the exception of residential use, most of these factors are outside the reasonable control of the average individual, whereas diet represents a modifiable risk factor that may be under individual control.

1.3. Monitoring Pesticide Exposure

Biological monitoring techniques (biomonitoring) assess pesticide levels in human tissue, and provide a measure of an individual’s total exposure to pesticides through dietary and non-dietary sources. Unfortunately biomonitoring data is not available for all pesticide classes or for all regions.

Some European countries [15], the CDC in the USA [18], and Health Canada [19] have conducted large scale biomonitoring studies assessing pesticide exposure in the general population, although such studies have not been conducted in countries such as Australia or most developing countries. These studies frequently detect pesticides or their metabolites in human tissue. The mean levels are almost always lower than those found in occupationally exposed individuals although those in the higher range can be similar to some occupationally exposed workers [15]. As the half-lives of modern pesticides are very short (often <24 hours), these data suggest that the population is continually and routinely exposed to pesticides [15].
1.4. Non-Occupational Exposure to Pesticides

Identifying health risks in non-occupationally exposed populations is difficult as pesticide exposure is diffuse and the source of exposure (dietary, environmental etc.) is not always clear. Of particular concern is the increased risk associated with pesticide exposure during critical periods of development, such as preconception, prenatal and early childhood. For example, high urinary levels of atrazine, alachlor and diazinon have been associated with abnormal sperm [20]. In the US a significant association has been reported between the months of increased risk of a birth defect and increased levels of pesticides (especially atrazine) in surface water [21]. Higher prenatal urinary concentrations of dialkyl phosphate (DAP) (which are metabolites of organophosphate pesticides [OPs]) have been associated with poorer intellectual development in 7-year-old children [22] and elevated levels of DAPs have also been associated with an increase in the prevalence of ADHD in children aged 8 to 15 years [23]. These DAP concentrations were within the range of levels measured in the general U.S. population although the reasons for these elevated levels are not clear.

In recent times there has been considerable media attention around obesity and insulin resistance. These are common conditions which can influence other disease processes and impact on quality of life and mortality. In rats chronic administration of low concentrations of atrazine has been shown to increase body weight, intra-abdominal fat and insulin resistance and reduce basal metabolic rate. While obesity and insulin resistance were further exacerbated by a high-fat diet they also occurred without changing food intake or physical activity level [24]. Adding to these concerns, data from the Center for Disease Control and Prevention (CDC) shows an apparent overlap between areas of heavy atrazine use in the USA and the prevalence obesity (BMI > 30) [25].

As the primary route of exposure for most pesticides is via the ingestion of food exposed through conventional agricultural practices [14-16], such findings in addition to uncertainty about the evaluation of pesticides [26], raise concern amongst some consumers.

2. Organic Diets as an Intervention

Organic farming practices do not use synthetic pesticides and data from food residue surveys confirm that organic produce has reduced pesticide levels [27-29]. This provides a rationale that organic food consumption should result in reduced pesticide exposure. However, studies describing reduced risk of developing pesticide related diseases, or improved health outcomes as a result of consuming organic foods are lacking. Despite a lack of supporting research, adopting an ‘organic diet’ appears to be an obvious way to reduce pesticide exposure for a growing number of concerned individuals. Some believe that ‘on the basis of the precautionary principle alone, choosing organic food appears to be an entirely rational decision’ [30]. Assessing the efficacy of such an intervention, however, is not a simple feat.

In a recent attempt initiated by the Food Standards Authority (FSA) in the UK to investigate the ‘putative health effects’ of organic food, studies that were primarily concerned with chemical residues (including pesticides) were specifically excluded. The focus on nutrition-related health effects yielded only twelve relevant articles [31]. In one study the consumption of organic dairy products within the context of a general organic diet was associated with a 36% lower risk of infantile eczema in children who exclusively consumed organic dairy products (i.e., weaned on organic milk, cheese and yoghurts
and who were breastfed by mothers eating organic dairy products). However, the authors attributed these results to increased levels of omega-3 fatty acids and conjugated linoleic acid in organic compared to conventional milk and the likely reduction in pesticide exposure was not discussed [32].

Understanding the health impact of dietary pesticide exposure, and therefore any potential benefit of reducing exposure by adopting an organic diet, begins with determining actual exposure levels. While monitoring of pesticide residues in food may provide a useful insight into the potential sources of dietary exposure, biomonitoring is more likely to correlate with adverse health effects as it directly measures the amount of a pesticide (or its metabolites or degradation products) in human tissue. However, it should be stated that high levels of these markers have not been consistently associated with adverse health effects [15].

Regarding organic consumers only a few published reports in children have utilised biomonitoring [33-35]. These have examined urinary metabolites of OP and synthetic pyrethroid insecticides (PYRs). Dietary exposure to other classes of pesticides such as carbamate insecticides; fungicides and herbicides has not been formally evaluated in organic consumers.

In 2003 Curl et al. reported that children who consumed organic fruit, vegetables and juice had a mean total urinary dimethyl alkylphosphate metabolite (DMAP) concentration (a non-specific measure of OP exposure) that was approximately nine times lower than children consuming conventional foods. This corresponded to a reduction in the children’s exposure levels from above to below the U.S. Environmental Protection Agency’s guidelines, shifting exposures from a range of uncertain risk to negligible risk [33].

