Development of a proxy response instrument to measure the physical activity behaviours of adults with an intellectual disability

by

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

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DECLARATION

I 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; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

Kerrie Lante
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THESIS SUMMARY

The research thesis includes four independent but related studies. The primary aim of the research was to develop a tool to measure the physical activity behaviour of adults with an intellectual disability (AWID). As part of the thesis, related studies investigated the energy expended of adults with and without an intellectual disability during common activities of daily living (ADL) as well as the validity of energy expenditure values derived through use of the Caltrac® accelerometer with adults with and without an intellectual disability.

Study one described in Chapter 3 investigated the energy cost of seven ADL commonly engaged in by AWID and established if the MET values reported in the Compendium of Physical Activities are accurate for use with this population. Thirty AWID (n = 20 males, n = 10 females) and 15 age, weight and gender matched adults without an intellectual disability (AWOID) (n = 6 males, n = 9 females) completed seven ADL; sitting quietly (SitQ), sitting watching television (SitTV), sitting assembly task (SitAT), standing assembly task (StaAT), walking at 3.0 km/hr (WalkS), 6.0 km/hr (WalkQ), 9.0 km/hr (WalkF). Participants undertook each activity for 10 minutes in a laboratory based setting with expired air being analysed for carbon dioxide (CO₂), oxygen (O₂) and volume expired, through the use of a calibrated MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA). Findings suggested that the MET values reported in the Compendium of Physical Activities may not be accurate for use with AWID.

The second study described in Chapter 4 investigated the relationship between energy expenditure values derived from indirect calorimetry and values derived from Caltrac® accelerometer for AWID undertaking ADL. Following the protocol outlined above participants completed the seven ADL while wearing a Caltrac® accelerometer. Energy expenditure values derived from the MedGraphics Metabolic Measurement Cart were compared to energy expenditure values derived from the Caltrac® accelerometer. Findings question the validity of the Caltrac® accelerometer as a measure of energy expenditure for AWID or AWOID.

The third study, outlined in Chapter 5, explored the validity of the Caltrac® accelerometer among adult men and women with and without an intellectual disability in the seven ADL outlined in study one and two. Metabolic equivalent (MET) values derived from the Caltrac®
accelerometer were compared to the values reported in the Compendium of Physical Activities. Findings demonstrated, that despite significant differences and underestimation of the energy expended by AWID, MET values derived from the Caltrac® accelerometer for the ADL that required less effort fall within the light activity intensity classification as outlined in the Compendium of Physical Activities. Results indicated that for AWID and AWOID the validity of the Caltrac® accelerometer decreased as the intensity of the ADL increased.

The study outlined in Chapter 6 describes the development of the IPAQ-ID, a telephone proxy response instrument to measure the physical activity behaviours of AWID. To assess the measurement properties of the IPAQ-ID, forty-five AWID (n = 19 males, n = 26 females) residing at home with family members or in a community based group home in the Northern and Western metropolitan regions of Melbourne, Australia wore a accelerometer for seven consecutive days. In the week following, proxy-respondents from both the AWID home and day agency environment completed the IPAQ-ID. The IPAQ-ID was found to have good measurement properties with reliability and validity testing indicating that the IPAQ-ID is suitable for use as a common surveillance tool by researchers to collect data on the physical activity behaviours of AWID.

Collectively, these results make a unique contribution to the body of knowledge relating to the measurement of physical activity of AWID. Results indicating differences in energy expended between adults with and without an intellectual disability, as discussed in Chapters 3, 4 and 5 are important for researchers in attempts to validate physical activity measurement tools for AWID. The development of the IPAQ-ID will enable researchers to collect accurate information on the physical activity of AWID. Data obtained from the IPAQ-ID can be used to enhance intervention efforts and provide valuable information required to evaluate physical activity campaigns among AWID.
CHAPTER 1

INTRODUCTION

1.1 Intellectual Disability

Within Australia there is diversity in the underlying concepts, definitions and classifications of intellectual disability (Wen, 1997). The Intellectually Disabled Persons’ Services Act 1986 (Government Printer, 1991) offers the following definition; ‘intellectual disability in relation to a person over the age of 5 years means a significant sub-average general intellectual functioning existing concurrently with deficits in adaptive behaviour and manifested during the developmental period’ (p.3). A communiqué from the Victorian Government Department of Human Services indicates that the Intellectually Disabled Persons’ Services Act 1986 provides a legal definition of intellectual disability. To aid understanding of the definition the communiqué reported that a person is determine as having an intellectual disability if they have a significantly below average intelligence (an intelligence quotient of 70 or below) and difficulties with everyday life skills including personal skills, such as the ability to dress without assistance or clearly express thoughts at the same level of ability as same aged peers. These two factors need to have been assessed or be prevalent during the developmental period before a person turns 18 years of age (Department of Human Services, n.d.).

Intellectual disability is associated with various diseases or conditions (Australian Institute of Health and Welfare, 2003). Statistics from the 2003 Australian Bureau of Statistics Survey of Disability, Ageing and Carers indicated that 20% of Australians have a disability (Australian Bureau of Statistics, 2004). It is estimated that within Victoria approximately 40, 000 Victorians or 1% of the population have an intellectual disability (Department of Human Services, n.d.). As a result of de-institutionalisation many adults with a mild to moderate intellectual disability are more likely to live in a community based setting, with many adults with an intellectual disability (AWID) residing in a community residential unit (CRU) (Draheim, Williams, & McCubbin, 2002), a group home that accommodates up to six people supported by one or two staff (Sparrow & Sharp, 1991). Within this setting AWID are provided with less direct supervision, allowing for greater personal choice in areas including engagement in leisure time physical activity.
1.2 Physical Activity, Health and Intellectual Disability

Comparatively little direct evidence is available regarding the physical activity behaviour of adults with an intellectual disability (AWID). The lack of evidence on the physical activity of AWID is in part attributed to methodological challenges in working with AWID (Temple, Frey, & Stanish, 2006). A very small number of studies have used direct measures of physical activity to evaluate the intensity level of physical activity, physical activity counts per minute or daily steps among participants. Indirect information obtained from investigations into the health of AWID have also been used to make conclusions on the physical activity behaviours of AWID.

Evidence comparing the extant data between the physical activity behaviour of AWID and the general population has indicated that AWID are less active (Beange, McElduff, & Baker, 1995; Frey, 2004; Temple & Walkley, 2003; Wells, Turner, Martin, & Roy, 1997). Advances in health care and medical technology means the general population are living longer, thus it is likely that AWID will also have an increased life expectancy (Fisher, 2004). An increase in life expectancy brings with it an increased susceptibility to lifestyle influenced age related health conditions of which physical activity is an essential component in reducing this risk (Blair & Church, 2004; Walsh, Heller, Schupf, & Van Schroenstein Lantman-de Valk, 2003).

High rates of health problems are reported in AWID. It has been demonstrated that AWID have an elevated risk factor of coronary heart disease and stroke, and elevated rates of obesity (Krahn, Hammond, & Turner, 2006). Significantly increased cardiovascular risk factors and mortality have been found among AWID in comparison to the general population (Beange, McElduff, & Baker, 1995). Despite the existence of elevated risk factors among AWID, little information is available in relation to the physical activity behaviours of AWID, limiting the ability of investigators to determine the risk of chronic diseases that may be attributed to physical inactivity (Draheim, Williams, & McCubbin, 2002).

1.3 Measurement of Physical Activity among Adults With an Intellectual Disability

Various techniques have been developed to measure the physical activity behaviour of population sub-groups. Measurement may occur through indirect self-report measures (diaries, logs, recall survey, telephone survey) or by means of direct monitoring (observation, motion sensors). Direct monitoring techniques provide the most accurate data yet are time consuming,
costly and often not appropriate in population-based research. In comparison, indirect self-report measures are time and cost efficient but the accuracy of the data is highly variable.

Physical activity recall questionnaires are commonly used to assess population physical activity. The acquiescence and comprehension of AWID make the use of recall questionnaires with AWID difficult (Finlay & Lyons, 2001). To enable information to be obtained on the physical activity behaviours of AWID researchers have utilised a third person that knows and responds on behalf of the AWID. However, the measurement tools and procedures used in these investigations have not been shown to be either valid or reliable when used with AWID (Temple, Frey, & Stanish, 2006).

To date, accurate, precise, reproducible and inexpensive measures are not available to establish the physical activity levels of AWID (Stanish, Temple, & Frey, 2006). The absence of a valid, reliable and low cost instrument to accurately measure the physical activity behaviour of AWID has greatly impeded this aspect of health promotion to this group. Gaining accurate knowledge on physical activity behaviours of AWID will allow the collection of evidence that can be used to inform government and non-government agencies about the participation of AWID in physical activity. In turn, this will assist in influencing the decisions of policy makers and resource allocation related to health promotion through physical activity. Additionally, data obtained from such instrumentation could be used to inform intervention efforts and evaluate health-related campaigns (Timperio & Salmon, 2003).

The World Health Organization (WHO) and the WHO Collaborating centre for physical activity and health promotion have combined to develop a standard set of physical activity questions known as the International Physical Activity Questionnaire (IPAQ). The IPAQ was designed as a universal, standard tool for collection of information on population physical activity (International Physical Activity Questionnaire, n.d.-a). However, the questionnaire is developed from research using adults without a disability (AWOID) and without further validation and reliability evidence, it would be inappropriate to use this instrument with AWID.

1.4 Use of Proxy-respondents with Adults With an Intellectual Disability

Researchers have attempted to use proxy-respondents as a means through which information can be collected about a person when that person is unable to respond personally. Parents and
caregivers of AWID are often used to assist an AWID with daily decision making and in other circumstances where an AWID is deemed to lack the capacity (Keywood, 2003).

Investigation into the reliability and validity of proxy responses has received little scientific attention. Various factors including the number of years known, frequency of contact and if the participant and proxy-respondent have resided together are suspected of being able to influence levels of agreement between a proxy-respondent report and participant (Cusick, Brooks, & Whiteneck, 2001). Evidence does suggest that levels of agreement between a proxy-respondent and participant are greater for directly observable measures in comparison to non-observable measures (Jokovic, Locker, & Guyatt, 2004).

Research into the physical activity behaviours of AWID has had a strong reliance on information provided by proxy-respondents (Draheim, Williams, & McCubbin, 2002; Frey, 2004; Robertson et al., 2000; Stanish & Draheim, 2005; Temple & Walkley, 2003; Temple, Frey, & Stanish, 2006). While a seemingly simple approach, the use of responses from proxy-respondents as an alternate source of information is justifiable only if the accuracy of responses is shown to be high (Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). The methodological quality of physical activity studies that have relied on the use of proxy-respondents are questionable, with limited evidence available on the ability of proxy-respondents to provide accurate or reliable information (Temple, Frey, & Stanish, 2006).

1.5 Aims

The primary aim of this series of studies was to develop a psychometrically sound proxy-respondent measurement tool that could be used by researchers, epidemiologists and public health personnel to gather information on the physical activity behaviours of adults with an intellectual disability (AWID). The assessment of population based physical activity is commonly done through recall questionnaires, and often via telephone. The International Physical Activity Questionnaire (IPAQ) is a recently published tool with good psychometric properties when used as a self-report tool with adults without a disability (AWOID), but no evidence exists as to the validity or reliability of this tool when used by proxy respondents to report on the physical activity behaviour of AWID. Therefore, the objective linked to the primary aim of this research was to determine the validity and reliability of a proxy-respondent modification of the IPAQ.
Given little is known about the energy expenditure characteristics of AWID, nor the accuracy of tools developed for use AWOID when applied to AWID, two secondary aims with associated objectives were set for evaluation through this research. The aims and associated objectives were:

Aim 1: Measure the energy expended by male and female AWID and AWOID during seven common activities of daily living (ADL).

Objective 1: Determine if the energy expenditure, expressed as metabolic equivalent (MET) values, reported in the Compendium of Physical Activities (CPA) for common ADL are accurate for male and female AWID and a matched sample of male and female AWOID.

Aim 2: Assess the accuracy of an objective physical activity measurement tool (accelerometer) for use with male and female AWID.

Objective 2: Determine if the energy expenditure values measured by the Caltrac® accelerometer for seven common ADL are accurate for male and female AWID and a matched sample of male and female AWOID.

1.6 Overview of Study

This thesis begins with a review of the literature followed by reports on the findings of four studies. Chapter 2 examines the literature pertaining to the benefits, measurement and prevalence of physical activity. Although the studies focus is on AWID, the review has been broadened to include a summary of evidence pertaining to AWOID due to limited data on the measurement, health and physical activity behaviours of AWID.

Chapters 3, 4 and 5 explore the energy expended by adults with and without a disability. Chapter 3 explores the energy expenditure of AWID during seven common activities of daily living (ADL). The study also investigates if the metabolic equivalent (MET) values reported in the Compendium of Physical Activities (CPA) are accurate in relation to the seven common ADL for AWID. Chapter 4 discusses the validation of a direct measurement source, the Caltrac® accelerometer, in the seven ADL among AWID and AWOID. This was followed by a study described in Chapter 5 that compared the MET values derived from the Caltrac® accelerometer to the values reported in the CPA. Chapter 6 describes the development of the
International Physical Activity Questionnaire – Intellectual Disability (IPAQ-ID). Findings from the validity and reliability testing of this proxy-respondent questionnaire are discussed within chapter 6. The final chapter presents a general discussion of the findings of the studies and the implications of these findings to inform the development of policy or intervention. Chapter 7 also makes recommendations for future research.
CHAPTER 2

LITERATURE REVIEW

The aim of this chapter is to review the existing literature pertaining to adult physical activity and health, with a specific focus on intellectual disability. The chapter begins with a brief discussion of the health consequences of physical activity, followed by an overview of the evidence on the health of adults with an intellectual disability (AWID). An outline of the National physical activity recommendations for Australian adults, as well as methods used in the assessment of physical activity, follows. Epidemiological evidence from international and Australian studies on the prevalence of physical activity among adults and adults with an intellectual disability is then reviewed. A discussion on the significance of energy expenditure in relation to physical activity follows. The chapter concludes with a discussion on the reliability and use of proxy-respondents among different sub-populations, and where available, literature related to people with an intellectual disability is reviewed.

2.1 Physical Activity and Health

This section provides a brief overview of the contribution of physical activity to health in adults. While the literature provides an abundance of evidence on the importance of physical activity for adults in general, limited evidence is available in relation to the relationship between physical activity and the health of AWID. Therefore, the review has been written to include a summary of the available evidence on the health status of AWID. The section concludes with discussion of the National physical activity recommendations.

2.1.1 Physical and Psychological Health Benefits of Physical Activity

A strong body of evidence provides scientific support for the health benefits of being physically active. The evidence base has been available for a considerable time and has confirmed that regular moderate-intensity physical activity has a health promoting impact on the physical and psychological health of adults (Armstrong, Bauman, & Davies, 2000; Australian Institute of Health and Welfare, 2006; Bauman, Bellew, Vita, Brown, & Owen, 2002; Bauman, Owen, & Rushworth, 1990; National Heart Foundation, 2005; Pate et al., 1995; U.S. Department of Health and Human Services, 1996; Villeneuve, Morrisin, Craig, & Schaubel, 1998). Activities
of moderate-intensity can be defined as activities that result in a noticeable increase in breathing and possible light sweating (Commonwealth Department of Health & Aged Care, 1999). Examples of moderate-intensity activities include brisk walking, vacuuming, washing a car, swimming at a regular pace and climbing stairs. Adults who regularly engage in moderate to vigorous intensity physical activity and/or have higher cardio-respiratory fitness levels have a lower mortality rate compared to people that lead a sedentary lifestyle and/or have lower cardio-respiratory fitness (Warburton, Nicol, & Bredin, 2006).

Developing good physical activity behaviours makes an important contribution to maintaining appropriate body weight, strength, flexibility, the health of joints, protection against the development of osteoporosis and some cancers and assist in reducing the risk of diabetes and associated long-term complications (Australian Institute of Health and Welfare, 2004a; Bauman, Bellew, Vita, Brown, & Owen, 2002; Brill, Macera, Davis, Blair, & Gordon, 2000; Lotan, Merrick., & Carmeli, 2005). Such complications include an increased risk of heart attack, stroke, blindness and kidney problems. Psychologically, a lifestyle that includes regular physical activity can reduce symptoms of stress, anxiety, depression and mental health and well-being (Centers for Disease Control and Prevention, 2006). Benefits are also gained through an increase in self-esteem, social skills and improvement in quality of life (Hassmen, Koivula, & Uutela, 2000; Laforge et al., 1999).

Participation in physical activity has been shown to be effective in the secondary prevention of cardiovascular diseases (CVD) (Warburton, Nicol, & Bredin, 2006). CVD is a leading cause of death throughout industrialised countries (Leon & Norstrom, 1995) and is one of Australia’s greatest health problems. In 2002, the recorded number of deaths in Australia caused by CVD reached 50,294 (National Heart Foundation, 2005). The development of CVD risk factors including high blood pressure and obesity can be delayed or prevented by regular participation in physical activity (Centers for Disease Control and Prevention, 1999). Compared to people that engage in regular moderate-intensity or vigorous-intensity physical activity, people who are sedentary display lower levels of physical fitness and have a 150 – 200% increase in the risk of a fatal or non-fatal cardiovascular event, such as coronary heart disease (CHD) (Bauman & Campbell, 2001). A 24-year follow up study examining the association between body-mass index and physical activity with death among middle aged women (n = 116,564) found a doubling of cardiovascular related mortality in women who engaged in less than an hour of exercise per week (Hu et al., 2004). It has been reported that the greatest CVD benefit occurred
for people who discontinued their sedentary behaviour and became physically active, with those who participate in regular moderate intensity physical activity gaining the greatest benefit (Blair et al., 1995; Kushi et al., 1997).

Another major health issue related to low levels of physical activity is overweight and obesity. Globally, overweight and obesity is a major public health problem, a problem held up as requiring urgent intervention (Australian Institute of Health and Welfare & National Heart Foundation of Australia, 2004; Bjorntorp, 1997; Bundred, Kitchiner, & Buchan, 2001; Flegal, Carrol, Kuczmarski, & Johnson, 1998; Lindstrom, Isacasson, & Merlo, 2003; Nammi, Koka, Chinnala, & Boini, 2004; Sahota et al., 2001; Segal, Carter, & Zimmet, 1994; Tremblay & Willms, 2003). Overweight and obesity is associated with many diseases and health risk factors including CVD, diabetes and hypertension (Marshall, McConkey, & Moore, 2003). Some of these risk factors are reported to have substantial morbidity and mortality implications (Australian Institute of Health and Welfare, 2004a; Bundred, Kitchiner, & Buchan, 2001). Cardiovascular diseases including hypertension and CHD, respiratory diseases, musculoskeletal problems and metabolic disorders such as diabetes mellitus are all known consequences of obesity (Australian Institute of Health and Welfare, Dixon, & Waters, 2003; Nammi, Koka, Chinnala, & Boini, 2004). The Australian Diabetes, Obesity and Lifestyle Study (AusDiab), a cross-sectional study completed with Australian adults (25+ years) between May 1999 and December 2000, provides estimates on the prevalence of obesity in Australia. Approximately 60% of adults were found to be overweight (39%) or obese (20.8%) (Australian Institute of Health and Welfare & National Heart Foundation of Australia, 2004; Cameron et al., 2003). In comparison 20% of Australian children and adolescents were reported to be overweight and 5% obese (Australian Institute of Health and Welfare, 2004b).

An increase in overweight and obesity has occurred alongside changes in our environment, lifestyle habits and physical activity behaviours. A reduction in physical activity can be associated with an ever increasing dependence on labour saving devices, resulting from continual advancements in technology. Data collected between 2000 and 2002 from 10,878 residents of Atlanta, United States of America explored the relationship between obesity and travel patterns (Frank, Andresen, & Schmid, 2004). Investigators found a 6% increase in the likelihood of obesity for each additional hour spent in a car per day. Conversely, a 4.8% reduction in the likelihood of obesity was associated with each additional kilometre walked per
day. An increase in consumption of energy dense foods and a reduction in physical activity behaviors have played a significant role in levels of overweight and obesity.

Physical activity also has an important role in the prevention and treatment of type 2 diabetes (Bauman, Bellew, Vita, Brown, & Owen, 2002; Centers for Disease Control and Prevention, 1999). Participation in activity may improve glucose metabolism and increase insulin sensitivity (Bauman, Bellew, Vita, Brown, & Owen, 2002). The Finnish Diabetes Prevention study, a randomized trial involving 522 middle aged adults, reported that lifestyle interventions focusing on physical activity and diet reduced the risk of type 2 diabetes by 58% (Tuomilehto et al., 2001). Eligible participants who were overweight (BMI = 25), 40 to 65 years old, had an impaired glucose tolerance and who were not diagnosed with type 2 diabetes were allocated to a control or intervention group. Investigators provided the intervention group with detailed advice on nutrition and on increasing physical activity to improve aerobic capacity and cardio-respiratory fitness. Participants were also offered individual resistance training sessions. The authors concluded that a reduced incidence of diabetes among the intervention groups in comparison to the control group was directly associated with participants changes in lifestyle. These findings are supported by previous studies that have reported that engagement in an adequate amount of weekly physical activity reduced the incidence of type 2 diabetes (Manson & Spelsberg, 1994; Manson et al., 1992).

Participation in physical activity is important for the maintenance of bone health (Bauman, Bellew, Vita, Brown, & Owen, 2002; Centers for Disease Control and Prevention, 1999). Osteoporosis, a disease characterised by low bone mass and deterioration of bone tissue can lead to an increase in susceptibility to fractures (National Osteoporosis Foundation). Osteoporosis has become a growing public health concern, affecting 10 million people in the United States of America, with many more reported to be at risk (Tucci, 2006). Investigators report a lower incidence of hip fractures among people that engage in physical activity, including weight bearing activities (Bauman, Bellew, Vita, Brown, & Owen, 2002; Warburton, Nicol, & Bredin, 2006). A 21 year study of 3262 healthy men found the risk of hip fracture decreased with increasing physical activity (Kujala, Kario, Kannus, Sarna, & Koskenvuo, 2000). Baseline physical activity data, collected through a series of structured questions, revealed that compared to participants engaged in sedentary behaviours, participants that engaged in at least moderate levels of physical activity reduced the risk of hip fracture. It was reported that the greater the intensity of physical activity engaged in, the greater the reduction in
risk of hip fracture (Kujala, Kaprio, Kannus, Sarna, & Koskenvuo, 2000). Regular involvement in physical activity is an effective secondary strategy in maintaining bone health and preventing osteoporosis (Warburton, Nicol, & Bredin, 2006).

Evidence suggests that involvement in physical activity is associated with a decreased risk of some forms of cancer (Armstrong, Bauman, & Davies, 2000). A clear and consistent dose-response relationship has been reported between physical activity and colon cancer (Colditz, Cannuscio, & Frazier, 1997). It is believed that among Australians inactivity causes approximately one-fifth of all incidences of colon cancer (Bauman, Bellew, Vita, Brown, & Owen, 2002). A review of epidemiological studies examining the relationship between physical activity and the incidence of cancer found that men and women who had been physically active had reduced the risk of colon cancer in the order of 30 – 40% in comparison to people who were inactive (Lee, 2003). The author also found evidence of a 20 – 30% reduction in the risk of breast cancer among physically active women.

Results surrounding the relationship between physical activity and the risk of ovarian cancer are inconclusive (Patel, Rodriguez, Pavluck, Thun, & Eugenia, 2006). Case control studies have found that higher levels of total physical activity are associated with a lower risk of ovarian cancer (Monson & Christiani, 1997; Rossouw et al., 2002) however other observational studies report no association (Angell, 1990; Collaborative Group on Hormonal Factors in Breast Cancer, 1997). In contrast, three cohort studies reported no association between levels of total physical activity and ovarian cancer risk (Byers et al., 1999; Colditz, DeJong, Hunter, Trichopoulos, & Willett, 1996; Willett, Colditz, & Mueller, 1996). Patel and colleagues (2006) investigated levels of recreational physical activity, sedentary behaviour and ovarian cancer risk among 59,695 postmenopausal women (mean age = 62.7 years). Information was collected on baseline physical activity and sedentary behaviour through questions including, “during the last year, what was the average time per week you spent at the following kinds of activities …..” and, “during the past year, on an average day (not counting time spent at your job) how many hours per day did you spend …..” The authors report that engagement in light and moderate physical activity did not have a major role in the risk of ovarian cancer however an association between duration (6+ hours) of sedentary behaviour, including watching television and reading, and risk of ovarian cancer was reported.

A positive relationship has been reported between physical activity and feelings of wellness and mental health (Bauman, Bellew, Vita, Brown, & Owen, 2002; Simonsick, 1991). Studies have
found that being physically active assists in relieving symptoms of depression, anxiety and stress (Glenister, 1996; Hassmen, Koivula, & Uutela, 2000; Paluska & Schwenk, 2000). Improvements in quality of life, self-esteem and social skills have all been associated with high levels of participation in physical activity (Evans & Roberts, 1987; Hassmen, Koivula, & Uutela, 2000; Maxwell & Tucker, 1992). It has been suggested that mental and psychosocial health benefits of physical activity are a result of a combination of participation in activity and the social aspects that can accompany the activity (Armstrong, Bauman, & Davies, 2000). The relationship between engagement in physical activity and psychological factors including depression, anger, distrust and stress was explored among 3397 Finnish adults aged 25 - 64 years (Hassmen, Koivula, & Uutela, 2000). Participants self-completed questionnaires exploring the frequency and intensity of physical activity engaged in, as well as the Beck Depression Inventory, State-Trait Anger Scale, Cynical Distrust Scale and the Sense of Coherence Inventory. Hassmen and colleagues (2000) found that in comparison to participants that engaged in physical activity irregularly, participants that were physically active at least two to three times a week for at least 20 – 30 minutes on each occasion experienced less depression, anger, cynical distrust and stress.

As reviewed in this section evidence on the importance and benefits of participation in physical activity for adults, including the prevention of cardiovascular disease, weight control, diabetes prevention and control, bone health and psychological health, is consistently highlighted in the literature (Bauman, Bellew, Vita, Brown, & Owen, 2002; Centers for Disease Control and Prevention, 2006; Lotan, Merrick., & Carmeli, 2005; Marshall, McConkey, & Moore, 2003; National Heart Foundation, 2005; Paluska & Schwenk, 2000; Warburton, Nicol, & Bredin, 2006). In comparison, the significance of participation in physical activity for AWID has not been investigated in depth (Walsh, Heller, Schupf, & Van Schroenstei Lantman-de Valk, 2003). However, a more extensive body of evidence does exist in relation to the health status of AWID.

### 2.2 Health Status of Adults With an Intellectual Disability

Over the past decade concerns regarding the mortality and morbidity of AWID has increased (Prasher & Janicki, 2002; Sutherland, Couch, & Iacono, 2002; Walsh & Heller, 2002). Despite longevity of AWID increasing, investigators have found that the life expectancy of AWID remains lower than among the general population (Janicki, Dalton, Henderson, & Davidson, 1999; Patja, Iivanainen, Vesala, Oksanen, & Ruoppila, 2000; Strauss, Cable, & Shavelle, 1999).
Researchers report that high rates of undetectable health problems among AWID may be attributable to health practices for the population (Beange, McElduff, & Baker, 1995; Sutherland, Couch, & Iacono, 2002).

Available evidence documents a high rate of health problems among AWID in studies that used proxy-respondents to complete surveys (Krahn, Hammond, & Turner, 2006). Although limited in number, studies indicate AWID demonstrate substandard levels of cardiovascular fitness, high levels of percent body fat, low levels of muscular strength, and with the exception of people with Down syndrome, poor flexibility (Beange, McElduff, & Baker, 1995; Pitetti & Campbell, 1991; Pitetti & Tan, 1991). AWID are more susceptible to being obese (Draheim, 2006), have a greater incidence of chronic diseases and are reported to have longer and more complicated health related illnesses (Graham & Reid, 2000).

Research has shown the risk for health problems among people with an intellectual disability to be 2.5 times greater than among people without an intellectual disability (Van Schrojenstein Lantman-de Valk., Metsemakers, Haveman, & Crebolder, 2000). Van Schrojenstein Lantman-de Valk and colleagues (2000) accessed the health records of general practitioners in the Netherlands to investigate the health status of 318 AWID in comparison to 48,459 adults without an intellectual disability (AWOID). The investigation revealed that only 12% of AWID had no major health problems in comparison to 21% of AWOID. In respect to weight status, 4% of AWID were found to be overweight compared to 2% of AWOID and 9% of AWID were found to be obese compared to 4% of AWOID. While low levels of obesity and overweight are reported in this Dutch population compared to current reported levels of obesity in western society it is the proportion of AWID to AWOID that is of interest here. A higher prevalence of lower leg fractures were found to have occurred among AWID (5%) in comparison to AWOID (2%). In respect to hypertension Beange and colleagues (1995) reported 9% of female AWID are hypertensive whereas a comparison group of AWOID indicated only 4% of female AWOID had the condition. A greater percentage of males were reported to have hypertension with 12% of male AWID and 9% of male AWOID reported to be hypertensive.

High mortality rates among AWID has been reported to be due to cardiovascular disease, intestinal obstruction, pneumonia and trauma (Patja, Molsa, & Iivanainen, 2001; Shavelle & Strauss, 1999). CVD has been identified as one of the leading causes of death among AWID and account for a greater number of deaths among AWID in comparison to their non-disabled counterparts (Beange, McElduff, & Baker, 1995; Day, Strauss, Shavelle, & Reynolds, 2005;
Hill et al., 2003; Janicki, Dalton, Henderson, & Davidson, 1999). Investigating cause-specific mortality in Finnish children and adults with an intellectual disability (AWID) over a 35 year follow-up study of a nation-wide population (2 - 97 years), Patja and colleagues (2001) found that the most common diseases causing death in AWID were cardiac diseases [i.e. cardiovascular disease], followed by respiratory diseases and neoplasms [i.e. cancer]. Compared to the general population, people less than 40 years of age with an intellectual disability had a higher disease mortality rate (Patja, Molsa, & Iivanainen, 2001). Differences in cause-specific mortality between AWID and the general population faded with advancing age.

The risk of CHD is approximately equal to the risk associated with smoking, hypertension and high cholesterol (Emerson, 2005). A United Kingdom study reports that AWID have a higher incidence of CHD, stroke risk factors and a higher body mass index to that of the general population (Wells, Turner, Martin, & Roy, 1997). With support of the participants general practitioner Wells and colleagues (1997) completed health screenings of 120 AWID. The health screens placed a particular emphasis on family history of CHD and other CHD risk factors. Data was compared with a control group (n = 7469) from the wider population of AWOID. The authors reported that AWID were significantly heavier than the general population of AWOID. No significant difference between AWID and the general population was reported for blood pressure, although 22.5% of AWID were found to be clinically hypertensive. Such risk factors, ever-present amongst AWID, are at least equal to that of the general population (Turner & Moss, 1996).

Obesity, coupled with an absence of physical activity has been identified as a major risk factor to health (Ezzati et al., 2003) and has found to be a prevalent problem among AWID living in community-based residences (Draheim, 2006). Internationally studies have shown that levels of overweight and obesity among AWID are at least as high as their non-disabled counterparts (Draheim, 2006). Studies investigating the prevalence of obesity among AWID in industrialised countries are illustrated Table 1, which has been modified and adapted from Rimmer and Yamaki (2006). Data from a study investigating the effects of a health promotion program for adults with disabilities (n = 306) was used to report on the prevalence of overweight (BMI = 25), obesity (BMI = 30) and extreme obesity (BMI = 40) among participants (Rimmer & Wang, 2005). The sample included 91 AWID of which 64% had Down syndrome. Rimmer and Wang (2005) found that 85% of AWID were overweight. From the 85% of overweight AWID 61% were obese (BMI = 30) and 12% were classified as extremely obese (BMI = 40). Findings were
compared to results obtained for adults without a disability using data obtained from the 1999 – 2000 National Health and Nutrition Examination Survey. The authors reported that prevalence of overweight, obesity and extreme obesity among all people with disabilities in the sample were significantly higher than people without a disability. In comparison, data collected from the existing service records of 1304 participants with an intellectual disability from 2000-2002 in Northern England, found 27% obese (BMI = 30), 28% overweight (BMI 25.1 - 30) and 14% underweight (BMI < 20). Data also indicated females had a higher rate of overweight and obesity than males (Emerson, 2005).

Differences in weight distribution between genders has been explored among 93 Australian AWID (41 female, 52 male) (Moore, McGillivray, & Illingworth, 2004). Participants (aged 18 – 63 years) were from four non-government agencies offering services to AWID in the Southern Region of Victoria, Australia. Height and weight measurements occurred at the AWID residence or at the place they attended during the day. Height was measured with a custom-made 3.5 meter wooden ruler and weight was measured using a set of digital scales. Australian general population data (Catford, 2000) was used to compare AWID data from Moore and colleagues (2004). The authors reported that compared to the general population female AWID were more overweight (AWID 41%, AWOID 29%) and obese (AWID 37%, AWOID 18%). Little variation was seen between male AWID and AWOID in levels of overweight (AWID 31%, AWOID 45%) and obesity (AWID 31%, AWOID 19%).

Some evidence is available that suggests that the incidence of overweight and obesity has increased during the last 20 years (Yamaki, 2005). To establish the weight status of AWID and AWOID Yamaki (2005) extracted data from the American National Health Interview Survey across four single years between 1985 and 2000. The percentage of AWID classified as obese (BMI = 30) increased from 19% between 1985 and 1988 to 35% between 1997 and 2000 (See Table 1). Data on the number of obese AWID, obtained from the 1993 to 1996 and 1997 to 2000 surveys, were found to be significantly higher than the 1985 to 1988 data. Likewise obesity incidence for AWID from 1997 to 2000 was significantly higher than data obtained from the 1989 to 1992 surveys. A steady increase in obesity levels was also observed for AWOID. In comparison to AWOID, the prevalence of obesity among AWID was reported to be significantly higher (Yamaki, 2005).
Table 1: Prevalence of obesity among AWID in industrialised countries*

<table>
<thead>
<tr>
<th>Country</th>
<th>Study</th>
<th>Participants</th>
<th>Obesity (BMI = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Lewis, Lewis, Leake, King, &amp; Lindemann, 2002</td>
<td>Adults (n = 350) with a mild to profound intellectual disability.</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Harris, Rosenberg, Jangda, O'Brien, &amp; Gallagher, 2003</td>
<td>Adults (n = 443) with intellectual disability that participated in the World Winter and Summer Special Olympics games.</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Rimmer &amp; Wang, 2005</td>
<td>Adults (n = 91) with intellectual disability. Adults with Down syndrome (64%).</td>
<td>61% of adults with intellectual disability. 71% of adults with Down syndrome.</td>
</tr>
<tr>
<td>England</td>
<td>Bell &amp; Bbate, 1992</td>
<td>Adults (n = 182) with intellectual disability living with other family members.</td>
<td>19% for males. 35% for females.</td>
</tr>
<tr>
<td></td>
<td>Robertson et al., 2000</td>
<td>Adults (n = 500) with intellectual disability living in residential campuses, dispersed housing, village communities.</td>
<td>13% for males. 24% for females.</td>
</tr>
<tr>
<td>Country</td>
<td>Study</td>
<td>Participants</td>
<td>Obesity (BMI = 30)</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Ireland</td>
<td>Marshall, McConkey, &amp; Moore, 2003</td>
<td>Adults (n = 321) with intellectual disability.</td>
<td>36%</td>
</tr>
<tr>
<td>Australia</td>
<td>Beange, McElduff, &amp; Baker, 1995</td>
<td>Adults (n = 202) (20-49 yrs) with mild (35%), moderate (40%), severe (14%) and profound (11%) intellectual disability residing in institutions (29%) and the community (31% group homes, 40% private accommodation). Adults with Down syndrome (27%).</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Moore, McGillivray, &amp; Illingworth, 2004</td>
<td>Adults (n = 93) with mild (50%), moderate (25%) and severe (25%) intellectual disability residing in community residential units (21%), with parents (44%), fully supported in a cluster cottage, independently (8%) and the environment (27%).</td>
<td>33%</td>
</tr>
<tr>
<td>Germany</td>
<td>Frey &amp; Rimmer, 1995</td>
<td>Adults (n = 105) with intellectual disability in Southwest Germany.</td>
<td>7% adults in institutions, 24% adults living with family.</td>
</tr>
<tr>
<td>Country</td>
<td>Study</td>
<td>Participants</td>
<td>Obesity (BMI = 30)</td>
</tr>
<tr>
<td>----------</td>
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<td>----------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Norway</td>
<td>Hove, 2004</td>
<td>Adults (n = 282) with a mild (39%), moderate (42%) or</td>
<td>19% of adults with an intellectual disability, 45%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>severe (16%) intellectual disability living on the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Western Coast of Norway. Adults with Down syndrome (n = 38)</td>
<td></td>
</tr>
</tbody>
</table>

* Adapted from Rimmer and Yamaki, 2006
An Australian study indicates a higher prevalence of factors associated with poor health outcomes among AWID (Beange, McElduff, & Baker, 1995). Beange and colleagues (1995) investigated the frequency of medical disorders among adults with a mild (35%), moderate (40%) or severe (14%) intellectual disability living in Northern Sydney. Data was compared with data derived from general population health surveys. Prevalence rates indicated AWID were more obese with 16.3% of AWID males found to be obese compared to 8% of AWOID males and 16% of female AWID were found to be obese in comparison to 8% of female AWOID. Similar results were seen in a Norwegian study that found among 282 community living AWID, 15% of men and 25% of women were classified as obese, compared to only 6% for men and 7% for women of the AWOID comparison population at that time (Hove, 2004).