The results of the Curl study are supported by the Children’s Pesticide Exposure Study (CPES) [34] which also reported reductions in urinary pesticide metabolites in children consuming organic produce. This study included measurements of select urinary OP and PYR metabolites in 23 children aged 3–11 years over a 15-consecutive-day sampling period. Children consumed their usual conventional diet with an organic intervention phase for five consecutive days, at which time organic food items were substituted for most of the children’s conventional diet (fruit, vegetables, juice, wheat and corn products). The organic intervention resulted in a decrease in certain pesticide-specific OP metabolites to non-detectable or close to non-detectable levels [14] and a reduction of approximately 50% in PYR exposure [35]. These results confirm that consumption of organic produce appears to provide a relatively simple way to reduce children’s exposure, especially to OP pesticides [14,33], and that this occurs relatively quickly. However, drawing any general conclusions from these biomonitoring studies to support the hypothesis that organic diets reduce pesticide exposure will require further studies in different population groups.

3. Complexities and Limitations of Biomonitoring

Designing biomonitoring studies to assess the efficacy of an organic diet in reducing pesticide exposure must be carefully devised. Appropriate study design requires consideration of the limitations of biomonitoring and the complexities involved in contextualising the results. This includes careful selection of which pesticides will be targeted and the most appropriate analytical methods to use. Ideally the methods chosen should be able to attribute the source of exposure to dietary intake. Study design must also consider confounders such as the unpredictable nature of chemicals and individual
genetic and environmental factors that might influence susceptibility to disease. Contextualising the results also requires consideration of the data available for comparison purposes.

3.1. Study Design

The population of interest needs to be clearly defined with careful consideration of factors that may affect exposure and susceptibility. Consideration should be given to whether the study will use an organic intervention or observe free living organic consumers eating their usual diet. As free-living consumers are unlikely to consume a 100% organic diet detailed survey instruments need to record dietary intake to quantify the level of organic consumption. Other sources of exposure and potential confounding factors such as age, health status, medication use and other factors that may influence the metabolism of, and susceptibility to, pesticides must also be determined.

Targeted pesticides need to be selected based upon the likelihood of dietary exposure in the general public. This is likely to vary from region to region and over time depending on prevalence of use but may be informed by studies which monitor pesticide residues in food. Seasonal and regional variations can be anticipated depending on the time of the year and the nature of pest infestations. Priority might be given to assessment of pesticides with high prevalence of use, those with the greatest public health concerns or to newer chemicals so that potential human health risks can be more accurately determined. Once chosen the most appropriate methods of testing these pesticides must be considered.

3.2. Analytical Methods

There is an increasing amount of biomonitoring data available and Barr [36] and Aprea et al. [1] have previously described biomonitoring methods for assessing pesticide exposure. However choosing and conducting such tests requires a high level of technical expertise. Scientists do not always agree on the most appropriate methods for assessing pesticide exposure, limits of detection may vary and data collection and analysis can be laborious, expensive and place unacceptable demands on study participants.

In humans, most current-use pesticides are excreted within 24 hours as either the parent pesticide, a mercapturic acid detoxification product or as a metabolite [36]. Therefore collecting samples that degrade quickly requires a level of urgency. While many herbicide compounds are poorly metabolised and are excreted largely unchanged in the urine [1], the parent compounds of many other pesticides are metabolised very rapidly, making their measurement impractical. As a result, metabolites are often used as surrogate markers for exposure. Several methods have been reported which measure intact OP pesticides in blood, serum, or plasma, however, for the most part these tests are used for detecting acute poisoning or very high levels of exposure [37]. Similarly, occupational exposure to PYRs can be assessed by monitoring intact PYRs, yet due to their rapid elimination, unmodified compounds are less sensitive indicators of exposure than the metabolites [1] and thus may not be suitable for detecting differences in dietary exposure.

Determining the most appropriate tests is not always straightforward. For example according to Barr [36], atrazine mercapturic is often tested but may not be the best marker for atrazine exposure, recommending instead analysis of dealkylated or hydroxylated metabolites of triazine herbicides, mercapturic acids of the dealkylation products or free atrazine. Determining suitable limits of detection
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(LODs) may also be open to conjecture. As it is difficult to confidently determine the levels of pesticide exposure that are safe under all circumstances [26], the LODs should be set as low as possible. Lower detection limits will yield more samples with detectable metabolites, and lower LODs will more accurately reveal differences in dietary exposure between consumers of organic and conventional food [15].

Defining appropriate sampling times and collecting representative samples can be difficult; and pure standards for measuring pesticide metabolites are not always available [1]. Analytical methods often involve gas chromatography (GC) or high-performance liquid chromatography (HPLC) following sample preparation and extraction requiring specialised equipment and technicians. The choice of analytical methods must also consider practicalities such as financial restraints and the potential burden on study participants and researchers. This may include whether invasive methods are required to collect samples and the timing and costs of such procedures.

3.3. Attributing the Source of Exposure

Although useful in determining an individual’s total exposure (dietary and non-dietary) to pesticides, biomonitoring methods are not always able to attribute the source of exposure, especially when metabolites are used. Metabolites may reflect exposure to more than one parent pesticide, may be markers for substances other than pesticides, or may be preformed or result from biological processes in the body.

Some metabolites are markers for specific pesticides while others are representative of a number of pesticides. Urinary 3-phenoxybenzoic acid (3PBA) is a non-specific metabolite common to a number of PYRs, and trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (trans-DCCA), is common to permethrin, cypermethrin, and cyfluthrin [14]. With OPs the most commonly reported method is to measure DAP metabolites which are formed in the human body during the metabolism of OP pesticides and excreted in urine [18]. The data generated can provide a cumulative index of exposure to most members of the OP class but are not pesticide-specific. Each DAP metabolite is associated with a number of OPs, and many OPs can form more than one of these metabolites [37]. Specific biomarkers for individual pesticides in this class are also available, such as 3,5,6-trichloro-2-pyridinol (TCPy) for chlorpyrifos and malathion dicarboxylic acid (MDA) for malathion. However urinary DAPs may provide a more useful assessment for exposure to the class in general and this may be advantageous in providing an overview of the impact of an organic diet. If the purpose however, is to determine the effect of the diet on individual pesticides then pesticide-specific markers may be more useful.