Little information is available concerning the occurrence of diabetes among AWID. One known study investigating the healthcare needs of 1309 children and adults with an intellectual disability provides limited information on the incidence of diabetes among the population (Lin, Wu, & Lee, 2003). Results of a self-completed questionnaire by parents and main caregivers of participants indicated that 39.5% of participants regularly took medication. It was identified that 0.9% of participants took medication due to diabetes however the authors failed to discuss this. Likewise, the authors did not investigate the incidence on un-medicated participants with diabetes.

Osteoporosis is a disease characterised by low bone mass (Center, Beange, & McElduff, 1998). A loss of calcium from the bones can cause them to weaken, increasing the risk of bone fracture (Cummings et al., 1993). In a study of the health status of 1373 AWID, survey results found that 7% of AWID have had a broken bone or fracture in the previous 12 months (Janicki et al., 2002). Although methods of data collection differed, the authors compared some of their data to relevant data from the National Health and Nutrition Evaluation Survey III (NHANES III). It was found that levels of osteoporosis for the two cohorts were similar (Janicki et al., 2002). Other studies report similar findings. A study among 107 community-dwelling AWID found 21% of participants had osteoporosis and 34% were at risk of developing osteoporosis (Tyler, Snyder, & Zyzanski, 2000). A comparison across genders indicated that adults with a mild (59%), moderate (30%) and severe (11%) intellectual disability had significantly lower bone mineral density than age and gender matched AWOID (Center, Beange, & McElduff, 1998). Bone mineral density was measured among 94 AWID (41 males, 53 females) using dual photon absorptiometry. The authors reported that 21% of participants had Down syndrome.
Information on fracture history, medication, exercise and height and weight were obtained from the AWID, their main caregiver or medical records during an examination by an endocrinologist. A comparison of participants with and without Down syndrome found that adults with Down syndrome have a lower bone mineral density.

To determine the risk of osteoporosis (osteopenia) and frequency of osteoporosis among women with an intellectual disability, bone mineral density was investigated and compared to sex and aged matched women without a disability (Foster et al). Dual energy X-ray absorptiometry was used to determine the frequency of osteopenia and osteoporosis across four areas (lumbar spine, femoral neck, ward’s triangle, trochanter) among 35 young community (n = 22) and institution (n = 13) residing women with an intellectual disability (21 - 39 years). The comparison group comprised of 70 premenopausal women without an intellectual disability. Despite results indicating no significant difference between the two groups, approximately one-quarter of women with an intellectual disability were found to have low bone density at the lumbar spine (6%), ward’s triangle (14%) and trochanter (13%) and are therefore at risk of osteoporosis as they age (Foster et al).

Information on the prevalence of cancers among AWID is limited. Patja and colleagues (2001) found that cancer accounted for 4% of deaths in participants (n = 2369) with a profound intellectual disability, 11% in participants with a moderate intellectual disability and 16% in participants with a mild intellectual disability. Results from Janicki and colleagues study (2002) revealed that 3% of female and 1% of male AWID aged between 40 - 49 years, 5% of female and 3% of male AWID aged between 50 - 59 years, 16% of female and 6% of male AWID aged between 60 - 69 years, and 17% of female and 13% of male AWID aged between 70 - 89 years had cancer. The incidence of cancer among this population increased significantly with age and was more likely to occur in females (Janicki et al., 2002).

The psychological health of AWID often goes undiagnosed with behaviours relating to mental health problems among AWID being mistakenly attributed to the individuals intellectual disability (Krahn, Hammond, & Turner, 2006). Notwithstanding this a recent review found that approximately one-third to one-half of participants across studies had been medicated for psychiatric concerns (Krahn, Hammond, & Turner, 2006). An Australia study found that mental health concerns were two to four times more likely in people with an intellectual disability (Torr & Chiu, 2002). Janicki and colleagues (2002) study of American AWID found
that depression, anxiety disorders and behavioural problems occurred in 15-20% of the population.

In comparison to the general population, AWID are at a greater risk of developing health problems. It has been found that AWID are at an increased susceptibility to lifestyle influenced age related health conditions including heart disease, obesity, diabetes, hypertension and osteoporosis (Beange, McElduff, & Baker, 1995; Janicki et al., 2002; Krahn, Hammond, & Turner, 2006; Walsh, Heller, Schupf, & Van Schroenenstein Lantman-de Valk, 2003). Physical activity is an essential component in reducing the risk of these lifestyle associated diseases. To determine if sufficient health promoting physical activity is engaged in it is important to compare data to a baseline standard.

2.3 Physical Activity Guidelines

Physical activity guidelines have been developed to provide guidance on the minimum level of physical activity required to obtain a health benefit (Australian Government. Department of Health and Ageing, 2003). Guidelines allow health and government officials to monitor and ascertain whether population groups are engaging in sufficient health related physical activity. Monitoring assists in identifying groups who are not meeting the guidelines and allows health and government officials to target intervention strategies towards these groups.

Worldwide various physical activity guidelines exist for different sub-populations including adults, the overweight and obese, children, and adolescents (Australian Government. Department of Health and Ageing, 2005). To date, no guidelines exist for people with an intellectual disability. The National guidelines and current recommendations for Australian adults to achieve a health benefit from participation in physical activity are:

1. Every person should accumulate 30 minutes or more of physical activity.

2. Physical activity should be of at least moderate-intensity. Physical activity should occur on most (five or more), preferably every day of the week.

3. Time spent in moderate-intensity activity may occur throughout the day, for example in three, 10-minute bouts or two, 15-minute sessions. It does not need to occur all at once.
4. To be active on a daily basis in as many ways as possible.

(Commonwealth Department of Health & Aged Care, 1999)

The importance of promoting physical activity to AWID and the need for guidelines targeted towards this population has been recognised (Bauman, Bellew, Vita, Brown, & Owen, 2002; Commonwealth Department of Health and Family Services, 1998; Stanish, Temple, & Frey, 2006). Establishing recommendations for AWID will give health professionals a consistent criterion against which to evaluate the prevalence of health promoting behaviours among this group and aid the development of a better understanding of the relationship between AWID physical activity participation and health. However, prior to this being possible there is first the need to be able to accurately measure the prevalence of physical activity among AWID.

2.4 Measurement of Physical Activity

This section provides an overview of different types of physical activity measurement tools. Both indirect and direct physical activity measures are reviewed as well as the advantages and disadvantages of these techniques.

2.4.1 Measurement Tools

Various techniques are used to measure the physical activity behaviour of population sub-groups. Measurement may occur through indirect self-report measures and direct monitoring approaches. Accurate measurement of physical activity is important as it allows for the collection of up-to-date information on population physical activity levels (Sirard & Pate, 2001) which in turn permit researchers to identify groups in need of physical activity intervention, and allow for the planning and assessment of physical activity intervention programs (Timperio & Salmon, 2003).

Traditionally population based physical activity has been measured through the use of recall questionnaires (Sirard & Pate, 2001). For example, self-report and interview administered questionnaires (in person or by telephone), proxy-report recall questionnaires and physical activity diaries. Various recall questionnaires exist. However, the period of recall (i.e. last day, last week, last month) and detail the respondent is asked to provide can differ between questionnaires (Timperio & Salmon, 2003). For instance, some questionnaires ask the respondent to indicate from a specific list of activities the frequency and duration the listed
activity was engaged in, whereas other questionnaires ask the respondent to recall the frequency, duration and/or intensity of all physical activities engaged in for the specified time period.

2.4.2 Indirect Physical Activity Measures

Indirect physical activity measures include physical activity diaries, self-report, interviewer and proxy report questionnaires. In comparison to more direct measures, indirect measures are more subjective in nature and less expensive (Dale, Welk, & Matthews, 2002). These measures require participants to recall and record physical activity behaviour for a given time period and are ideal for use in population based studies (Matthews, 2002). This section will briefly review different types of indirect physical activity measures including self-report and interviewer administered questionnaires, proxy-respondent questionnaires and physical activity diaries.

2.4.2.1 Self-Report and Interviewer Administered Questionnaires.

Self-report and interviewer administered questionnaires commonly require the respondent to recall their physical activity (Timperio & Salmon, 2003). This method is reliant on the participants recall to provide accurate information (Matthews, 2002). National self-report questionnaires are commonly used to assess the physical activity behaviour of the general population.

The reliability and validity of physical activity recall questionnaires have been consistently questioned (Stanish, Temple, & Frey, 2006). Some physical activity questionnaires have however demonstrated psychometrically sound properties (Jacobs, Ainsworth, Hartman, & Leon, 1993). An American study explored the validity and reliability of 10 commonly used physical activity questionnaires (Jacobs, Ainsworth, Hartman, & Leon, 1993). Overall, questionnaires related to performance of heavy intensity physical activity and treadmill performance. A smaller number of questionnaires related to performance of light-intensity or moderate-intensity physical activity. In completing questionnaires respondents tended to overestimate physical activity and underestimate sedentary activities engaged in (Klesges et al., 1990). The failure of questionnaires to capture the lower end of physical activity intensity is a major criticism (Tudor-Locke & Myers, 2001). The desire for respondents to provide socially acceptable answers and/or not being able to accurately remember their physical activity for the recall period may explain this trend (Timperio & Salmon, 2003).
The accuracy of physical activity recall questionnaires is dependent on various factors. For example, responses are dependent on an individual's understanding of physical activity, the complexity of physical activity addressed, subjectivity of the questions, memory or recall errors, conscious misrepresentation or social desirability (Dishman, Oldenburg, O'Neal, & Shephard, 1998; Sirard & Pate, 2001). The use of an interviewer as opposed to self-report has been reported to improve results however it may introduce an additional bias (Sirard & Pate, 2001).

Difficulties with recall questionnaires are enhanced when attempting to investigate the physical activity of AWID (Stanish, Temple, & Frey, 2006). It has been reported that almost all AWID are unable to accurately self-report their physical activity behaviour (Temple, Anderson, & Walkley, 2000). The acquiescence and comprehension of AWID is a major limitation in obtaining self-report physical activity data among this population (Finlay & Lyons, 2001). Notwithstanding the above mentioned issues physical activity recall questionnaires are commonly used among AWID. They are an inexpensive measurement tool that enables physical activity to be assessed among a large populous without altering the behaviour under study (Sirard & Pate, 2001). Recall questionnaires are an important tool that enable researchers to obtain detailed information on the frequency, duration and intensity of the respondent’s physical activity in a socially acceptable manner (Stanish, Temple, & Frey, 2006).

Data obtained from population based studies using self-report techniques are used to aid the allocation of funding for physical activity research, programs and interventions (Sirard & Pate, 2001). Caution must be taken in interpreting and comparing results of studies as questionnaires assess various aspects of physical activity. For instance, many questionnaires assess only leisure time physical activity (Brown, Ringuet, Trost, & Jenkins, 2001). This can result in a misclassification of individuals that have limited leisure time physical activity opportunities, but engage in physical activity through other means, including caring for children, paid or voluntary work (Brown, Ringuet, Trost, & Jenkins, 2001).

A questionnaire developed in 1996 - the International Physical Activity Questionnaire (IPAQ) addresses this issue. The IPAQ was designed to provide a standardised instrument to assess and monitor national and international estimates of population physical activity (International Physical Activity Questionnaire, n.d.-a). A lack of availability of various instruments has not allowed questionnaires to be compared globally because they use different terms, define aspects of physical activity differently, questions focus on different settings in which physical activity
occurs and data collection between instruments vary (International Physical Activity Questionnaire, n.d.-a).

Eight draft versions of the IPAQ have been developed including four long and four short telephone interview and self-administered versions. The IPAQ short versions are designed to obtain information on the amount of time spent in vigorous, moderate and sedentary activities as well as walking. The IPAQ long versions are designed to provide information on areas of household and yard work, occupational activity, transport for activity and leisure time physical activities. The IPAQ short versions are suitable for the purpose of national and regional surveillance, whereas the IPAQ long versions are more appropriate for research work and evaluation purposes (Craig et al., 2003).

The measurement properties of the IPAQ are equal in accuracy to other established self-report physical activity measurement tools. Evidence as to the reliability and validity of the IPAQ was established through a series of studies (Craig et al., 2003). Approximately 2,450 males and females (age 24 – 49 years) across six continents (12 countries) participated in studies to investigate the test-retest reliability, and the criterion and concurrent validity using standardised methods and protocols. The reliability study occurred over a 3-7 day period. Very good repeatability was found for the long versions of the IPAQ, with Spearman correlation coefficients ranging from 0.46 to 0.96 (with most around 0.8). The reliability of the short IPAQ versions was found to be acceptable, with Spearman correlation coefficients ranging from 0.32 to 0.88, with most correlation coefficients above 0.65.

MTI (formally CSA) accelerometers (model 71256) were used as an objective, standard measure to assess the criterion validity of the IPAQ. Participants wore the MTI accelerometer during waking hours for seven consecutive days (Craig et al., 2003). A comparison between the measures found fair to moderate agreement. A medium Spearman Rho of approximately 0.30 was reported for minutes of moderate, vigorous, walking and sedentary behaviours (International Physical Activity Questionnaire, n.d.-c). The criterion validity values derived for the IPAQ long and short versions were found to be approximately equivalent.

Despite the IPAQ being found suitable for population based prevalence studies, caution is required in interpreting results. The cut-points used to estimate different intensity levels were established from laboratory-based studies (IPAQ Executive Committee, 2001). The accuracy of translating laboratory results to diverse populations living in diverse environments is unknown.
Results of reliability and validity testing of the IPAQ should therefore only be generalised to the sample population (middle aged adults). Further research is required to examine regional, gender, age, socio-economic, cultural and population differences in the reliability and validity of the IPAQ (Craig et al., 2003).

It is not uncommon for participants to overestimate physical activity in self-report questionnaires (Klesges et al., 1990). This is of particular concern in relation to questions that seek to measure the average time per day participants are engaged in physical activity (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). The extent of over-reporting in the IPAQ is relatively unknown. A recent study investigated this phenomenon in adults that had previously completed the IPAQ in a national survey (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). Fifty Belgium adults completed the short telephone version of the IPAQ. Interviewers used exactly the same protocol as was used in the national survey and had received specialised training to prevent the incidence of over-reporting. At the completion of the initial survey interviewers spoke with participants at greater length. Participants were asked to explain their answers, giving more complete and detailed information about their reported activity, the time they had engaged in the activity as well as the intensity of their effort while undertaking the activity. This was known as the IPAQ-Probe. In comparison to the IPAQ-Probe, the incidence of reported physical activity for the IPAQ short telephone version was significantly greater for all components. Rzewnicki and colleagues (2003) found that 75% of participants reported less physical activity under the IPAQ-Probe. It was reported that 23 of the 50 respondents indicated engaging in some physical activity when responding to the IPAQ questions (either walking or vigorous or moderate physical activity). Using the IPAQ-Probe Rzewnicki and colleagues (2003) found that participants should have reported that they engaged in no walking or vigorous or moderate physical activity. When using the IPAQ 44% of participant’s over-reported moderate-intensity physical activity. The IPAQ-Probe revealed that significant reductions in reported physical activity were due to the time engaged in the activity being too brief, or the activity being engaged in occurred at an insufficient intensity to be eligible for inclusion according to the IPAQ inclusion criteria.

Specific training and guidelines focusing on over-reporting, such as those developed for the Minnesota physical activity interview, are important for interviewers (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). Rzewnicki and colleagues (2003) recommend that users of the IPAQ should ensure that interviewers receive adequate training, supervision and feedback.
Knowledge of issues surrounding over-reporting and how to promote accuracy in participant reporting is also important. To confirm participant’s comprehension, it is suggested that interviewers repeat or phrase questions from specific parts of the IPAQ to the participant (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003).

Data collection centres identified various research issues during the reliability and validity testing of the IPAQ. Technical problems with the accelerometers and problems in obtaining follow-up interviews with participants at the protocol defined time were reported (Craig et al., 2003). Difficulties arose in participants distinguishing between moderate-intensity and vigorous-intensity levels of physical activity, interpretation of the term ‘usual week’ and an inability to accurately report physical activity engaged in for 10 minutes or more at a time (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). Despite the protocol allowing for culturally applicable examples to be used, it was found that activities given as examples were not always relevant. This contributed to participant’s difficulty in understanding and answering questions.

2.4.2.2 Proxy-respondent Questionnaires.

When an individual is unable to complete a self-report questionnaire due to verbal, sensory or cognitive factors researchers have used a proxy-respondent, a person known to the participant, to complete the questionnaire on the participant’s behalf. The differences in format of proxy-respondent physical activity questionnaires and self-report or interviewer administered questionnaires are minimal. Proxy-respondent questionnaires are commonly used to investigate the physical activity behaviours of individuals with cognitive limitations. Parents or teachers have been used to report on the physical activity of children (Sallis & Owen, 1999; Telford, Salmon, Jolley, & Crawford, 2004) and caregivers or parents are typically used to report on the physical activity behaviours of people with a disability (Rimmer, Braddock, & Marks, 1995; Robertson et al., 2000; Stanish & Draheim, 2005; Temple & Walkley, 2003).

Many of the same difficulties and advantages of self-report and interviewer administered questionnaires exist with proxy-respondent questionnaires. Although self-report and proxy-respondent questionnaires seek the same type of information, including details on the frequency and duration of physical activity, significant problems exist for proxy-respondent questionnaires. Questionnaires requiring information on subjective behaviours, such as quality of life, produce lower agreement between the criterion measure and proxy-respondent responses in comparison to questions focusing on a behaviour that can be directly observed (Whiteman &
Green, 1997). Studies that have investigated the physical activity behaviour of various groups through proxy-respondents often fail to report on the validity and reliability of the measure and the proxy-respondent. While proxy-respondent questionnaires do have an advantage in that they seemingly can reduce recall errors caused by cognitive limitations of the target person (Sirard & Pate, 2001), concern remains as to the efficiency of proxy-respondents when used with AWID (Finlay & Lyons, 2001). A comprehensive review of this issue is provided in section 2.7.7.

2.4.2.3 Physical Activity Diaries.

Physical activity diaries require participants to record their physical activity behaviour on a regular basis for a defined period of time (Timperio & Salmon, 2003). The level of detail required in physical activity diaries can vary (Montoye, Kemper, Saris, & Washburn, 1996). Physical activity diaries are one of the most accurate indirect measures of physical activity for adults (Sirard & Pate, 2001). The convenience and low cost in administering a physical activity diary is a major advantage of the approach. However, the approach does place a burden on the participant and the intention to record may have a reactive effect on the participant’s actual physical activity behaviour (Matthews, 2002).

One known study has used self-completed physical activity diaries with AWID (Frey, 2004). It is anticipated that a lack of studies using self-completed physical activity diaries by AWID is due to an inability of AWID to accurately recall and record their own physical activity behaviours (Frey, 2004). To determine the physical activity levels of AWID, Frey (2004) asked participants with a mild intellectual disability \( n = 22 \) to record the amount of time they spent on the computer or watching television and the frequency and intensity of everyday activities including walking, house or yard work, personal care and transportation. The author reported that participants had difficulty recalling the frequency and intensity of the activity they engaged in. Participants who were able to maintain their own physical activity diary \( n = 7 \) needed the process simplified. The author achieved this by asking participants to identify the television programs they watched and the instances in which they exercise, such as walking to the bus stop.

2.4.3 Direct Physical Activity Measures

Direct measurement techniques provide an objective measure of physical activity. Direct measures include the use of motion sensors (pedometers and accelerometers) and observation...
(Tudor-Locke & Myers, 2001). In comparison to indirect measures, direct measures can be time consuming, costly and are deemed to be inappropriate for population based research (Dale, Welk, & Matthews, 2002). This section will briefly discuss different types of direct physical activity measures including direct observation and the use of motion sensors including pedometers and accelerometers.

2.4.3.1 Direct Observation.

Direct observation involves the observation of participants and recording their physical activity behaviour (Montoye, Kemper, Saris, & Washburn, 1996). It is a practical and appropriate criterion measure for physical activity research (Sirard & Pate, 2001) that is used to quantify and describe not only the type of activity but related social interactions and the environmental setting (Sallis & Owen, 1999). Although allowing for only the required information to be recorded, direct observation is not practical for large scale studies (Timperio & Salmon, 2003). The use of direct observation is resource intensive. This technique requires observers to be trained and is costly. For most observational instruments the amount of observation time per day required to attain acceptable day-to-day stability is unclear (Sirard & Pate, 2001). The burden placed on researchers as well as the reactivity of participants that can occur when the observer is unknown to the participant or the observers intention is clear to the participant are an additional drawback of this technique (Sirard & Pate, 2001). Only one known study investigating the physical activity behaviour of AWID has used direct observation (Temple, Frey, & Stanish, 2006). Participants (n = 6) were observed for seven consecutive days, for a total of 564 hours. Motion sensors (Caltrac® accelerometer) were used to determine the validity of observation. The use of direct observation allowed investigators to determine how participants accrued moderate-intensity physical activity.

2.4.3.2 Motion Sensors.

Motion sensors such as pedometers and accelerometers have commonly been used in field based physical activity research. They provide an estimate of physical activity through the detection of body movement in single (uniaxial) or multiple (triaxial) planes (Stanish, Temple, & Frey, 2006). The use of accurate measurement tools including motion sensors such as pedometers and accelerometers enable prevalence data to regularly be collected on adults. Validation of field and laboratory measures of motion sensors among adults yield relatively high correlations, ranging between 0.62 and 0.93 using oxygen consumption as a criterion measure and 0.80 to 0.97 for direct observation (Sirard & Pate, 2001). Although the cost of
of the physical activity of AWID (Stanish, Temple, & Frey, 2006). Recent studies have effectively used motion sensors including pedometers and accelerometers in this population (Frey, 2004; Stanish, 2004; Suzuki et al., 1991; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003).

Pedometers are a simple electronic device worn on the body that estimate the total counts, number of steps or distance walked over a given time period (Montoye, Kemper, Saris, & Washburn, 1996). Pedometers place minimal burden on participants and can be used as a measure of physical activity (Bassett & Strath, 2002). Pedometers do not, however, assess the intensity of physical activity behaviour that is undertaken (Sirard & Pate, 2001) and only newer more costly models have the ability to store data for several days (Stanish, Temple, & Frey, 2006). Despite their downfalls pedometers are a useful, re-useable and objective measure of physical activity that have been found to produce valid and reliable results (Bassett et al., 1996; Sirard & Pate, 2001; Stanish, Temple, & Frey, 2006).

Pedometry is one of the few direct measure of physical activity that has been investigated to determine validity when used by AWID (Stanish, Temple, & Frey, 2006). The accuracy of the Yamax Digiwalker (Yamax Corporation, Tokyo, Japan) was explored for walking behaviours of ambulatory adults aged 19-65 years (n = 20) with a mild intellectual disability with no known mobility impairments (Stanish, 2004). Direct observation of steps was made using a hand-held counter as participants walked around a measured track. Pedometers were found to be highly accurate (0.95 - 0.99) in measuring steps regardless of the type of track or speed walked (Stanish, 2004). Although further research is required, results of this study suggest pedometers can accurately record walking step counts among this population.

An accelerometer is a small electronic device worn on the body, usually at the hip, that measures the acceleration of body movement (Sirard & Pate, 2001). Accelerometers detect movement through the accelerometers motion sensor. Each time the accelerometer moves a single voltage is generated. The information generated from this is stored in the memory of the device that can be downloaded onto a personal computer (Stanley, 2003). Many of the advantages and disadvantages of accelerometers are the same as those found for pedometers. Unlike most pedometers, accelerometers have the ability to store data for several days and assess the intensity of the physical activity behaviour undertaken (Stanish, Temple, & Frey,
A criticism of accelerometers is that when worn at the hip they are limited in their ability to assess activities with limited torso movement, including most light-intensity physical activity such as typing at a computer while seated (Sirard & Pate, 2001).

Researchers have conducted several validation studies of accelerometers under free living conditions. A review article by Westerterp (1999) included studies that had assessed the validity of commercially available accelerometers including the Caltrac®, MTI accelerometer (formally CSA accelerometer), Mini Motionlogger Actigraph, Tritrac-R3 D and Tracmor accelerometers when used by adults. Indirect calorimetry was used as a criterion measure in all of the studies reviewed. The accelerometers were validated during short term protocols with defined physical activities such as walking. Placement of the accelerometers in each of the studies varied, being either on the hip, wrist or lower back. Overall, large variability in the validity was found across the accelerometers ($r = 0.25 - 0.91$) with the Tracmor found to have the highest correlation when validated in free living conditions. The review found that for sedentary based activities tri-axial accelerometers, like the Tracmor, appeared to be the most effective (Westerterp, 1999). The variability in the validity coefficients derived from these studies has been suggested to have occurred as a result of the accelerometer brands and models used, the variability of their placement on the body and the activities undertaken (Sirard & Pate, 2001). The validity of accelerometers when used by AWID has not been explored (Temple, Frey, & Stanish, 2006). This is an area that warrants further investigation with limited research in the area indicating energy differences between AWID and AWOID (Iwaoka et al., 1998; Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). Iwaoka and colleagues (1998) and Ohwada, Takeo, Suzuki, Yokoyama and Ishimaru (2005) postulate that differences between the populations may be due to biomechanical efficiency, co-ordination and excess body movements.

To gain an understanding of the physical activity behaviours of the population researchers have used indirect, direct or a combination of indirect and direct physical activity measures. These measures have included the use of self-report, interviewer administered and proxy-respondent questionnaires, physical activity diaries, observation and motion sensors. Each approach have their own strengths and weaknesses, some of which are more profound when used with AWID. None-the-less no psychometrically sound measurement tool currently exists to collect data on the physical activity of AWID.
2.5 Prevalence of Physical Activity among Populations

Information on the prevalence and trends in physical activity behaviour is essential for monitoring the extent to which physical activity guidelines are being met. This section commences with a brief overview of the most current international and Australian evidence related to the physical activity behaviour of adults. In comparison to that for adults who do not have a disability, limited evidence is available on the physical activity of AWID. This section concludes with a comprehensive review of available studies investigating the physical activity behaviour of AWID and an overview of the methodological limitations of these studies.

2.5.1 Physical Activity among Adults

Use of print and electronic media has been influential in promoting knowledge of the importance of regular participation in moderate-intensity physical activity. Despite widespread publicity leading to increased awareness and knowledge of the importance of the health benefits associated with physical activity, participation levels have not improved in recent years (Armstrong, Bauman, & Davies, 2000; Centers for Disease Control and Prevention, 2005). In the United States, over half the adult population are not physically active enough on a regular basis to achieve a health benefit (Centers for Disease Control and Prevention, 2003). This is supported by data from the 2004 Behavioural Risk Factor Surveillance System (BRFSS) which found that 21% of men and 26% of women engaged in no leisure-time physical activity. Over the period from 1994 to 2004 participation in leisure-time physical activity among adults in the United States of America declined on average 0.6% per year (Centers for Disease Control and Prevention, 2005). The BRFSS defined no leisure-time physical activity as answering ‘no’ to the question “During the past month, other than your regular job, did you participate in any physical activities or exercise, such as running, callisthenics, golf, gardening or walking for exercise.” Despite this decline a sizeable number, nearly one in four adults in the United States, did not participate in leisure-time physical activity. In comparison engagement in total physical activity to achieve a health benefit was only met by men that fell within the 18-29 and 30-39 year age categories (Centers for Disease Control and Prevention, 2005).

Numerous recent reports indicate unacceptably low levels of physical activity behaviour among adult Australians (Australian Institute of Health and Welfare, 2006; Bauman, Bellew, Vita, Brown, & Owen, 2002; Bauman, 2001; Bull, Milligan, Rosenberg, & MacGowan, 2000; Department of Human Services, 1999, 2004; Stephenson, Bauman, Armstrong, Smith, &
Bellew, 2000). Self-reported data collected from national surveys of physical activity for
Australian adults from 1997 to 2000 suggests participation rates were relatively low and
decreasing. During 2000, 57% of Australians were found to be sufficiently physically active to
achieve a health benefit, a decrease of 5% from 1997 (Department of Human Services, 2004).

The Victorian Population Health Survey, undertaken in 2005, provides a snapshot of the
physical activity of Victorian adults. Data indicates that in the week prior to the survey, 6% of
adults (male 6%, female 5%) did not engage in any physical activity and a further 29% (male
28%, female 29%) participated in insufficient physical activity to achieve a health benefit
(Department of Human Services, 2004). Walking was found to be the most prevalent physical
activity, and for many, the only type of physical activity engaged in. Evidence from the
Victorian Population Health Surveys between 2002 and 2005 has revealed that levels of
sedentary behaviour and insufficient physical activity participation decreased by 2.7% for
sedentary behaviour and 5.1% for insufficient physical activity. Victorian data from the 1998
revealed that 51% of females and 34% of males did not engage in sufficient physical activity to
achieve a health benefit (Department of Human Services, 1999). Comparable results were found
for Western Australian adults with 42% of Western Australian adults not engaging in sufficient
physical activity for a health benefit (Bull, Milligan, Rosenberg, & MacGowan, 2000).

Data from the 2005 Victorian population health survey showed consistent trends across age and
gender. Males aged 65+ years had the highest prevalence of sedentary behaviour (13%)
compared to young adult males (18 – 24 years) who engaged in the lowest prevalence of
sedentary behaviour (3%). Thirty-five percent of males aged 65+ and 35% of males aged 18 –
24 years were reported to engage in insufficient physical activity behaviour. A similar pattern is
seen for female adults. Females aged 65+ years had the highest prevalence of sedentary
behaviour (12%); and of those 36% engaged in insufficient physical activity to achieve a health
benefit. Compared to older females, younger females (18 – 24 years) engaged in the lowest
prevalence of sedentary behaviour (2%). Females aged between 25 and 34 years were
categorised as engaging in the least amount of physical activity to achieve a health benefit
(26%). Individual characteristics were reported to influence the amount of physical activity
Victorians engaged in. People born overseas, those with lower levels of education, not working
or in a non-professional occupation and those with low incomes were more likely to be
classified as sedentary or insufficiently active.
Although numerous reports on the physical activity levels of adults exist, the available evidence is difficult to interpret. A lack of universal, standardised measurement tools and definitions and methodological differences have created inconsistencies in the collection and reporting of physical activity evidence. Despite this limitation, available information indicates that many adults engage in insufficient physical activity to gain a health benefit (Australian Institute of Health and Welfare, 2006; Department of Human Services, 2004).

2.5.2 Levels of Physical Activity among Adults With an Intellectual Disability

Scant evidence is available regarding the physical activity behaviour of AWID and of that available, little was derived through the use of objective measurement approaches. Methodological challenges are in part deemed responsible for the lack of available objective evidence regarding the physical activity behaviour of AWID (Temple, Frey, & Stanish, 2006). Investigations into the physical activity of AWID have varied considerably in the type of measurement approach used (Temple, Frey, & Stanish, 2006). More recently, investigators have utilized multiple data sources, including objective measurement techniques including pedometers and accelerometers to investigate the physical activity of AWID (Temple, Frey, & Stanish, 2006).

The main findings of investigations using objective physical activity measures to collect information on the physical activity behaviour of AWID are summarised in Table 2, adapted and modified from Temple and colleagues (2006). Each of the studies evaluated levels of physical activity of moderate-intensity or greater, physical activity counts per minute or daily steps among participants. The sample size of six of the eight studies (n = 37) places a significant limitation on the generalisability of the evidence. However, the use of a direct measurement instrument (motion sensors) in all but one of the studies and a second physical activity data source (questionnaire or observation) in some studies are major advantages.
Table 2: Studies investigating physical activity among AWID using objective measurement techniques*