Some metabolites utilised in biomonitoring studies are not entirely specific to pesticides. For instance, 1-naphthol (1NAP), a metabolite of carbaryl is also a marker for the ubiquitous naphthalene (found in mothballs, petroleum and cigarette smoke) [15]. A further consideration is the potential contribution from preformed metabolites. This can occur with OP metabolites such as DAPs which may be detected as a result of the metabolism of ingested parent compounds but may also result from the ingestion of preformed metabolites which may be present on food as a result of environmental degradation. In addition sources of inorganic phosphate may be alkylated within the body to form dimethylphosphate (DMP), and this may also contribute to urinary DAP levels [15].
3.4. Unpredictable Nature of Chemicals

When attempting to understand the impact of individual pesticides on human health, consideration must be given not only to the specific chemicals targeted in the biomonitoring study but also to the potential impact of other chemicals and risk factors for disease progression. We have previously described some of these factors including: the effects of exposure to mixtures of chemicals; the dose, duration and timing of exposure; the complexities and lack of complete safety assessment data; as well as variations in the exposure, metabolism and susceptibility of different individuals [38].

Humans are exposed to a unique and ever changing cocktail of chemicals. This cocktail may include pesticides and other chemicals acquired through ingestion, inhalation or dermal absorption. Some of these substances may have similar mechanisms of action or may interact via toxicokinetic (absorption, distribution, metabolism and excretion) or toxicodynamic (binding, interaction and induction of toxicity) processes to produce additive, antagonistic or synergistic effects [39]. For instance the synergistic effects of mixtures of sub-lethal doses of OPs in juvenile salmon are sufficient to cause anticholinesterase intoxication and death [40].

Although most pesticide formulations are mixtures of chemicals, most safety assessment methods focus on individual ‘active’ chemicals rather than ‘whole formulations’ including their adjuvants, metabolites and degradation products. A case in point is glyphosate. The adverse effects associated with glyphosate appear to be more dependent on the formulation tested than on the glyphosate concentration [41,42]. It is possible that these effects may be more appropriately attributed to other compounds in the formulation or to the environmental breakdown product of glyphosate, aminomethyl phosphonic acid (AMPA) [42-44]. Similarly recent studies suggest that prenatal exposure to piperonyl butoxide (a PYR synerget) has been negatively associated with neurodevelopment [45].

Depending on the disease process in question non-chemical risk factors such as physical inactivity or nutrient deficiencies or excesses as well differences in genetic susceptibility, may also confound results. Using biomonitoring data from a few select targeted chemicals is unlikely to provide sufficient data to deal with the inherent complexities of disease progression.

3.5. Individual Factors

In addition to chemicals behaving in potentially unpredictable ways, an individual’s response to chemicals may also be unpredictable. Although a 100-fold safety factor is taken into account when establishing acceptable daily intakes for humans [26], this must overcome differences between experimental and real world conditions, as well as account for individual variability in exposure and metabolism. There is currently insufficient data from epidemiological studies to confidently predict the levels of pesticides (either the parent compounds, metabolites, degradation products or adjuvants) that might be associated with human health risks and such levels are likely to be highly variable. For example levels of 3PBA are known to be influenced by factors such as tobacco use, time spent gardening and the use of cytochrome p450-inhibiting medications [17]. This may in part reflect differences in exposure but also differences in the metabolism of pesticides and these are likely to vary not only between different individuals but also within the same person over the course of their lifetime. A progressive increase in DMAP metabolites at 6, 12 and 24 months of age has been positively associated with the number of children’s daily servings of fruits and vegetables [46]. At the same time
the activity of enzymes which play an important role in the detoxification of many pesticides are known to be impaired in children [47].

To a limited extent biomonitoring can account for poorly understood processes such as bioaccumulation, excretion and metabolism [37], but demonstrating pesticide exposure at a specific time point does not provide information about the lifetime exposure to pesticides or the increased risk of exposure during critical periods of development (such as in utero). Assessing risk relies not only on determining individual exposure but must also consider variations in an individual’s ability to metabolise, detoxify and excrete mixtures of chemicals as well as their susceptibility to disease which may vary with genetic, developmental, physiological and environmental conditions.

3.6. Comparative Data

Once measurements have been collected the results must be carefully interpreted. Where possible, results from organic consumers may be compared with reference values of the general population although such studies do not enquire about levels of organic food consumption [1].

OPs are frequently detected in general population studies [15,18,19] and have been assessed in comparative studies of children consuming organic and conventional diets [14,33]. In the CPES the pesticide-specific OP metabolites TCPy and MDA had the highest frequency of detection representing chlorpyrifos and malathion exposure from the conventional diet [14]. PYR metabolites have also been detected with varying frequency in population studies [15,18,19] and differences have been observed in children when switched from a conventional diet to an organic diet for 5 days [48].

For both general population and organic consumption studies there may be significant heterogeneity with regard to the pesticides chosen for monitoring and the methods and LODs used. Methods and detection performance have improved over time, especially for OP metabolites, so care must be taken when attempting to compare results from older studies [15].

4. Conclusions

The effects of pesticides on the general population, largely as a result of dietary exposure, are unclear. If the precautionary principle is applied then adopting an organic diet appears to be an obvious solution for reducing pesticide exposure and this is supported by biomonitoring studies in children. However the few attempts that have been made to determine the efficacy of such an intervention are difficult to interpret in light of the many complexities.