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<tr>
<th>Study</th>
<th>Participants</th>
<th>Data Source</th>
<th>Findings</th>
<th>Comments</th>
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<tr>
<td>Stanish &amp; Draheim, 2005</td>
<td>Adults aged 19-65 years (n = 103) with mild to moderate intellectual disability (65 males, 38 females). Adults with Down syndrome (n = 19).</td>
<td>NHANES III, Physical activity survey; interviewer administered with participant and proxy-respondent (direct caregiver) and Yamax Digiwalkers (SW-500 and SW-700) for 7 consecutive days.</td>
<td>Average daily steps = 7832. 21% recorded 10,000 steps per day. 17.5% engaged in 5 or more 30 minute bouts of moderate-vigorous physical activity per week. Walking was the most frequently reported physical activity.</td>
<td>Previously established reliability of NHANES III found moderate-vigorous physical activity bout and min/week reliable ($r = .087$ and $r = 0.89$) and walking bouts and min/week less reliable ($r = 0.60$ and $r = 0.61$).</td>
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<td>Stanish, 2004</td>
<td>Adults (n = 20) with mild intellectual disability (8 males, 12 females).</td>
<td>Yamax Digiwalkers and hand counting.</td>
<td>45% achieved 10,000 steps or more on weekdays and 20% on weekend days. Significantly higher step counts for adults without Down syndrome compared to adults with Down syndrome.</td>
<td>Participants from the one geographical area where participants walked for transport through necessity. The authors report a possible Hawthorne effect with participants reacting to study’s arrangements, increasing walking behaviour.</td>
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<tr>
<td>Study</td>
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<td>Frey, 2004</td>
<td>Adults (n = 22) with mild to moderate intellectual disability (11 men; 11 women).</td>
<td>MTI (formally CSA) accelerometer (Model 7164) for 7 days and activity diaries completed by the participant, caregiver or with assistance from the researcher.</td>
<td>Active controls (n = 9) without a disability were significantly more active (55.9 Moderate-hard physical activity) than participants with an intellectual disability (19.7 Moderate-hard physical activity) and sedentary controls (n = 17) without an intellectual disability (31.6 Moderate-hard physical activity). Watching television was the most commonly reported leisure time activity for adults with an intellectual disability.</td>
<td>Quality of physical activity diaries varied and was overall unsuccessful. Nine were not completed or were incomplete.</td>
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<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
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<td>Temple &amp; Walkley, 2003</td>
<td>Ambulatory, community living adults (n = 37) with mild to moderate intellectual disability (19 males, 18 females) attending day training programs (n = 22) or supported employment (n = 15).</td>
<td>Proxy-respondents (caregiver) were trained to complete Bouchard physical activity diaries and Caltrac® accelerometer for 3 days.</td>
<td>Majority of time in day spent in sedentary activities; 10 hrs lying down/sleeping, 10 hours engaged in activities sitting, 1.5 hours in light activities while standing, 1 hr personal tasks such as showering, 67 minutes in at least moderate intensity activities. 32% met the Australian physical activity guidelines. Walking for transport and work related activity most common physical activity engaged in.</td>
<td>Sample not truly representative. Validity of physical activity diary was established from correlations with Caltrac® accelerometer (r = 0.78). Caution required in interpreting data, as energy expenditure estimates used by both instruments were established with general population, not adults with an intellectual disability.</td>
</tr>
<tr>
<td>Grace et al., 2003</td>
<td>Overweight and obese adults (n = 20) with Bardet-biedl syndrome (9 males, 11 females) and matched controls.</td>
<td>MTI (formally CSA) accelerometer (Model 7164) for 7 days.</td>
<td>Lower physical activity for participants with Bardet-biedl syndrome.</td>
<td>All participants had BMI = 25. Incomplete data excluded 5 participants. Participants required to wear accelerometer for minimum of 5 days and 9 hrs a day.</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
<td>Findings</td>
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<tr>
<td>Temple, Anderson, &amp; Walkley, 2000</td>
<td>Community living adults aged 19-45 yrs (n = 6) with mild to moderate intellectual disability (3 male, 3 female).</td>
<td>Direct Observation (564hrs) with observations recorded per minute by trained observers using the Bouchard Three day physical activity record and Caltrac® accelerometer for 7 consecutive days.</td>
<td>On average participants spent 10hrs lying down, 6 hrs sitting, 3 hrs standing, 3hrs undertaking personal tasks and engaged in light to moderate sport, leisure or work at other times. One participant met the Australian physical activity guidelines.</td>
<td>Validity of observation was established from correlations with Caltrac® accelerometer (r = 0.83).</td>
</tr>
<tr>
<td>Suzuki et al., 1991</td>
<td>Ambulatory children, adolescents and young adults aged 6-22 yrs (n = 217) with intellectual disability (136 males, 81 females).</td>
<td>Pedometers for 1 day.</td>
<td>Significantly lower pedometer scores than general population. Males 16 000 counts per day, females 12 300 counts per day.</td>
<td>Validity and reliability of measure not reported.</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
<td>Findings</td>
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<tr>
<td>Sparrow &amp; Sharp, 1991</td>
<td>Community living adults (n = 4, 1 ppt 26 yrs, 3 ppt 40 yrs) with intellectual disability (2 males, 2 females).</td>
<td>Direct observation (2 minute intervals per resident) after hours on the weekday and Saturday for 8 weeks (215 hrs).</td>
<td>Personal and domestic activities and sedentary activities combined accounted for between 52% (Saturdays) and 72% (weekdays) of total time sampled.</td>
<td>Observation only after hours (from 4pm weekday and 11am on Saturday). No observation on Sundays. Observation not continuous. No information on validity provided.</td>
</tr>
</tbody>
</table>

* Adapted from Temple and colleagues (2006)
An Australian study explored the physical activity of six community living AWID using direct observation (564 hours) and a Caltrac® accelerometer (Temple, Anderson, & Walkley, 2000). Participants (3 men and 3 women) with a mild to moderate intellectual disability resided in the same group home and travelled independently to and from their work or day programs. Observers received training in the use of the Bouchard Physical Activity Scale and were given additional verbal instructions in interpreting the scale and on the participant’s likely activities. Participants wore the Caltrac® in a small bag during waking hours for seven consecutive days. Data from the Caltrac® was used to validate estimates of activity intensity derived from direct observation (intra-class correlation = 0.83). Caution must be taken in interpreting and generalising these results as these measurement tools have not been validated for use with this population.

Temple and colleagues (2000) found that community living AWID engaged in insufficient moderate-intensity physical activity to achieve health benefits. On average per day, participants in their study spent 10 hours lying down, 6 hours sitting involved in activities such as eating or watching television, 3 hours standing, and 3 hours undertaking personal tasks and engaged in light to moderate sport, leisure or work at other times. Direct observation data indicated that one of the six participants achieved 30 minutes of moderate-intensity activity on at least 5 days of the week. This daily criterion was met by a second participant on three of the seven days. Investigators reported that this participant was home due to illness on the remaining four days.

A follow-up study utilized Caltrac® accelerometers and caregiver physical activity diary entries to investigate the concurrence between proxy and accelerometer generated estimates of physical activity among 37 AWID (Temple & Walkley, 2003). Participants (19 – 60 years old) had a mild to moderate intellectual disability and lived in supported accommodation. A standardized approach was used to train direct-care staff working in the participant’s home and work or day placement environment on how to complete the 3-day activity diary and look for signs to recognize intensity level of an activity. The physical activity diary was completed by staff at set intervals throughout each day, including meal times, upon arriving at work/day placement and at the end of the day as the participant retired for bed. The three consecutive days of data collection occurred over two weekdays and one day of the weekend.

Temple and Walkley (2003) found that trained caregivers could provide meaningful data through physical activity diary entries. Caregiver reports indicated that the majority of participant’s time included sedentary activities. However, 14% of participants were reported to
engage in an hour or more of daily, light manual work. Only 32% of participants were reported to be sufficiently active to achieve a health benefit, in comparison to 57% of the general Australian population at the time of this study (Armstrong, Bauman, & Davies, 2000). Similar findings are reported in a study using MTI(formally CSA) accelerometers (model 7164) to compare physical activity levels of adults with a mild intellectual disability (n = 22) and adults (n = 17 sedentary controls; n = 9 active controls) (Frey, 2004). Twenty-eight percent of AWID were reported to achieve 30 minutes of moderate-intensity activity per day. Although unsuccessfully completed, physical activity diaries allowed researchers to ascertain that physical activity was achieved through participation in household chores, walking and Special Olympics. Watching television was reported to be the most common leisure activity of participants.

Pedometers (Yamax Digiwalkers; SW-500 and SW-700) and a physical activity questionnaire were used in a larger scale study assessing the walking activity of AWID (Stanish & Draheim, 2005). Yamax Digiwalkers have been shown to be reliable when used with AWID (Stanish, 2004). Participants (n = 103) and their direct caregiver completed an interviewer administered physical activity questionnaire (NHANES III). Caregivers were reported to assist participants with questions as required. The type or amount of assistance participants required was not reported by Stanish and Draheim (2005). Participants wore a pedometer for one week, during waking hours. A non-significant relationship was found between pedometer counts and participants responses to the physical activity questionnaire. Stanish and Draheim (2005) identified a number of methodological concerns including inaccurate reporting, tampering with pedometers and the participants walking speed and gait possibly influencing the accumulation of erroneous data.

The average number of daily steps participants achieved in the study by Stanish and Draheim (2005) was 7832. The authors found that a threshold of 10,000 steps per day was achieved by only 21.4% of participants. In comparison, based on questionnaire responses, the authors found that only 17.5% of participants engaged in at least five bouts of moderate-intensity to vigorous-intensity physical activity per week, for a minimum of 30 minutes per day (Stanish & Draheim, 2005). Similar results were reported in a small scale study investigating the accuracy of pedometers (Yamax Digiwalkers) and walking activities in 20 adults with a mild intellectual disability (Stanish, 2004). Results of this study may not be representative of this population as
participants were from the one geographical area. This area was without public transport, thus many participants were likely to walk for transport through necessity.

To estimate the daily physical activity of 217 children, adolescents and young adults with an intellectual disability Suzuki and colleagues (1991) used pedometers. Participants wore pedometers (Yamasatokei Co, Tokyo) on their waist belt during a 24 hour period, which included a regular school day. When an extremely low or high pedometer score was found an additional 24 hour measurement was taken. The authors failed to define low or high pedometer scores or report the number of participants that wore the pedometer for a second 24 hour period. Results revealed that pedometer scores for male and female AWID were significantly lower in comparison to the general population (Suzuki et al., 1991). Similarly, low levels of physical activity are reported in a study that explored the energy metabolism of adults with Bardet-Biedl syndrome (Grace et al., 2003). Participants (9 males & 11 females) wore a MTI (formally CSA) actigraph (model 7164) during waking hours for seven consecutive days. Participants data was only included for analysis if the actigraph was worn for a minimum of five days and nine hours a day. Incomplete data was reported for five participants.

An Australian study exploring the leisure time activity patterns of four AWID residing in a community-residential unit (CRU) also report participants engage in predominately sedentary and passive activities (Sparrow & Sharp, 1991). Participants were observed for eight weeks from 4.00pm on weekdays and 11.00am on Saturdays for a total time of 215 hours. No observation occurred on Sundays. Restricting the hours of observation to out-of-hours activity and only one of two days of the weekend is a significant limitation of this study. It has been demonstrated that AWID engage in the most beneficial type of activity for their health throughout their day; whether it involves activities at, or travelling to and from their place of work, supported accommodation or day placement (Temple, Anderson, & Walkley, 2000). Observations found participants predominantly engaged in sedentary activities, including personal domestic activities (53.5%), doing nothing (22.8%), watching TV, reading, socialising or other sedentary activity (26%), or outdoor physical activity (7.7%). It is unknown if the use of observers affected the participants behaviour.

Similar to the limited number of investigations using direct physical activity measurement techniques, few large-scale investigations of the physical activity participation of AWID have been undertaken using subjective measurement techniques, such as questionnaires. The available studies are summarised in Table 4, which has been adapted and modified from
Temple and colleagues (2006). A recent study using the physical activity scale included in the Health Survey for England investigated weight and physical activity levels of 1542 AWID living in supported accommodation in Northern England (Emerson, 2005). The physical activity scale collects data on the type and intensity level of involvement in physical activity, focusing on moderate-intensity and vigorous-intensity physical activity, as well as the number of occasions activity was engaged in at each intensity level. To be classified as active, participants were required to engage in more than 12 bouts of moderate-intensity or vigorous-intensity intensity physical activity over the previous four weeks. Participation in sports or exercise were included only if the activity lasted for 20 minutes or more. Based on responses provided by proxy-respondents Emerson (2005) found that of participants reported as being physically capable of engaging in physical activity (n = 1458), only 8% participated in more than 12 bouts of moderate-intensity or vigorous-intensity physical activity in the preceding four weeks. Table 3 displays the percentage of AWID by age and gender reported to be physically inactive. Overall AWID engaged in high levels of physical inactivity, with all age and gender categories of physical inactivity greater or equal to 83%. Observations revealed an age effect for males with levels of physical inactivity increasing as male AWID age. The author reports that both male and female AWID were less significantly active than their male and female counterparts without a disability.

Table 3: Percentage of physically inactive AWID by gender living in Northern England

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>16 - 24 years</td>
<td>83</td>
<td>100</td>
</tr>
<tr>
<td>25 - 34 years</td>
<td>88</td>
<td>85</td>
</tr>
<tr>
<td>35 - 44 years</td>
<td>89</td>
<td>97</td>
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<tr>
<td>45 - 54 years</td>
<td>90</td>
<td>92</td>
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<tr>
<td>55 - 64 years</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>65 - 74 years</td>
<td>100</td>
<td>96</td>
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<tr>
<td>75+</td>
<td>100</td>
<td>100</td>
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n = 1458
<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Data Source</th>
<th>Findings</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Emerson, 2005</td>
<td>Physical activity data available on 1458 of 1542 adults with intellectual disability living in supported accommodation. A comparison group from the health survey for England for 1998.</td>
<td>Physical activity scale used in the Health Survey for England.</td>
<td>Excluding participants (44%) physically incapable of at least 1 of the 12 categories of physical activity measures, 8% meet criteria for being physically active. Participants were significantly more inactive than general population.</td>
<td>Although large sample it is not fully representative. No evidence of measure validity and reliability reported.</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
<td>Findings</td>
<td>Comments</td>
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<tr>
<td>Robertson et al., 2000</td>
<td>Adults (n = 500) with intellectual disability living in different residential services (residential campuses, dispersed housing, village communities). Excluded participants with impaired mobility.</td>
<td>Structured interview with proxy-respondents (care staff) using selected parts from the Health Survey for England.</td>
<td>12% from village community, 7% from residential campus and 20% from dispersed housing classified as active. 83% men and 97% of women from village community, 92% men and 94% women from residential campus and 80% of men and women from dispersed housing classified as inactive.</td>
<td>Validity and reliability of measure or proxy-respondents were not reported.</td>
</tr>
<tr>
<td>Wells, Turner, Martin, &amp; Roy, 1997</td>
<td>Adults (n = 110) with intellectual disability and 46 controls.</td>
<td>Physical activity questionnaire from the Health Survey for England completed by participant, caregiver or care staff to measure physical activity.</td>
<td>51.8% had not engaged in moderately intense activity over past 4 weeks. 93.5% of controls had engaged in some moderately intense activity over past 4 weeks.</td>
<td>Unclear to extent who or what combination of participants and proxy-respondents completed questionnaire. No evidence of validity or reliability provided.</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
<td>Findings</td>
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<tr>
<td>Beange, McElduff, &amp; Baker, 1995</td>
<td>Adults (n = 202), 20-49 yrs with mild (35%), moderate (40%), severe (14%) and profound (11%) intellectual disability residing in institution (29%), community group homes (31%), private accommodation (40%). Down syndrome (27%). A comparison group of 619 adults, 20-50 yrs from 1989 National Heart Foundation Risk Factor Prevalence Study.</td>
<td>Questionnaire with participant and proxy-respondent (caregiver).</td>
<td>72% men and 75% women were not physically active. Male participants were significantly less active than the comparison group.</td>
<td>Unclear to extent who or what combination of participants and proxy-respondents completed questionnaire. No evidence of validity or reliability provided.</td>
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<td>Study</td>
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<td>Data Source</td>
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<tr>
<td>Rimmer, Braddock, &amp; Marks, 1995</td>
<td>Ambulatory adults (n = 329), 17-70 yrs with mild to severe intellectual disability living in institutions (n = 184), group home (n = 39) or family home (n = 106).</td>
<td>Proxy-respondent questionnaire completed by parent, guardian or staff member.</td>
<td>24% participants exercised regularly (3-4 days/week), 33% 1-2 days/week, 18% once month and 25% never exercised. The most common exercise was walking.</td>
<td>No information on questions related to exercise type provided. No details provided on reliability or validity of measure or ability of proxy-respondents to report exercise frequency.</td>
</tr>
<tr>
<td>Messent, Cooke, &amp; Long, 1998</td>
<td>Ambulatory adults (n = 24), average age of 34 years with mild to moderate intellectual disability from residential homes and a day centre (14 males, 10 females).</td>
<td>Interviews with participants and confirmed by residential managers to construct 7 day activity profiles.</td>
<td>93% engaged in significantly less than the recommended minimum daily level of physical activity.</td>
<td>No evidence of measure validity and reliability was recorded.</td>
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<td>Study</td>
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<tr>
<td>Janicki et al.,</td>
<td>Adults (n = 1371) 40-79 yrs with mild (1.3%), mild to moderate (50.3%),</td>
<td>Nonstandardised questionnaire requiring yes/no responses mailed to and</td>
<td>&gt;50% participants reported to engage in no exercise and 43% reported to exercise lightly.</td>
<td>No specific information on questions related to exercise given. No details provided on</td>
</tr>
<tr>
<td>2002</td>
<td>severe to profound (47%) and uncoded (1.4%) adults with intellectual disability</td>
<td>completed by proxy-respondents (nursing staff or service coordinators) familiar with participant.</td>
<td></td>
<td>reliability or validity of measure reported.</td>
</tr>
<tr>
<td>Draheim, Williams,</td>
<td>Volunteered community living ambulatory adults (n = 150), 19-65 years with mild to moderate intellectual disability (76</td>
<td>The NHANES III, Physical activity survey; interviewed administered to participants and proxy-respondents (direct caregivers).</td>
<td>47% men and 51% women reported little to no leisure time physical activity. Walking and cycling for transport were the most frequent activities engaged in.</td>
<td>NHANES - designed for use with proxy-respondents where necessary. No details of validity and reliability of instrument were reported.</td>
</tr>
<tr>
<td>&amp; McCubbin, 2002</td>
<td>males, 74 females).</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Data Source</td>
<td>Findings</td>
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<td>Jobling, Cuskelly, &amp; Rutherford, 2006</td>
<td>Adults (n = 18) with Down syndrome, 17–23 years and their siblings, 14–21 years.</td>
<td>Structured interview with participant and parent using a similar format to the Physical Activity Interview.</td>
<td>Adults with Down syndrome participated in significantly less physical activity than their siblings (47 vrs 109 total physical activity units) and watched more television (223 vrs 115 minutes per day).</td>
<td>Unclear to what extent parents assisted participants to respond to interview questions. Lack of evidence of validity or reliability of instrument provided for use with adults with Down syndrome.</td>
</tr>
</tbody>
</table>

* Adapted and modified from Temple and colleagues (2006)
Using the same questionnaire, investigators of two earlier English studies reported low levels of physical activity among a combined total of 610 AWID (Robertson et al., 2000; Wells, Turner, Martin, & Roy, 1997). Robertson and colleagues (2000), and Wells and colleagues (1997) failed to provide evidence of the validity or reliability of the questionnaire when used with this population and the ability of the proxy-respondents to accurately or reliably use the surveys. In the study by Robertson and colleagues (2000) the questionnaire was fully completed by proxy-respondents. The authors reported that based on information provided by proxy-respondents 83% of men and 97% of women from village communities, 92% men and 94% women from residential campuses and 80% of men and women from dispersed housing were classified as physically inactive. In comparison, Wells and colleagues (1997) reported that 52% of AWID had not regularly engaged in moderately intense physical activity in the previous four weeks. Based on the reports in this study it was not possible to ascertain to what extent the questionnaire was completed by the AWID, caregivers or a combination of both.

A methodological limitation of the three English studies is a failure to provide evidence of the validity or reliability of the questionnaire with this population and the accuracy of the respondents. In two of the three studies, the questionnaire was fully completed by proxy-respondents (Emerson, 2005; Robertson et al., 2000). The questionnaire in the third study was completed by caregivers and/or the AWID (Wells, Turner, Martin, & Roy, 1997). It is difficult to ascertain to what extent the questionnaire was completed by participants, caregivers or a combination of both. Additionally, the psychometric properties of the instrument when used by proxy-respondents were not reported.

An Australian study sought to investigate medical disorders among 202 community-dwelling AWID (Beange, McElduff, & Baker, 1995). To assess physical activity, AWID and their caregivers were asked if they had engaged in vigorous exercise, defined as exercise “which made you breathe harder or puff and pant”, in the past two weeks. The authors do not report evidence of the validity or reliability of the questionnaire they used. Results found that 28% of men and 25% of women with an intellectual disability engaged in moderate-intensity to vigorous-intensity exercise in the preceding two weeks, compared to 51% of men and 35% of women without a disability (Beange, McElduff, & Baker, 1995).

A recent study used a structured interview format to explore the physical activity of adults with Down Syndrome and their siblings (Jobling, Cuskelly, & Rutherford, 2006). Participants with Down syndrome resided in the family home with their parents. The mean age of participants
with Down syndrome was 20 years 8 months. The mean age of siblings was 18 years and 3 months. Jobling and colleagues (2006) reported that the interview format used in the study was similar to the physical activity interview (Simons-Morton, Taylor, & Huang, 1994). Jobling and colleagues (2006) reported that this instrument has been shown to have 86% agreement between participant reports and observation of participant’s physical activity. However, the validity and reliability of the instrument when used with adults with Down syndrome is unknown. The interview required participants, with the assistance of their parents to recall their physical activity over two consecutive days, one of which was a weekend day. The time and intensity level of the activity was also recorded. The authors failed to describe the amount of assistance parents gave their children in recalling the physical activities they had engaged in and if the level of assistance differed between siblings. All participants were interviewed twice, two to four weeks apart. Jobling and colleagues (2006) reported that adults with Down syndrome participated in significantly less vigorous physical activity than their siblings. Adults with Down syndrome most frequently participated in walking and swimming whereas siblings partook in a variety of sports including football and netball.

Other investigations into the health characteristics and behaviours of AWID suggest that this population do not engage in sufficient amounts of physical activity (Janicki et al., 2002; Rimmer, Braddock, & Marks, 1995). Nursing staff and service co-ordinators reporting on the health status of 1371 AWID (aged 40-79 years) residing in group homes in two regions of New York State, United States of America, indicated that over 50% of participants engaged in no exercise and 43% exercised lightly (Janicki et al., 2002). Investigators used a non-standardised questionnaire requiring yes/no responses. Specific information or details of the validity and reliability of the instrument was not reported. A previous, smaller scale study on the health behaviours of ambulatory AWID (n = 329) residing in institutions, group or family homes examined participants health behaviours through a questionnaire that was completed by parents, guardians or staff members. Proxy responses indicated only 24% of participants regularly exercised, 33% exercised only one or two days per week and 25% never exercised. Not dissimilar to the studies discussed above, limited information is provided on the questionnaire, its’ psychometric properties or the validity of use with proxy-respondents and no direct measures were used in these studies to confirm proxy reports.

The NHANES III questionnaire was interviewer administered in an American study to report on the frequency and intensity of activities engaged in by AWID (Draheim, Williams, &
McCubbin, 2002). The validity of using this instrument with caregivers has not been investigated. Participants (n = 150) were volunteered, had a mild to moderate intellectual disability and resided in community based residences. Where necessary direct care providers supported participants to answer questions with which they required assistance. In contrast to findings of other studies, 42% of men and 47% of women were reported to participate in five or more bouts of moderate to vigorous leisure time physical activity per week. Data indicates that of this, only 1% of men and 1% of women engaged in regular vigorous-intensity leisure time physical activity. In comparison, 10% of men and 15% of women participated in no leisure time physical activity and 51% of men and 47% of women, reported participating in little to no leisure time physical activity. As recognised by Draheim and colleagues (2002), an overestimation of the prevalence of physical activity behaviour possibly resulted due to the duration of participant’s activity not being measured. The exclusion of duration of physical activity may explain differences in these results and of other recent studies (Draheim, Williams, & McCubbin, 2002). Not dissimilar to other studies (Draheim, Williams, & McCubbin, 2002; Rimmer, Braddock, & Marks, 1995; Stanish & Draheim, 2005; Temple & Walkley, 2003), the most frequent physical activity engaged in by AWID was walking, followed by cycling. Investigators believed walking was the primary independent means of transportation of participants in the study.

Smaller scale investigations report low levels of physical activity among the population. An English study investigating the daily physical activity of 24 adults with a mild and moderate intellectual disability indicates that AWID did not engage in sufficient activity to achieve a health benefit (Messent, Cooke, & Long, 1998). Based on participant interviews, followed with confirmation from day and residential staff where possible, investigators report that participants engaged in fewer physical activities than the general population. Ninety-three percent of participants did not engage in sufficient activity to meet the physical activity recommendations. Neither the reliability nor validity of the measure used was reported. A large number of participants in this study (n = 20) required constant supervision and were restricted to the home environment, unless supervised. Participants in this study reportedly spent over 90% of their time during the evening and weekends in their home environment. The effect of participant characteristics or living environment on their physical activity behaviour was not explored in this study but is likely to have influenced results (Messent, Cooke, & Long, 1998).
A major methodological limitation of many of the studies investigating physical activity among AWID is their reliance on measurement tools and/or procedures that have not been shown to be either valid or reliable when used with this population. As illustrated in Table 4, studies using indirect physical activity measures have used proxy-respondents or a combination of proxy-respondents and AWID to complete the interview or questionnaire. However, every study failed to describe the degree of assistance provided by proxy-respondents or evidence of the respondent’s ability to provide accurate and reliable information (Temple, Frey, & Stanish, 2006). Often studies have used indirect information to make inferences about the physical activity behaviour of AWID. Notwithstanding the weakness of reported research, studies using indirect measurement techniques, including physical activity questionnaires and observation, supports more recent evidence using direct and/or multiple data sources that AWID engage in less health-related physical activity than similar age and gender non-disabled peers. Evidence from studies using multiple data sources are seen in Table 2.

2.6 Energy Costs of Physical Activity

This section provides a description of the measurement of energy expenditure. The use of energy expenditure estimates in physical activity research has been outlined and evidence on the energy expenditure of different sub-populations undertaking a variety of activities of daily living (ADL) has been examined.

2.6.1 Energy Expenditure

Estimates of the energy cost of ADL can be derived through questionnaires, diaries, observations, direct calorimetry or indirect calorimetry assessments of a person’s daily activity (Department of Human Services, 1999; Montoye, Kemper, Saris, & Washburn, 1996). To gain comparative information from these data collection methods, data is analysed and converted to estimates of energy expenditure.

The total energy an individual expends is comprised of three components:

1. Basal Metabolic Rate (BMR). The BMR is the energy required to maintain normal bodily functions. BMR is affected by gender, age, weight, diet and physical activity. It is the largest component of total energy expenditure, accounting for 60 - 75% of a person’s total metabolic rate (McArdle, Katch, & Katch, 1991; Westerterp, 2003).
2. Thermogenic influence of food. The thermogenic influence of food refers to the effect energy expenditure resulting from the digestion, absorption and conversion of food to energy by the body. This accounts for approximately 5 to 10 percent of the average total daily metabolic rate of a person that consumes an average mixed diet that meets energy requirements (Pi-Sunyer, 2000; Westerterp, 2003).

3. Activity-Induced Energy Expenditure. Activity-induced energy expenditure is the energy expenditure associated with physical movement, ranging from small actions such as shivering or fidgeting to larger, more purposeful movements and physical activity such as running. The nature and duration of any type of physical activity engaged in largely influences the total amount of an individual’s daily energy expenditure. This component of total energy expenditure is the most variable and is reported to have the most profound effect (15 to 30 percent) on human energy expenditure (McArdle, Katch, & Katch, 1991; Pi-Sunyer, 2000; Westerterp, 2003).

2.6.2 Measurement of Energy Expenditure

The measurement of energy expenditure can be determined through direct or indirect calorimetry (McArdle, Katch, & Katch, 1991; Westerterp, 2003). Direct and indirect calorimetry are an accurate means to determine energy expenditure for ADL. Despite their accuracy, these methods can be problematic. They require trained personnel, are time-consuming, expensive and some ADL are not able to be replicated easily or at all in the clinical setting (Montoye, Kemper, Saris, & Washburn, 1996). In an attempt to overcome these issues, standard prediction equations have been developed that use data from more readily measurable variables. This is an inexpensive, universally available alternative approach that can readily be used in the field, but is more susceptible to errors (Gibney, 2000).

Direct calorimetry measures energy expenditure through the production of heat (Montoye, Kemper, Saris, & Washburn, 1996). Heat produced by an individual is measured in a sealed insulated chamber. Studies investigating the energy expended by humans, particularly during sporting, recreational and occupational related activities, have found direct calorimetry to be highly impractical (McArdle, Katch, & Katch, 1991; Montoye, Kemper, Saris, & Washburn, 1996). A suitable alternative is to measure human energy expenditure in a laboratory based setting by indirect calorimetry. This allows for energy expenditure estimates to be made
through the measurement of oxygen consumption and the production of carbon dioxide over a period of time (Montoye, Kemper, Saris, & Washburn, 1996).

2.6.3 Estimates of Energy Expenditure

Energy expenditure estimates are commonly used by researchers and physical activity specialists in the exercise science and public health fields to assist in interpreting information obtained from physical activity surveys. The Compendium of Physical Activities (CPA) is a resource that provides estimates of energy expenditure across a wide range of ADL. It is a widely regarded resource commonly referred to by researchers and specialists seeking information on the energy cost of common ADL.

All activities in the CPA are assigned an intensity level. The intensity level is based on the estimated rate per minute of energy expenditure for each activity. This is expressed as a metabolic equivalent (MET). One MET is considered a resting metabolic rate obtained during quiet sitting (Ainsworth et al., 2000). Activities are listed in the CPA as multiples of the resting MET level and range from 0.9 (sleeping) to 18 METs (running at 10.9 mph) (Ainsworth et al., 2000). Activities in the range of 3 - 6 METs meet the criterion for moderate-intensity activities and activities greater than 6 METs meet the criterion for vigorous-intensity activities (Brown, Ringuet, Trost, & Jenkins, 2001).

Despite widespread acceptance and use of the CPA, concerns have been expressed regarding the accuracy of the MET values that have been assigned to various household, lawn and garden, walking and some occupational activities (Brooks et al., 2004; Brown, Ringuet, Trost, & Jenkins, 2001; Dong, Block, & Mandel, 2004). Particular concerns have been raised for activities performed by older adults, people of non-caucasian race and women. It is argued that MET values assigned to these activities have not been objectively measured, but were only assigned an estimated value, thus leading to questions as to the accuracy of some of the assigned MET values (Ainsworth et al., 2000).

A recent Australian study investigated the energy expenditure of middle aged women (n = 36) during self-paced household and garden tasks (Brooks et al., 2004). To establish if the household tasks of sweeping, window cleaning, vacuuming and mowing were performed at a moderate-intensity (3 - 6 METs), energy expenditure was measured in the participant’s home and in the laboratory, using the same equipment. Women were excluded from the study if they
were smokers, had a history of any clinical eating disorder or had a diagnosed medical condition or were taking medication; all of which are known to affect a person’s metabolism. Results indicate that each activity was performed at a moderate-intensity (>3 MET). This suggests that these household and garden activities could contribute to the recommended 30 minutes a day of moderate-intensity activity required to obtain health benefits. The authors reported that due to between-subject variability, some participants performed the activities at less than 3 METs (light-intensity). This study illustrated that self-paced energy expenditure can be affected by factors including the environment and a person’s motivation.

Using a similar protocol and exclusion criteria to Brooks and colleagues (2004), a parallel South Australian study investigated the energy expenditure of middle aged males (n = 36) during self-paced household and garden tasks (Gunn et al., 2004). It was found that males performed each activity at an intensity level of three or more METs (moderate to vigorous intensity). All activities, except vacuuming in the laboratory, were significantly greater than 3 METs. These studies suggest that when engaged in for the appropriate duration and frequency by middle aged adults, these activities achieved an adequate intensity to confer a health benefit.

Debates over the accuracy of assigned MET values for various household, lawn and garden, walking and occupational activities have raised questions about the intensity level of domestic tasks and if they are sufficient to confer health benefits. Ordinary, everyday activities often make the greatest contribution to our daily energy expenditure (Dong, Block, & Mandel, 2004). To investigate this the energy expenditure of daily tasks of mothers of young children (n = 7) was explored in an Australian study (Brown, Ringuet, Trost, & Jenkins, 2001). Brown and colleagues (2001) investigated the energy cost of sitting quietly, vacuum cleaning, washing windows, walking at a moderate pace (approximately 5km/hour), walking with a stroller and grocery shopping. Activities were completed, as they would normally be in the participant’s own home using their own equipment. For the walking activity a research assistant walked with the participant to maintain the correct pace. The shopping activity was completed in a supermarket close to the participant’s homes. Energy expenditure levels were found to be highest when walking with a stroller. Results indicated that vacuum cleaning (3.6 METs), window washing (3.2 METs) and walking with and without a stroller (4.9 and 3.8 METs respectively) were classified moderate-intensity activities. Sitting (1.1 METs) and grocery shopping (2.3 METs) were activities that did not reach the criteria for moderate-intensity activity.
A comparison between Brown and colleagues (2001) study and the CPA revealed similar MET values for most of the reported activities. However, for both walking with and without a stroller MET values reported by Brown and colleagues (2001) were higher than that reported in the CPA. The CPA underestimated by nearly 2 METs the energy cost of walking with a stroller. This variability may be accounted for by environmental conditions, in this case terrain, speed, stroller type and child’s weight (Brooks et al., 2004). The energy expenditure for walking, vacuum cleaning and grocery shopping of mothers in Brown and colleagues (2001) study are comparable with a study by Bassett and colleagues (2000). Bassett and colleagues (2000) investigated the validity of motion sensors when used by 19 - 74 year olds (n = 81) across a range of ethnic backgrounds. The authors reported that MET values for walking and vacuum cleaning were found to be of moderate-intensity. These findings add to the growing evidence that some household activities are performed at a sufficient intensity to confer some health benefit.

Inaccuracies in the CPA have also been attributed to variances among body mass and body fat percentage. A study investigating weight-bearing activities found that the energy costs reported in the CPA were inaccurate, underestimating the energy cost of weight bearing activities, for the sample population (Howell, Earthman, Reid, Delaney, & Houtkooper, 1999). Variances in energy cost have been shown to apply to people of different ages, disability, cardio-respiratory fitness levels, and mechanical efficiency and when activities are performed in different environmental conditions (Brooks et al., 2004; Suzuki et al., 1991; U.S. Department of Health and Human Services, 1996).

Despite the criticisms of the CPA, a strong view exists that it has well served its purpose. The primary purpose of the CPA was to allow physical activity specialists to use a standardised coding system that compares data across physical activity survey instruments and research (Ainsworth et al., 2000). Recent research has however explored and questioned the effect of individual differences, disabilities and other conditions on metabolic efficiency (Brown, Ringuet, Trost, & Jenkins, 2001; Mil et al., 2000; Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005; Pi-Sunyer, 2000).

2.6.4 Energy Expenditure of Sub-populations

Energy expenditure can vary dramatically among individuals (Schulz & Schoeller, 1994) and different groups (Schoeller & Fjeld, 1991). A study of 7,515 adults (3,330 males; 4,185
females) investigated how much energy activities including sitting, sleeping, leisure time and household related activities contributed to total energy expenditure (Dong, Block, & Mandel, 2004). The authors used data from the National Human Activity Pattern Survey collected between 1992 and 1994. Dong and colleagues (2004) found that leisure time physical activity accounted for only 5% of total daily energy expenditure. In comparison, household related activities accounted for 27% of total energy expenditure. ‘Sleeping or napping’, which was found to be the largest component of energy expenditure, and sitting quietly, accounted for 19% and 5.8% of total daily energy expenditure. Other light-intensity activities, including driving, office work and watching television accounted for 10.9%, 9.2% and 8.6% respectively of total daily energy expenditure.

The type of activities commonly engaged in by an individual will contribute to the variability in the total energy expended by an individual. Studies exploring total daily energy expenditure in obese adults have shown that obese individuals expend more energy in comparison to non-obese individuals while undertaking the same task (Casper, Schoeller, Kushner, Hnilicka, & Gold, 1991; Meijer, Westerterp, Van Hulsel, & Ten Hoor, 1992; Pi-Sunyer, 2000). The increased levels of fat free mass in the obese has been offered as an explanation for this difference (Pi-Sunyer, 2000; Schoeller & Fjeld, 1991). Results of these studies are supported by a recent review exploring the effect of vigorous-intensity and non-vigorous-intensity activity on energy expenditure (Westerterp, 2003). The authors reported that people who are obese spend more energy on physical activities. In contrast a study exploring energy expenditure in 10 - 11 year old lean and obese children (n = 46) found no differences in resting metabolic rate (RMR), activity induced energy expenditure or total daily energy expenditure (DeLany et al., 1995). A meta-analysis of 13 published studies in adults (n = 162) yielded similar results (Carpenter, Poehlman, O'Connel, & Goran, 1995).

Investigators have explored differences in energy expenditure between active and sedentary groups (Horton & Geissler, 1994). In determining the effect of habitual exercise patterns on metabolic rate and daily energy expenditure, Horton and Geissler (1994) compared sedentary, moderately and highly active male adults. The authors defined sedentary as no or little, weekly, regular exercise. Moderate-intensity physical activity was defined as engaging in an average of six hours of weekly physical activity. The highly active group comprised of competitive amateur sportsmen that trained 12 - 16 hours per week. Participants (n = 30) were matched for height (± 5cm), weight (± 3kg) and age (± 5yrs). Energy expenditure was measured for 24
hours on two occasions; a sedentary day and an exercise day. Standardised cycling and stepping exercises were completed on the exercise day. A significant difference in the energy expenditure measured over a 24-hour period was found between the highly active and sedentary group.