Biomonitoring cannot be considered an end in itself but simply a tool for integrated health assessment; an intermediate step for establishing a link between exposure and adverse health effects. The limitations of biomonitoring and the complexities involved in interpreting the results must be acknowledged. As previously mentioned, both dietary and non-dietary sources of exposure can vary among individuals. While biomonitoring can account for differences in overall exposure it cannot necessarily attribute the source. Due diligence must be given to appropriate study design and selection of analytical methods to ensure that the data generated will be both scientifically rigorous and clinically useful, while minimising the costs and difficulties associated with biomonitoring studies. Currently the most useful candidates for assessment are urinary DAPs and urinary 3PBA and trans-DCCA. These assessments provide evidence of exposure to OP and PYR insecticides
respectively and as they are in common use they can provide a broader overview of the impact of an organic diet on pesticide exposure than pesticide-specific metabolites. As previously discussed these metabolites have frequently been detected in population studies and have been assessed in children consuming organic foods providing useful data for comparison. However the contribution of preformed metabolites in the diet must be considered.

Depending on the prevalence of use in the region of interest, specific metabolites for chlorpyrifos (TCPy) and malathion (MDA) may also be incorporated. In addition select herbicides may be useful, although comparative data from similar studies is not currently available and the frequency of detection in population studies tends to be relatively low.

Despite its limitations, biomonitoring remains the most useful surrogate indicator of pesticide exposure currently available. The above discussion highlights some of the many issues encountered when selecting biomonitoring methods for assessment of pesticide exposure. It provides an outline of some of the complexities encountered when attempting to ascertain the efficacy of an organic diet intervention in reducing such exposure.

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Human Consumption of Agricultural Toxicants from Organic and Conventional Food. (2009)

HUMAN CONSUMPTION OF AGRICULTURAL TOXICANTS FROM ORGANIC AND CONVENTIONAL FOOD

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Abstract
Over the past 60 years both the number of agricultural toxicants in use and rates of toxin-related diseases have increased dramatically, and countless studies attest to a link between the two. While data from residue surveys confirm higher levels of toxicants in conventionally farmed produce, few studies directly assess whether consuming organic produce results in a reduction in pesticide exposure in humans or confers any health benefits. Future research needs to confirm whether and to what extent agricultural toxicant levels vary between consumers of organic and conventional produce before attempting to draw any conclusions about the potential health implications of such differences.

Keywords: organic farming, agricultural toxicants, pesticides, safety

Introduction
Chemical use has increased dramatically in developed countries since the 1940s and more recently in other regions. In excess of 80,000 chemicals are now commercially available for use by agriculture and industry and many potentially toxic compounds have been embraced to increase productivity and financial gain (Erskine 2009). These toxicants are widely distributed in nature and many lack an established NOAEL (no observed adverse effect level) or consensus about long term health effects. The presence of toxicants in humans is ubiquitous, increasing with age and exposure, and this has been widely confirmed by studies analysing breast milk (Somogyi & Beck 1993) and other human tissue (Dewailly et al. ‘1999). Both the number of toxicants in the environment and rates of toxin-related diseases have increased dramatically in the past 60 years, and countless published studies attest to a link between toxicants and health risks. For instance, comprehensive reviews highlight numerous studies which have identified a positive relationship between exposure to pesticides and the development of certain cancers, as well as adverse reproductive, metabolic and mental health effects (Sanborn et al. 2004, Moroni & Fait 1993). The ‘Agricultural Health Study’, a large prospective cohort study conducted in the United States in the 1990’s also identified, among other things, cancer risks associated with direct exposure to pesticides and other agricultural agents (Alavanja et al. 2003, Lee et al. 2007, Alavanja et al. 2004).

Such findings have lead some consumers to turn to organic produce in the hope that limiting the consumption of conventionally farmed food will result in a reduction in exposure to agricultural toxicants (especially pesticides) and therefore reduce any associated health risks. European surveys indicate that 70% of EU citizens are ‘worried’ about pesticide residues in food (Tasiopoulou et al. 2007). Similarly a 2004 Australian survey conducted on a randomly selected population from Victoria (n=223) reported that 74% of respondents agreed with the statement ‘Organic food is healthier than conventionally grown food because it has no pesticide residues’ (Lea & Worsley 2005). While this notion makes intuitive and theoretical sense, according to the New Zealand Food Safety Authority, at present ‘there is no conclusive evidence to suggest that organic food in general is more or less safe or nutritious than conventionally produced foods’ (NZFSA 2009).

The Food Standards Agency (UK) recently commissioned two separate systematic reviews evaluating these issues. The first review compared the composition (nutrients and other nutritionally-relevant substances) of organically and conventionally produced foods (Dangour et al. 2009). The second review evaluating the putative health effects of organic food is yet to be released (FSA 2008). As the study protocols specifically exclude addressing contaminant content (such as herbicide, pesticide and fungicide residues) these reviews are unlikely to further our understanding of the potential health impact of residues in organic or conventional foods. A team of European scientists affiliated with the Quality Low-Input Food project are currently working on assessing the effect of organic and ‘low input’ production methods on food quality and safety and human health (QLIF 2008) and this may prove more useful to consumers.

Consumer interest appears to be focused on whether a reduction in toxicant exposure by way of organic food consumption, might mitigate the perceived health risks associated with agricultural toxicants (especially

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ISSN 1177-4258
pesticides). To confidently establish this, researchers will firstly need to demonstrate that the differences in residues noted in surveys of fresh produce result in differences in toxicant levels in humans.