Individual characteristics can alter energy expenditure (Gibney, 2000; Kimm, Glynn, Aston, Poehlman, & Daniels, 2001). It is therefore important to recognise discrepancies may exist between the characteristics of the populations upon which predictive equations are based (Reeves & Capra, 2003). For example, a persons energy requirements and metabolism are altered during times of injury and disease (Gibney, 2000; Toth, 2000). Subsequently, caution is necessary in estimating energy requirements of sub-populations (Reeves & Capra, 2003). Recognising this, investigators have developed injury or stress factors to incorporate into equations for populations including the critically ill and burns patients (Ireton-Jones, Turner, Liepa, & Baxter, 1992; Swinamer et al., 1990; White, Shephard, & McEniery, 2000).

Few investigations have explored the energy expenditure of people with a disability. One such study among people with Prader-Willi syndrome (PWS) further illustrates differences in energy expenditure between groups (Mil et al., 2000). A contributing factor to a high prevalence of obesity among people with PWS is a low BMR. To investigate this phenomena Mil and colleagues (2000) measured the BMR and sleeping metabolic rate (SMR) of 17 people with PWS (8 – 20 years) and 17 obese control subjects, matched for sex and bone age. BMR and SMR of children and adolescents with PWS were significantly lower than sex and bone age matched control subjects. When adjusted for fat free mass, no significant difference was seen between the people with and without PWS. A lower than average BMR in people with PWS is consistent with past studies (Bakke, Draheim, Mendoza, & Serfass, 1995) however, these studies did not have control groups and were based on small sample sizes. A previous study comparing children and adolescents with PWS (n = 10) with healthy school children (n = 60), found similar results to Mil and colleagues (2000) with investigators concluding that reduced levels of energy expenditure in people with PWS is explained by low levels of fat free mass (Davies & Joughin, 1993).

Studies investigating energy expenditure do not commonly include AWID. The feasibility of measuring resting energy expenditure among AWID was explored by Pitetti (1993). A secondary purpose of this study was to establish the resting energy expenditure of AWID with and without Down syndrome to determine if a difference existed between these two groups.
Twenty-one AWID (10 without Down syndrome, 11 with Down syndrome) participated in the study. AWID were fasted and were rested in a supine position 30 minutes prior to the testing. A metabolic cart was used to determine oxygen consumption. Twenty of the 21 AWID complied with the investigators instructions and successfully completed the testing procedures. Results found no difference in resting energy expenditure between AWID with and without Down syndrome. For any firm conclusions to be made on similarities or differences in the resting energy expenditure of AWID with and without Down syndrome further investigation is required with a greater number of participants (Pitetti, 1993).

A Japanese study is one of the more recent studies to examine characteristics of energy expenditure among 23 male AWID aged between 18 – 49 years (Iwaoka et al., 1998). Individuals were excluded from the study if a specific cause of intellectual disability was identified, such as Down syndrome, if they had a chronic disease or were taking medication that may affect growth or body composition. Controls (n = 23) were individually paired and matched for age (± 3yrs), height (± 4cm) and weight (± 9kg). Energy expenditure of participants was measured when sitting, standing and walking at 30, 50 and 70m/min. No significant difference was found for basal or resting metabolic rates between the groups. Significantly higher energy costs were found for the sitting, standing, and walking at 30 and 50m/min tasks among AWID participants compared to their matched peers without a disability (p < 0.05). No significant difference was found for the fastest walking speed (70 m/min).

Iwaoka and colleagues (1998) found that maintaining a speed of 70m/min was too difficult for many AWID participants. Their actual speed varied between 50 to 70m/min resulting in the energy expenditure of AWID participants being underestimated in this condition. The authors concluded that adult men with an intellectual disability expended more energy and are less economical than their male counterparts without an intellectual disability when performing physical tasks, even very mild tasks. Iwaoka and colleagues (1998) surmised that their findings could be a result of (1) a lack of co-ordination when engaged in physical tasks, identified by a ‘clumsy’ walk (2) small, possibly unobservable movements during sitting and standing and/or (3) the sedentary lifestyles commonly engaged in by AWID.

The physical movement and metabolic capacity of skeletal muscle was explored by Ohwada, Takeo, Suzuki, Yokoyama and Ishimaru (2005), in the same participants, to investigate possible reasons for the metabolic difference observed by Iwaoka and colleagues (1998). Body movements were measured using a 3-dimensional accelerometer. The metabolic capability of
skeletal muscle was found to be similar among the two groups, adults without an intellectual disability (AWOID) and AWID. In comparison, subtle body movements were reported for all except one AWID, and no AWOID. For the walking activities body movements were greater among AWID in comparison to AWOID by 60% for 30m/min, 50% for 50m/min and 51% for 70m/min. Ohwada and colleagues (2005) concluded that excess body movements among male AWID accounted for differences in energy expenditure between the two populations. Results suggest that the current energy expenditure values designed for use with the general population are inappropriate for use in the assessment of energy expenditure during ADL of AWID (Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005).

Emerging evidence indicates that the energy costs of AWID performing physical tasks differ to that of the general population (Iwaoka et al., 1998; Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). This suggests energy expenditure estimates for ADL derived from research with the general population could therefore be misleading and not valid for use with AWID (Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). Further studies on the energy cost of particular activities among specific populations are needed to establish if energy expenditure estimates for ADL derived from research with the general population are misleading and not valid for use with AWID (Montoye, Kemper, Saris, & Washburn, 1996; Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005).

2.7 Proxy-respondents

This section provides an overview of the literature related to the use of proxy-respondents in the collection of information on behalf of another person. Reasons why proxy-respondents are used in research, agreement between and the inter and intra-reliability and validity of proxy-respondents are discussed. Researchers have commonly used Kappa values (?) and intra-class correlations to discuss their results and have considered values less than 0.40 to indicate poor agreement, values between 0.40 and 0.75 to indicate moderate to good agreement and values greater than 0.75 to indicate excellent agreement (Fleiss, 1981; Landis & Koch, 1977). Limited evidence is available on the reliability and validity of proxy-respondents for AWID in physical activity research. This section has therefore reviewed related areas in which proxy-respondents have been used, including quality of life, health related behaviours and physical activity among different populations including adults, children, people with a disability and intellectual disability.
2.7.1 Proxy-respondents in Research

Epidemiological research relies heavily on participant self-reported information. Various barriers impede researchers from obtaining data directly from vulnerable groups (Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). Age, verbal, sensory, physical and cognitive factors are barriers that can limit a participant’s ability to accurately complete self-report questionnaires (Koch, Marks, & Tooke, 2001; Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). Often investigators find the many complexities encountered when conducting research with vulnerable groups, such as AWID, makes obtaining data inherently difficult (Lefort & Fraser, 2002). When a person needs assistance or is unable to personally respond to a questionnaire, researchers have used proxy-respondents to obtain information about the person. Proxy-respondents, who may include parents, partners, siblings, caregivers, live-in-companions, close friends or adult children have been used in studies involving the aged (Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997; Neumann, Araki, & Gutterman, 2000), children (Dusza, Oliveria, Geller, Marghoob, & Halpern, 2005; Telford, Salmon, Jolley, & Crawford, 2004; Verrips, Vogels, den Ouden, Paneth, & Verloove-Vanhorick, 2000), sick and infirmed (Rothman, Hedrick, Bulcroft, Hickman, & Rubenstein, 1991) and those with language or cognition problems and/or other disabilities (Andresen, Victoria, & Donald, 2001; Cusick, Brooks, & Whiteneck, 2001; Janicki et al., 2002; Stanish & Draheim, 2005). It is not uncommon for parents to act as proxy-respondents for their children or for parents or caregivers to provide information on behalf of the aged or disabled (Janssen, Schuengel, & Stolk, 2005; Koch, Marks, & Tooke, 2001; Rajmil et al., 1999).

2.7.2 Reliability and Validity of Proxy-respondents

The criteria against which proxy reports are compared is of great importance (Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). In the clinical and research settings it is often assumed, and remains unchallenged that adults adequately answer on behalf of a child (Eiser & Morse, 2001). A criterion is essential in order to determine the feasibility and potential limitations of using proxy-respondents (Hays, 1995) and assists in determining if information obtained from proxy-respondents is sufficiently similar to what the individual would themselves provide (Stancliffe, 2000). Researchers have compared proxy-respondent reports with responses from participants, a third respondent including relatives, friends or health care providers and when available direct measures including medical reports. None-the-less the reliability and validity of proxy-respondents has received little evaluation.
Difficulties are associated in using participants or significant others as a criterion to compare proxy-respondent reports against. It is not always possible to determine the accuracy of responses provided by proxy-respondents (Sneeuw et al., 1997). An inability of AWID to express themselves results in the lack of a standard for validation research among this population (Janssen, Schuengel, & Stolk, 2005). The need to determine whose response should be conformed to, or if both responses are a true reflection of what the participant and proxy-respondent individually believe underpins the reliability of participant-proxy-respondent reports (Stancliffe, 1999). In fields such as quality of life a participant’s perception may differ depending on their own unique situation. Furthermore, it is possible that participants in a study do not, for whatever reasons, provide investigators with an accurate response (Rothman, Hedrick, Bulcroft, Hickman, & Rubenstein, 1991). The question as to whose response should be taken as the gold standard therefore becomes an issue.

For people with profound multiple disabilities important characteristics of quality of life (QOL) may not include many of the more traditional aspects such as productivity and independence. This could result from a lower level of functioning, complex and specific needs and a higher level of dependency in the daily life of people with profound multiple disabilities in comparison to people with a mild or without a disability (Petry & Maes, 2006). The way in which individuals own values can influence responses is seen in a study investigating life satisfaction of 93 adults with a mild or moderate intellectual disability living in a community based residence in Israel (Schwartz & Rabinovitz, 2003). Participants worked in either a sheltered workshop or market. Proxy-respondents were staff from the community residence of the AWID (n = 45) and a parent that had extensive direct contact with the AWID (n = 93). Parents and staff self-completed a 31-item life satisfaction scale requiring yes or no answers. The scale focused on areas including satisfaction with current residence, use of free time, community services and employment. The authors report a significant interaction between employment setting and life satisfaction. Staff rated the AWID satisfaction for employment in an integrated setting significantly higher than the AWID and parent reports. A significant interaction was not found for participants working in a non-integrated employment setting. These results may be reflective of differences in the staff, parents and AWID values which inturn influence their judgement as to the life’s satisfaction of another person.
2.7.3 Agreement between Observable and Non-observable Variables in Proxy Reporting

Differences in the methodologies used in studies that have investigated agreement between participants and proxy-respondents make it difficult for direct comparisons to be made. Notwithstanding this, studies consistently indicate greater levels of agreement for directly observable measures and variables regarding recent events (Neumann, Araki, & Gutterman, 2000). Levels of agreement for non-observable measures, including emotional or social health reports, are not as accurate as observable variables (Jokovic, Locker, & Guyatt, 2004).

Levels of agreement between participant and proxy-respondents for observable and non-observable measures have been investigated in a study on the health related quality of life of 14 year olds (Verrips, Vogels, den Ouden, Paneth, & Verloove-Vanhorick, 2000). Proxy-respondents consisted of the child’s parent, of which over 80% were mothers. Participants and proxy-respondents completed an interview via telephone and face-to-face interview. Proxy-respondents were also sent a questionnaire by mail. Questions were asked about objective and non-observable domains including motor functioning, autonomous functioning, cognitive functioning, social functioning, positive and negative moods. Greater inter-rater agreement was reported for the more observable domain of motor functioning (ICC = 0.67 - 0.72) in comparison to the more subjective non-observable domain of social functioning (ICC = 0.27 - 0.43), and mood (ICC = 0.40 - 0.46).

Similar findings are reported for studies involving proxy-respondents with older adults (Neumann, Araki, & Gutterman, 2000). Neumann and colleagues (2000) reviewed studies between 1990 and 1999 that used information obtained from proxy-respondents as a source of data with adults over the age of 60 years. The authors believed that although studies varied in their methods, overall agreement was good in assessments of functioning, physical health and cognitive status and fair to poor for subjective variables relating to psychological well-being. These key findings were clearly illustrated in a study investigating functional status of 233 aged participants (65+ years) with a hip fracture (Magaziner, Zimmerman, Gruber-Baldini, Hebel, & Fox, 1997). Participants identified a person they regarded as most knowledgeable about their health to act as a proxy-respondent. Proxy-respondents were predominantly female (77%) and consisted of children (38%), spouses (17%) and other relatives (28%). Thirty-eight percent of the proxy-respondents lived with the participant. Participants were interviewed in their place of residence while proxy-respondents completed a telephone interview. Agreement for observable domains, including social functioning, was substantial with respect to the number of activities...
performed by the participant (ICC = 0.61), as with questions relating to the number of minutes spent per day engaged in activities such as reading and watching television (ICC = 0.62).

Similar results are seen in a study investigating medical history and lifestyle factors of 224 healthy steel workers (Okamoto et al., 1999). Male (n = 192) and female (n = 32) participants aged between 19 - 67 years completed a self-administered questionnaire at their annual medical check-up. The participant’s partners completed the same self-administered questionnaire approximately four to five weeks later. Proxy-respondents were asked not to consult their husband or wife, however it is unknown if this request was adhered to. Despite a delay of between four to five weeks between the completion of participant and proxy-respondent reports, the authors believe that consistency in the participant’s lifestyle would not affect level of agreement. Consistent with other studies, a higher level of agreement was seen for directly observable variables including smoking; $\gamma = 0.86$, and drinking habit; $\gamma = 0.71$. Level of agreement was not as great for variables that were not as easily observable or that required more detailed information, including general life stress; $\gamma = 0.34$, number of cigarettes smoked per day; $\gamma = 0.60$, and quantity of alcohol consumed; $\gamma = 0.63$.

2.7.4 Relationship between Participant and Proxy-respondent

The relationship between a participant and proxy-respondent can influence the reliability of a proxy-respondents report (Chang & Yeh, 2005; Steel, Geller, & Carr, 2005). A good knowledge of, relationship with and regular contact with the participant is important when responding to questions on behalf of another (Stancliffe, 2000). The number of years in which a participant and proxy-respondent have known each other, if they have resided together, and the frequency of contact are important characteristics to consider when using proxy-respondents (Cusick, Brooks, & Whiteneck, 2001).

The influence of the relationship on level of agreement between a participant and proxy-respondent was investigated in a study exploring cardiovascular disease and oral contraceptives among women aged between 20 - 44 years (Poulter, Chang, Farley, & Marmont, 1996). Proxy-respondents (husbands or partners, n = 242; mothers, n = 61; sisters, n = 60; others, n = 40) were questioned on the age, parity, marital status, educational attainment, smoking habit, alcohol consumption, family history of cardiovascular disease, medical and contraceptive history. The authors report that agreement between participants and proxy-respondents, no matter the relationship, provided reliable information for lifestyle variables including alcohol
and smoking habits, marital status and educational attainment (?= 0.85 - 0.94) and contraceptive use (?= 0.75 - 0.88). Among the proxy-respondent groups, husbands provided more reliable information about contraceptive use (husbands ?= 0.90 - 0.92; mothers ? = 0.49 - 0.88; sisters ? = 0.75 - 0.88) and contraceptive brand (husbands ? = 0.39 - 0.72; mothers ? = 0.11; sisters ? = 0.14 - 0.30). The authors attribute these results to a reported lower number of ‘don’t know’ responses from husbands and believe that the optimal proxy-respondent appears to be question specific.

Levels of agreement between participant and proxy-respondent have commonly been investigated among groups that have been shown cannot accurately report their own behaviours. A study investigating the lifestyle and medical history of steel workers (n = 224) is one of the few studies that has investigated agreement among a population that can accurately indicate their responses (Okamoto et al., 1999). To allow for a true comparison of agreement between responses from participants and proxy-respondents (wives n = 192; husbands n = 32) a self-administered questionnaire was completed by both parties. One component of the questionnaire investigated physical exercise but this was not described in detail by investigators. Although partners tended to under report physical exercise in comparison to their spouse, moderate agreement was found for this variable (? = 0.65). Overall, good to excellent agreement was found between proxy-respondents and their partners for epidemiological information.

Similarly, research on the physical and psychosocial health status of elderly patients enrolled in a national study of Adult Day Health Care (n = 275) found proxy-respondents and participants with a close relationship of a care-giving nature can provide responses that could be expected from the participant themselves in the physical domain area (Rothman, Hedrick, Bulcroft, Hickman, & Rubenstein, 1991). Strong correlations were reported on the physical health status of participants (r = 0.72), however a weaker correlation (r = 0.33) was observed for the psychosocial dimension. Unlike Okamoto and colleagues (1999), participants of Rothman and colleagues (1991) study identified a proxy-respondent that provided ongoing care (spouse, other relative or friend). Seventy-seven percent of proxy-respondents were a spouse (mean age = 61.5 years), 95% were women and 87% resided with the participant. The Sickness Impact Profile was self-administered by proxy-respondents whereas participants were interviewed by trained observers. Despite differences in mode of administration, participants and the type of relationship to the proxy-respondent (caregivers or partners), all proxy-respondents were
reported to have a close relationship to the participant. None-the-less agreement between participants and proxy-respondents in the two studies were similar.

The influence of demographic, medical and lifestyle factors on the accuracy of different proxy-respondents has also been investigated (Nelson, Longstreth, Koepsell, Checkoway, & Belle, 1994). Proxy-respondents included a spouse, an immediate family member, other relatives or friends in a dependent like relationship with the participant (n = 283). Proxy-respondents, recruited in the order of spouse, sibling, son or daughter, parent, other relative, and friend were interviewed by trained interviewers. The authors reported that overall agreement ranged from moderate to good (κ = 0.50 - 0.85). Kappa values for the lifestyle factor of recreational physical activity indicated moderate to good reliability (κ = 0.66). Questions requiring more detailed information on physical activity, including minutes engaged in physical activity per week and kilocalories expended per week in recreational activity, yielded moderate to good agreement between proxy and participant reports (minutes ICC = 0.55; kilocalories ICC = 0.56). Excellent levels of agreement were found between participants and proxy-respondent reports in the friend/other category for both the broad indicators of physical activity, including physically active and intensity classification, and the more detailed aspects of physical activity (ICC range = 0.73 – 0.78). Agreement between participants and husband/wife proxy-respondent reports ranged from 0.52 to 0.66 for the broad area of physical activity but were not as strong for the more detailed aspects (ICC = 0.48 - 0.55). In comparison, agreement between participants and sibling or parent proxy-respondent reports ranged from 0.66 to 0.83 for the broad area of physical activity and 0.60 to 0.63 for the more detailed aspects. Levels of agreement between participants and son/daughter proxy-respondent reports ranged from 0.61 to 0.62 for the broad area of physical activity and were weaker for the more detailed aspects (ICC = 0.51 - 0.54).