This paper will review current evidence regarding health risks associated with agricultural toxicants, differences in residue levels in the produce itself and to what extent the consumption of foods produced by organic and conventional farming methods affect these toxicant levels in humans. It will further discuss some of the difficulties associated with comparing organic and conventional produce, and in assessing the human health risks from agricultural toxicants.

The Organic Industry and its Consumers

The organic food industry is currently undergoing a global expansion. According to the most recently published data (as at the end of 2007), there are currently 1.2 million organic producers, and 32.2 million hectares of land worldwide certified according to organic standards. Australia continues to account for the largest certified organic surface area globally, covering an area of 12.02 million hectares, a slight decrease on the previous year, with around 1,550 certified farms. New Zealand accounts for 65,000 hectares. In 2007 the global market for organic products was valued at over US$46 billion, up from US$38.6 billion in 2006, and more than double that of 2000 (Willer et al. 2009).

As yet, there is no consistent international definition of the term ‘organic’ although many regions have comprehensive standards regulating the production and processing of ‘certified organic’ food products. Most common definitions emphasise production practices and principles, and standards often refer to the avoidance of substances foreign to nature (such as synthetic fertilisers and pesticides), as well as promoting local, renewable resources; maintaining diversity; and consideration of animal welfare (United Nations 2008).

In addition to concerns about the health implications of pesticide (and other chemical) exposure, consumer decisions to purchase organic produce are influenced by various factors including beliefs that organic foods have a superior nutritional profile and taste; and that they are better for the environment, farm workers and animal welfare (Lockie et al. 2002, Lea & Worsley 2005). Lokie et al (2004, p 135) state that ‘on the basis of the precautionary principle alone, choosing organic foods appears to be an entirely rational decision’ (Lockie et al. 2004, p 135).

Agricultural Toxicants and Health Risks

More than 9000 agricultural and veterinary (Ag/Vet) chemicals are currently approved for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA) (Haddad 2009) and more than 2000 by Agricultural Compounds and Veterinary Medicines (ACVM) in New Zealand (Owens 2009). These agricultural toxicants include: synthetic fertilisers, pesticides (herbicides, insecticides, fungicides), fumigants, mycotoxins, hormonal growth promotants, anthelmintics, antibiotics, and other medications.

While food regulatory bodies worldwide fail to report any health benefits of organic foods, it has been acknowledged that ‘since organic production systems minimise the use of synthetic compounds it is likely organic produce will have lower residues than conventional produce’ (NZFSA 2009). The fact that these chemicals are widely utilised in conventional farming but are largely prohibited by organic certifying bodies suggests that organic food consumption should result in reduced human exposure to these chemicals, yet to date, only three published reports have directly assessed this (Lu et al. 2009, Lu et al. 2008, Curl et al. 2003). Furthermore, it is difficult to definitively determine the health impact of such exposure. Much of the current research is based on animal data, epidemiological studies of occupational exposure and reports of acute poisoning. The following is a summary of some of the major purported health concerns.

Pesticides

A number of large studies have attempted to identify links between pesticide use and chronic health effects. In the 1990’s researchers in the United States’ conducted a large prospective cohort study of pesticide applicators and their spouses known as the Agricultural Health Study. The study identified links between various pesticides and prostate, lung, rectal and colon cancers (Alavanja et al. 2003, Alavanja et al. 2004, Lee et al. 2007). More recently the Systematic Review of Pesticide Human Health Effects (Sanborn et al. 2004) assessed eighty three studies that met rigorous inclusion criteria. Studies with poor methodology (less than 4 on a 7-point scale) or those conducted on organochlorine pesticides (OCPs), which have been banned in many regions under the Stockholm Convention (DEH 2006), were excluded. A positive relationship was identified between exposure to pesticides and development of many cancers as well as the risk of genotoxic, immunotoxic and neurotoxic and adverse reproductive effects and an increased incidence of psychiatric and dermatological conditions.

Another review suggested that adverse effects from pesticide exposure are more likely to occur in children and highlighted concerns regarding neurobehavioral toxicity and endocrine disruption as well as implications
for childhood cancer and adverse reproductive outcomes (Garry 2004). In addition correlations have been made between levels of agricultural toxicants in surface water and higher risk of birth defects (Winchester et al. 2009).

**Persistent Environmental Chemicals**

Numerous chemicals, classed as persistent organic pollutants (POPs), have the ability to persist in the environment long after they have been utilised in farming. An example are the organochlorine pesticides once commonly used in conventional agriculture, hence the term organic in this context relates to the chemical structure of the substance rather than their approved use in ‘organic’ farming systems.

Many POPs have been shown to exert carcinogenic and endocrine disrupting effects (Jandacek & Tso 2001). Despite recent efforts to reduce their use, they continue to contaminate water, soil and air around the globe and their affinity for lipids, chemical stability and long biological half-lives has resulted in bioaccumulation and biomagnification throughout the world’s food chain (Jandacek & Tso 2007). Although organic standards prohibit their use and are somewhat protective against future occurrences of a similar nature, human consumers are unavoidably exposed to these substances whether they eat organic or conventional produce (Magkos et al. 2006). Residue surveys have identified these substances in both conventional and organic produce, most likely due to historical use (McGowan 2003, Tasiopoulou et al. 2007).

**Synthetic Fertilisers**

While fertilisers used on organic farms contain nitrogen bound to organic material from which it is slowly released (Benbrook et al. 2008), chemical fertilisers are absorbed rapidly into the plant and increase nitrate/nitrite levels and may result in formation of nitrosamines which have been associated with leukaemia and gastrointestinal cancers (Rembialkowska 2007).

**Mycotoxins**

Mycotoxins (fungal toxins) are secondary metabolites produced by microfungi which can cause acute toxicity or chronic health effects such as cancer, kidney or liver toxicity and immune suppression (Bennett & Klich 2003). An example is zearalenone, a metabolite of Fusarium spp. which possesses potent oestrogenic activity and may occur naturally or be added as a synthetic growth promotant known as zearanol (banned by the European Union since 1989).

It is estimated that one quarter of the world’s crops are contaminated to some extent with mycotoxins which can be transferred to humans through the ingestion of contaminated crops or animals (Bennett & Klich 2003). On average, mycotoxin levels in conventional food are twice as high and detectable 50 percent more frequently than in corresponding organic food (Benbrook 2005). This is attributed to the use of nitrogen based fertilisers and somewhat ironically to the use of synthetic fungicides which may lead to resistance or trigger shifts in the population mix of fungi that favour mycotoxin-producing strains.

**Pathogens**

The use of outdoor husbandry and manure application, and limited use of AgVet agents in organic farming systems has led to speculation that organic produce may be more vulnerable to bacterial and fungal contamination. However, there is no firm evidence that organic crops are more or less susceptible to microbial contamination or that animal health status is compromised (Magkos et al. 2006). In fact there appears to be a trend towards faster decline in E. coli O157:H7 levels in organic compared to conventional soils (Franz et al. 2005).

In organically farmed animals, it has been reported that while parasite problems tend to be worse, other health traits tend to be the same or better than in conventional farming (Lund & Algiers 2003). New Zealand researchers have reported on the challenges of controlling parasites without anthelmintics (medicines used to control internal parasites in animals) and were cautiously optimistic that an integrated approach by parasitologists, plant breeders, agronomists, and farming systems researchers may lead to the development of alternative methods for parasite control (Niezen et al. 1996).

**Veterinary medicines**

Arguably the most controversial of the veterinary medicines used in conventional agricultural practice are antibiotics. Antibiotics have been used extensively as growth promotants and for the control of infection in large-scale animal confinement operations (Dolliver et al. 2007). In addition, livestock feed produced as a byproduct of ethanol production may contain antibiotic residues providing another route of exposure for animals. The presence of antibiotic residues in manure used on farmland may also contribute to uptake by plants and spread to aquatic environments (Dolliver & Gupta 2008, Blackwell et al. 2009). As a result all human food sources may potentially contain antibiotic residues.

Concerns have been raised regarding the presence of antibiotic residues in foods produced for human consumption and the resulting development and spread of antibiotic resistant bacteria. Recent studies have
confirmed that organic farming practices result in reduced frequency of resistant strains (Schwaiger et al. 2008) however the implications for humans is unclear. In addition researchers have warned about the potential impact of chronic cumulative exposure to antibiotics, risk of allergic reactions and disruption of digestive function (Dolliver et al. 2007).

Secondary Metabolites

It has been proposed that organic farming practices encourage endogenous plant defence mechanisms to protect them against predators, resulting in increased toxin production (Magkos et al. 2006). While it is true that organic produce appears to be higher in plant derived secondary metabolites (phytochemicals) (Rembialkowska 2007) whether these substances exert positive or negative health effects is unclear, although the potential for positive health effects is suggested by evidence that many phytochemical compounds possess antioxidant, antimicrobial and other properties (Hounsone et al. 2008).

Comparisons of Organic and Conventional Produce

Difficulties in comparing organic and conventional produce

There are a number of barriers for researchers attempting to distinguish between organic and conventional produce for comparison purposes. Both organic and conventional farming practices vary widely and there are many factors that influence the final toxicant levels in produce as outlined below. While similar, the lack of complete uniformity in certification requirements by the hundreds of different certifying bodies worldwide makes cross-comparison of published studies problematic. In addition, some conventional farmers, while not certified as organic, may employ organic farming techniques or minimise chemical use for financial, environmental or other reasons. Therefore differentiating the two farming methods for comparison can be difficult.

Despite restrictions, rare cases of contamination of organic produce with ‘non-allowed’ residues have been reported (McGowan 2003). This may occur due to historical use or current use on neighbouring farms resulting in contamination of soil, groundwater or irrigation water; spray drift; percolation through soil on sloping fields; unauthorised use; or due to inadvertent contamination during transport, processing and storage (Magkos et al. 2006). Regulatory authorities such as the Australian Quarantine and Inspection Service recognise that it is virtually impossible to guarantee ‘product claims’ acknowledging that ‘non-allowed’ residues may occur and therefore permit certified organic produce to contain up to 10% of the Maximum Residue Levels (MRLs) and still be sold on the export market as ‘organic’ (AQIS 2008). Many certifying bodies however, have lower tolerance levels and may withdraw certification if certain residues are detected.

Whether chemical residues are detectable on produce at the point of sale and consumption will depend upon: the amount and how often it was applied; the persistence of the chemical; how long prior to harvest it was used; whether the plant consumed received direct application of the chemical (e.g. leafy greens); the addition of post-harvest treatments (e.g. fungicides); the fat content of the food; and food preparation techniques (washing, peeling and cooking) (Rumbold 2008). Furthermore the ‘lower limits of detection’ (LOD) used by laboratories assessing residues may vary and in some cases may be higher than the MRLs set by international regulatory bodies (Reichstein 2009). Therefore the use of chemicals in conventional farming does not always result in ‘detectable’ residues.

Residue Surveys

Residue surveys of agricultural and veterinary chemicals and environmental contaminants in food commodities are conducted in many countries to assess compliance with regulations and provide quality assurance to export markets. Organic produce is not always differentiated for analytical purposes, but where it is, studies consistently show that organically farmed produce contains lower levels of contaminants than conventional produce (McGowan 2003, Tasiopoulou et al. 2007, Baker et al. 2002).

In New Zealand chemical residue surveys have not identified any specific concerns relating to organic food products (NZFSA, 2009). In Australia results collected from the National Residue Survey (NRS) and Victorian Produce Monitoring Program (VPMP) suggest that maximum residue levels (MRLs) for individual toxicants are rarely exceeded (<1%) even in conventional produce. Moreover Australian research has confirmed that organically-certified produce has even fewer pesticide residues than conventional food crops (McGowan 2003).

In a 2003 technical report to the Department of Primary Industries (DPI) 100% of 300 organic samples tested fell below the MRLs, 99.4% of which recorded no detectable residues for any of the 45 pesticides assessed. These included organophosphates, organochlorines, synthetic pyrethroids and others such as Atrazine and Carbaryl. Only two samples recorded any detectable pesticide residues. Dieldrin (~50% of the MRL) was reported in a sample of organic rockmelon most likely due to historical use in an old orchard on the property.
and iprodione (<2% of the MRL) was detected in a sample of apples likely due to contamination of a wooden crate that had previously stored conventional produce (McGowan 2003).

International studies have similarly reported higher levels of contaminants in conventional compared to organic plant produce. An Italian residue survey reported 10-fold greater contamination in conventional (27%) compared to organic products (2.6%) with multiple residues reported in 8.8% of conventional and only 0.8% of organic samples (Tasiopoulou et al. 2007). US data shows organically grown foods consistently record about one-third as many residues as conventionally grown foods, with multiple pesticide residues reported in 26.7% of conventional and 2.6% of organic samples (Baker et al. 2002). Recent comparative data is more difficult to obtain in Australia where the NRS is conducted with the funding and direction of industry bodies and organic produce is not differentiated in reports (Reichstein 2009).

While it can be assumed that organic food of animal origin contains fewer chemical and veterinary drug residues than conventional products, adequate research to support this assumption is currently lacking (Magkos et al. 2006). The NRS in Australia tests some residues in animal products however organic produce is not differentiated in the results.

Health Effects of Organic and Conventional Diets

As previously discussed there is some evidence to suggest detrimental health effects from certain agricultural contaminants and data from residue surveys to confirm higher levels of these toxicants in conventional compared to organic produce. It would seem reasonable to assume therefore that consumers of conventional produce are exposed to and accumulate higher levels of these toxicants and are thus at greater risk of associated health problems. Direct evidence to support this assumption however is currently lacking. Little is known about whether and to what extent agricultural toxicants accumulate in the human body and whether ‘normal’ exposure results in any health risks.

Designing high quality, large scale, long-term randomised controlled trials to compare the physiological and clinical effects of ingesting conventional and organic produce is not feasible for ethical and practical reasons. As a result studies comparing the effects of organic and conventional diets on toxicant levels or health-related biomarkers would provide some evidence of a plausible link. At present there are few such studies in either animals or humans. The studies that have been performed along with the difficulties in assessing the potential health effects of toxicant exposure are discussed below.

Animal studies

A number of studies have reported on animal health in organic and conventional farming systems. While an early review reported better growth and reproduction in animals fed organically grown feed (Worthington 1998) it has been suggested that older studies may not be relevant to modern farming practices (Lauridsen et al. 2008).

Feeding studies in rats suggest improvements in some health-related biomarkers for rats fed fertiliser and pesticide free diets (e.g. higher serum IgG concentrations; 14% less adipose tissue; less daytime activity suggestive of more uninterrupted sleep; and shorter half-oxidation time indicative of better hepatic metabolic activity) (Lauridsen et al. 2008) and an increase in immunotoxicity from the consumption of conventional wheat (Fin amore et al. 2004). In pigs, immune responses were similar but stress resistance at slaughter was improved in organic animals (Millet et al. 2005).

A 2003 review of comparative studies in the peer reviewed literature regarding animal health in organic systems drew a cautious conclusion ‘that parasite problems tend to be worse but other health traits tend to be the same or better in organic farming compared with conventional’ (Lund & Algers 2003, p 55).

Unfortunately, differences in organic regulations, changes in organic farming practices overtime and the lack of relevance of animal models impairs the application of findings to human consumers of organic food.

Human Data

While the self-reported health and well-being status of farm (field and pack-house) workers in the UK has been shown to be poorer than national norms, there do not appear to be any significant differences between those working on conventional and organic farms (Cross et al. 2008). One exception was that organic farm workers were happier than their counterparts, based on the Short Depression Happiness Scale (SDHS). Multiple regression analysis suggested that the difference was primarily due to an increase in the variety of tasks performed by this group. While this study reported on occupational exposure it did not assess dietary exposure via an organic or conventional diet.

To date few published studies (Lu et al. 2009, Lu et al. 2008, Curl et al. 2003) have directly assessed whether consuming organically-certified produce results in a reduction in pesticide exposure in humans. A recent study of children in Seattle USA demonstrated that substituting organic fresh fruits and vegetables for corresponding conventional food items for a 5-day period, resulted in a reduction in the median urinary
metabolite concentrations of malathion and chlorpyrifos (organophosphates) to non-detectable levels (Lu et al. 2008). The same research group has also reported a 50% reduction in synthetic pyrethroid insecticides under the same trial conditions, however due to widespread residential use the dietary intervention was not sufficient to lower exposure to non-detectable levels (Lu et al. 2009). A previous study conducted in the same area had assessed pesticide (organophosphate) levels in the urine of pre-school children and determined that “consumption of organic fruits, vegetables and juice can reduce children’s exposure levels from above to below the U.S. Environmental Protection Agency’s current guidelines, thereby shifting exposures from a range of uncertain risk to negligible risk” (Curl et al. 2003, p 377).

Children are particularly vulnerable to the toxic effects of chemicals for a number of reasons; they exhibit more hand to mouth behaviour, they eat and drink more per kilogram of bodyweight than adults, their skin is more permeable and their livers do not metabolise chemicals as efficiently (Sanborn et al. 2004). However, levels of POPs such as organochlorines are known to increase with age and exposure suggesting bioaccumulation in tissues (Jandacek & Tso 2007, Nickerson 2006) which may suggest increased levels of certain toxicants in adults. As a result it is not currently known whether findings in child studies can be extended to adult populations.

**Difficulties in assessing the health risks of toxicants**

While biological reasoning would suggest that reducing the intake of agricultural toxicants (via an organic diet) would result in reduced exposure and therefore reduce health risks, other factors need to be considered. All humans are exposed to environmental toxicants whether they be ingested from food sources, inhaled from polluted air or absorbed through the skin. The effects of these toxicants may be immediate or latent or only evident during certain developmental stages.

Although safety assessments of toxicants are conducted by government bodies it should be noted that adherence to residue standards does not guarantee food safety. While regulations are set for individual toxicants, humans are exposed to multiple chemicals through multiple routes and single chemicals with relatively low toxicity may combine to act additively or synergistically. A dose-response relationship has been demonstrated in studies that have analysed exposure to multiple rather than single pesticides (Bassil et al. 2007), suggesting that it is not the isolated acute exposure to individual toxicants but is greatest concern but rather the combined and cumulative effect of multiple toxicants.

Dose addition assumes that the cumulative toxicity of a mixture of chemicals can be predicted from the sum of the toxic potential of each individual chemical (Laetz et al. 2009), however this is not always the case. Mixtures of chemicals may also interact via toxicokinetic (absorption, distribution, metabolism and excretion) or toxicodynamic (binding, interaction and induction of toxicity) processes to produce either antagonistic or synergistic effects (Borgeit et al. 2004). Exposure to multiple chemicals need not necessarily be concurrent in order to produce additive or synergistic effects (Thiruchelvam et al. 2002). Thus estimating the impact of multiple environmental chemicals using studies that examine only single chemicals at high doses and often only in animals, may lead to significant underestimations of effects.

Thorough safety assessment is further compromised by: a lack of human data; gaps in the information for many individual chemicals; poorly understood pathways for chemical interaction; different responses among various species and individuals; a lack of sophisticated statistical tools for analysing complex data; and the vast number of potential combinations of chemicals (Laetz et al. 2009). Determining the separate and/or combined effects of different exposures, and the long latency periods between exposure and development of disease further complicates the issue. A further difficulty in assessing the validity of toxicant studies is a lack of consistency in the biomarkers and methods used by various researchers to determine toxicant levels (Sanborn et al. 2004).

Some individuals and population groups may be more vulnerable to the pathological effects of toxicants than others. For example, pregnant and lactating women require specific consideration to minimise exposure of the foetus or infant during critical periods of development when chemicals (such as pesticides) can interact with genes (epigenetics) turning them off or on at inappropriate times. The effects can persist long after the exposure has gone and increase susceptibility to disease even decades later (Hileman 2009). As previously mentioned children may also be particularly vulnerable due to a proportionately higher intake of toxicants and diminished capacity to detoxify them (Sanborn et al. 2004). Paraoxoase-1 enzyme (PON1) activity, responsible for the detoxification of many pesticides, is impaired in children until at least 7 years of age (Huen et al. 2009). Even in adults, variations in detoxification capacity or entero-hepatic recirculation may allow toxicants to remain or be reabsorbed into the body (Jandacek & Tso 2007). In addition greater fat stores may increase the body’s capacity to accumulate lipophilic contaminants (Schildkraut et al. 1999) and calorie restriction may mobilise stored toxicants allowing them to re-enter the circulation and be deposited in other tissues such as the brain (Jandacek et al. 2004). Genetic weaknesses and exposure to multiple chemicals may further contribute to the likelihood of adverse health effects.
Conclusion

Over the past 60 years both the number of agricultural toxicants in the environment and rates of toxin-related diseases have increased dramatically, and countless studies have been published suggesting a link between toxicants and health risks. As a result an increasing number of consumers are choosing to pay a price premium for organic food in the belief that it will reduce their exposure to agricultural toxicants and in turn reduce associated health risks. Health authorities currently maintain that there is 'no conclusive evidence to suggest that organic food in general is more or less safe or nutritious than conventionally produced foods'. While there is some evidence to suggest health risks from certain agricultural toxicants and data from residue surveys to confirm higher levels of these toxicants in conventional compared to organic produce, the significance of this for human dietary exposure is uncertain. To date only three published reports have directly assessed whether consuming organically farmed produce results in a reduction in the levels of pesticides (or other agricultural toxicants) in humans. While biological reasoning would suggest that reducing the intake of agricultural toxicants (via an organic diet) would result in reduced exposure and therefore reduced health risks, other factors need to be considered, and more research is required. Future research needs to confirm whether and to what extent agricultural toxicant levels vary between organic and conventional consumers before attempting to draw any conclusions about the potential health implications of such differences.

Acknowledgments

The authors would like to thank Dr Lesley Braun (Alfred Hospital, Melbourne).

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