Proxy-respondents for the aged and disabled often include individuals providing a care-giving role. Care-givers have an important role in the health and welfare of those they support (Keywood, 2003) and are responsible for many of the experiences and opportunities available to those in their care (Schwartz & Rabinovitz, 2003). It is expected that caregivers acting as proxy-respondents can accurately report the perceptions of those in their care, especially for caregivers responsible for daily care (Janssen, Schuengel, & Stolk, 2005). The validity of responses from caregiver proxy-respondents are questionable (Schwartz & Rabinovitz, 2003). Schwartz and Rabinovitz (2003) reported that staff proxy-respondents overestimated life satisfaction of AWID and concluded that this could be a consequence of the staff proxy-
respondent’s desire for positive outcomes of their work, even if these beliefs are not a reflection of the participant’s reality.

2.7.5 Parents as Proxy-respondents

Studies involving children often use parents as proxy-respondents. Research into the physical activity behaviours of children have used parents to recall their child’s physical activity behaviours (Sallis & Owen, 1999). Other health related studies have used parents to complete health questionnaires (Rajmil et al., 1999). Parents are commonly used as proxy-respondents in research with children (Jokovic, Locker, & Guyatt, 2004; Ronen, Streiner, Rosenbaum, & the Canadian Pediatric Epilepsy Network, 2003; Telford, Salmon, Jolley, & Crawford, 2004) as it is deemed children are unable to accurately provide the necessary information. It has been suggested that children under 10 years of age cannot accurately recall or self-report their physical activity and self-reported physical activity data should be used cautiously with 10-15 year olds (Sallis & Owen, 1999).

Researchers investigating health related areas among children have developed specific questionnaires to enable parallel parent-child reporting (Jokovic, Locker, & Guyatt, 2004). This involves the parent and child completing a near identical questionnaire. Studies on health related quality of life, which focuses on the areas of pain and symptoms, motor functioning, autonomous functioning, cognitive functioning, social functioning, positive and negative moods report conflicting findings in respect to level of agreement between parent-proxy-respondent reports and children’s self-report needs, ranging from low (Vogels et al., 1998) through to moderate to substantial agreement (Theunissen et al., 1998).

Levels of agreement between parent and child reports vary depending upon the variable under investigation and with different variables within the same topic (Dusza, Oliveria, Geller, Marghoob, & Halpern, 2005; Jokovic, Locker, & Guyatt, 2004). A study into sun protection practices and sun exposure among grade six and seven students (n = 50) and their parents highlights this phenomenon (Dusza, Oliveria, Geller, Marghoob, & Halpern, 2005). Proxy-respondents, predominately mothers (85.7%), and participants self completed a questionnaire about sun behaviours and practices of the participant. The authors reported good agreement for variables including skin colour (? = 0.73), sunscreen use (? = 0.52) and number of sunburns in the past summer (? = 0.55). Moderate agreement for questions focusing on limiting time in the sun (? = 0.44) and wearing of sunscreen at the pool, beach or outdoors (? = 0.32) was found. In
Contrast poor agreement was reported for variables including wearing of a shirt (\(\rho = 0.08\)) and hat (\(\rho = 0.28\)), sitting in the shade (\(\rho = 0.23\)) and parents applying sunscreen to the participants back (\(\rho = 0.27\)). Comparable findings on a similar topic, melanoma risk factors, are reported in a previous Australian study (Whiteman & Green, 1997).

Whiteman and Green (1997) investigated risk factors for melanoma among children. Parents, predominately mothers, and children self-completed a questionnaire on the child’s physical characteristics, characteristics associated with sun sensitivity and history of sunburn. The greatest agreement was found for general physical characteristics including eye colour (\(\rho = 0.88\)) and hair colour (\(\rho = 0.76\)). The authors report moderate levels of agreement for characteristics including freckling on the face (\(\rho = 0.62\)), tanning ability (\(\rho = 0.47\)), and reports of blistering sunburn (\(\rho = 0.35\)). No uniformity was found between child and parent reports (\(\rho = 0.11 – 0.88\)). The age of the population, variables under investigation, and high proportion of mothers as proxy-respondents was similar between Dusza and colleagues (2005) and Whiteman and Green (1997) studies. Despite this, caution is necessary in comparing and generalising results as the studies used different methodologies and questionnaires and the author’s use of terminology (i.e. good, moderate) were not consistent. Although Whiteman and Green (1997) provided some support for the reliability of responses by young people, they did not explore the data’s validity. Nevertheless, the authors confidently reported that levels of reliability or agreement in parent-child parallel reporting is dependent on the information being sought. This is consistent with other studies which indicate that in comparison to more subjective variables, proxy-respondent reports are more reliable for directly observable measures (Jokovic, Locker, & Guyatt, 2004).

The Children’s Leisure Activities Study Survey (CLASS) was developed to measure the physical activity of children aged 5 -12 years (Telford, Salmon, Jolley, & Crawford, 2004). As self-report instruments have been shown to be inappropriate for use with children under 10 years old, investigators designed a self-report and proxy-report instrument. Proxy-respondents (n = 111) for 10-12 year old children were their parents, of which 83% were women. Questionnaires required participants to indicate from a checklist the activities their child engaged in during a typical week. For these activities they were then asked to report the frequency and total time their child engaged in the activity. An MTI (formally CSA) accelerometer was worn by children over eight days as a criterion measure. Agreement of 70% or greater was found between the parent proxy-respondent and child self-report questionnaires.
for 24 of the 29 items. A correlation of 0.45 or higher was found for frequency and duration of physical activity. Overall, correlations were not as strong between the proxy-respondent and child self-report questionnaires for overall moderate-intensity (frequency, \( r = 0.07 \); duration \( r = 0.14 \)), vigorous-intensity (frequency, \( r = 0.49 \); duration \( r = 0.48 \)) and total physical activity (frequency, \( r = 0.14 \); duration \( r = 0.25 \)). The authors reported that the proxy-respondent CLASS questionnaire provided reliable estimates of physical activity between school age children and their parents.

A common occurrence in health related quality of life research is for parent proxy-respondents to produce lower scores than their child (Ronen, Streiner, Rosenbaum, & the Canadian Pediatric Epilepsy Network, 2003). Parents and children can place different values on different aspects of their life and therefore interpret and/or respond to the same questions from different perspectives (Jokovic, Locker, & Guyatt, 2004). A comparison of parent and child reports may therefore present a different perspective, each as valuable as the other (Eiser & Morse, 2001).

As children age they become more independent and parents become less knowledgeable about aspects of their child’s life (Jokovic, Locker, & Guyatt, 2004). This can result in differences in child-parent parallel reporting. A Canadian study investigating parental knowledge of oral health related quality of life illustrates how a parent’s lack of knowledge in an aspect of their child’s life can influence their response (Jokovic, Locker, & Guyatt, 2004). During the questionnaire development phases, parents reported difficulties in responding to some questions. Rather than compromising the content validity by excluding some questions, investigators included a ‘don’t know’ response within the questionnaire. Reflective of the change that occurs in a child-parent relationship, as a child ages and becomes more independent, age was found to have a consistent effect on the number of ‘don’t know’ responses in Jokovic and colleagues (2004) study. This was reported to be a significant predictor for variables relating to oral symptoms, emotional and social well-being. Almost half of the parents in the study responded ‘don’t know’ to at least one of the questionnaire items and a quarter of the parents responded ‘don’t know’ to three or more items. Overall, the social well-being scale, a scale concerned with activities, events and relationships that are not immediately observable by parents, yielded the greatest number of ‘don’t know’ responses. Investigators concluded that a parents understanding and knowledge of their child’s activities, relationships and thoughts are limited, mainly to occurrences that commonly occur within the family context.
2.7.6 Disability and Proxy-respondents

A lack of research exists related to the accuracy of proxy-respondents for adults with disabilities. Available evidence suggests that self-selected proxy-respondents can provide comparable responses provided by people with disabilities (Cusick, Brooks, & Whiteneck, 2001). Cusick and colleagues (2001) assessed levels of agreement in reporting community integration outcomes between people with disabilities. Disability was a result of amputation (n = 83), burns (n = 65), multiple sclerosis (n = 235), spinal cord injury (n = 224), stroke (n = 177) or traumatic brain injury (n = 199). Participants self selected a proxy-respondent (spouse 43%, parent 18%, other family member 14% or others 25%). Participants and proxy-respondents completed a telephone interview two weeks apart. The authors reported moderate to strong intra-class correlations across the six disability groups, ranging between 0.35 and 0.97. Correlations for amputees ranged from -0.02 to 1.00; 0.10 to 1.00 for burn patients and 0.13 to 0.99 for people with multiple sclerosis; 0.08 to 0.97 for participants with a spinal cord injury; 0.43 to 0.97 for stroke and 0.21 to 1.00 for traumatic brain injury. Previous studies with PWD and their proxy-respondents support these findings (Cusick, Gerhart, & Mellick, 2000).

Another study explored differences in levels of agreement between participants with a disability and different proxy-respondents with respects to health-related quality of life (Andresen, Victoria, & Donald, 2001). Participants (n = 131) were recruited from nursing homes, assisted and independent living centres, and provider/service organisations for people with Spinal Cord Injury, Multiple Sclerosis, Parkinson’s disease and Traumatic Brain Injury. Participants were also recruited from a medical practice and a prepaid managed care plan. Participants identified a person familiar with them to be their proxy-respondent. Family members (n = 78), health care providers (n = 34) and friends (n = 32) were identified. Participants in nursing homes commonly identified a health care provider, such as a nurse, that regularly cared for them as their proxy-respondent. Participants residing in independent living centres that identified health care providers named personal care assistants as their proxy-respondents. In comparison participants in assisted and independent living centres commonly named close friends as proxy-respondents.

Participants and proxy-respondents in Andresen and colleagues (2001) study completed a questionnaire exploring medical outcomes, basic and instrumental ADL. Instrumental activities of daily living (IADL) questions, assessed functional limitations using the telephone and in transportation, shopping, meal preparation, housework or handyman work, laundry, taking
medications and money management. Items in the ADL category included questions relating to transfer, dressing and bathing. Where necessary, questionnaires were completed in person or else in the form of a computer-assisted personal interview or by telephone. The telephone was the preferred method, occurring 91.6% of occasions for participants and 99.2% of occasions for the proxy-respondents. The mean amount of time between participants and proxy-respondents completing the questionnaire was 19 days. Excellent agreement (ICC = >0.75) between participants and proxy-respondents for ADL summary scores was reported. Family proxy-respondents were found to exhibit greater levels of agreement. An intra-class correlation coefficient of 0.87 was reported for ADL and 0.75 for IADL for family proxy-respondents; 0.86 for ADL and 0.70 for IADL for friends and 0.84 for ADL and 0.74 for IADL for health care providers. When discrepancies in responses existed, family responses were more discordant than friends or healthcare providers. Despite minimal differences between the three proxy-respondent groups, health care providers tended to indicate that the participant required more assistance than necessary or were more dependent on others than they actually were. It was found that 20% more health care providers than participants reported that the participant required help to get across a small room. This is consistent with previous quality of life studies of proxy reporting among the aged (Ostbye, 1997; Rothman, Hedrick, Bulcroft, Hickman, & Rubenstein, 1991).

Researchers have recently investigated the level of agreement between parents and their children, aged between 6 – 13 years, with cystic fibrosis (Czyzewski, Mariotto, Bartholomew, LeCompte, & Sockrider, 1994). A validated quality of life questionnaire, the Cystic Fibrosis Questionnaire, was administered to 29 of the 36 children participating in the study. Seven children aged 12 and 13 years, and all parents participating in the study self-completed the questionnaire. The questionnaire included seven domains: respiratory symptoms, digestive symptoms, physical symptoms, emotional functioning, body image, eating disturbances and treatment burden. Intra-class correlation coefficients found excellent agreement between parent and child reports for treatment burden (ICC = 0.75) and moderate agreement for respiratory symptoms (ICC = 0.50), digestive symptoms (ICC = 0.41), and body image (ICC = 0.40).

2.7.7 Intellectual Disability and Proxy-respondents

Proxy-respondents are used in many aspects of an AWID life (Koch, Marks, & Tooke, 2001). Parents and caregivers often assist an AWID with decision making and in other circumstances where AWID are deemed to lack the capacity (Keywood, 2003), or their disability inhibits them
from being able to participate, make an appropriate informed decision or accurately articulate their thoughts or concerns (Koch, Marks, & Tooke, 2001). This is common in quality of life (QOL) research, where AWID can have profound to moderate problems in communicating issues surrounding their perceptions of life (McVilly, Burton-Smith, & Davidson, 2000). Although proxy-respondents are common in the life of many AWID, minimal research exists regarding the validity and reliability of proxy-respondents in health related areas such as physical activity for this population.

Researchers have used proxy-respondents to investigate variables including QOL and physical activity among AWID. Results of studies into the validity and reliability of proxy-respondents in QOL research among AWID are inconclusive. Some studies (Andresen, Victoria, & Donald, 2001; Schwartz & Rabinovitz, 2003) report that proxy-respondents from the family of the AWID (predominately parents) are more accurate in their responses than other proxy-respondents. On the other hand, other studies have reported little differences between reports of different proxy-respondent groups (McVilly, Burton-Smith, & Davidson, 2000; Stancliffe, 1999).

In some circumstances proxy-respondents are the only viable source of information, however this methodology has been shown to be problematic. Issues of responder acquiescence, the need to provide socially acceptable responses, and validity of responses may influence levels of agreement (McIntyre, Kraemer, Blacher, & Simmerman, 2004). Despite debate surrounding the best methodology for measuring attributes and behaviours of AWID, it is recognised that when an AWID is unable to accurately report their own behaviours, thoughts or feelings, a person familiar to the AWID can undertake this task (Stancliffe, 1999). It is acknowledged that although questioning proxy-respondents on a subjective variable such as QOL, questions reflect another individual’s view that is open to interpretation. This judgement serves as an important criterion for comparison with client-perceived QOL as in practice, changes to improve care and QOL are made from caregivers judgements (Janssen, Schuengel, & Stolk, 2005).

The living environment and relationship between caregivers and AWID had been expected to be similar to the relationship between a parent and their child with an intellectual disability (Schwartz & Rabinovitz, 2003). Despite this a recent study investigating life satisfaction of 93 AWID living in community-based residences in Israel found parent reports were more accurate in comparison to reports of staff who had extensive direct contact with participants (Schwartz & Rabinovitz, 2003). Participants (n = 93), their parents (n = 93) and staff (n = 45) completed the
lifestyle satisfaction scale. A large percentage (84%) of participants previously lived with their family. Staff self-completed the 31 item scale at the same time the scale was interviewer-administered to the participant. The scale which was mailed to parents to self complete included questions on current residence, about friends and free time, community services and work. A significant correlation was found between participant and staff reports \((r = 0.48)\) and parent and staff reports \((r = 0.43)\). The authors reported being surprised at these results however failed to clearly clarify why they were surprised with their findings.

A previous study exploring one component of the Quality of Life Questionnaire (QOL-Q) scale, the empowerment factor, among AWID, investigated the level of agreement between one or two proxy-respondents (Stancliffe, 1999). The QOL-Q scale was designed for use with people with disabilities. The empowerment factor component, exploring choice and control over variables including job selection, guardianship, spending money, pets, having friends visit and daily choices, such as meals and bedtime was interviewer-administered to 63 adults with severe to mild intellectual disabilities (male, \(n = 28\); female, \(n = 35\)). Two proxy-respondents, both staff members from the community living services of the AWID and that had extensive direct contact with the participant independently completed the QOL-Q scale. Strong correlations with low variability in differences were seen when the scores of the two proxy-respondents were used (staff 1 = 0.59; staff 2 = 0.62; combined = 0.64). These results are supported by a previous study investigating the level of agreement between responses provided by the chronically dependent elderly, their informal and professional caregivers (Santos-Eggimann, Zobel, & Berod, 1999). Santos-Eggimann and colleagues (1999) reported that in comparison to a single caregiver, responses from a team of care-givers may be more representative.

Some studies report large discrepancies between staff and participant responses on variables relating to QOL (Janssen, Schuengel, & Stolk, 2005). A study investigating life satisfaction of AWID reported correlations of 0.11 between participants and staff life satisfaction predictions (Burnett, 1989). Similarly, a recent exploratory study found low to moderate levels of agreement between participants and proxy-respondents across seven QOL domains (Janssen, Schuengel, & Stolk, 2005). The seven domains included in the QOL instrument were physical (health, physical fitness, mobility), personal (mental health), material (possessions, environment), relations (with caregivers and family), participation (within society), recreation and work. Another section on goals was also included. Participants were 539 people with a profound, severe, moderate or mild intellectual disability living in residential or community
Participants that could not independently complete the client QOL questionnaire were assisted by or had the questionnaire completed by their parents (90%). Investigators do not report the psychometric properties of the instrument for use with proxy-respondents. Trained caregivers with three to four years professional training were proxy-respondents. Low to moderate agreement was found with correlation values less than 0.30 for 17 of the 21 sub-domains of life and less than 0.50 with respect to goals. The authors reported Pearson correlations of 0.15 for daily activities, 0.09 for the work domain, 0.30 for recreation and 0.25 for physical fitness.

Results from Janssen and colleagues (2005) study are supported by a previous study investigating opportunities for decision making of 20 adults in community residences with a mild or moderate intellectual disability (Jenkinson, Copeland, Drivas, Scoon, & Yap, 1992). Proxy-respondents comprised of residential care staff (n = 17). Participants and proxy-respondents completed separate questionnaires which evaluated perceptions of the decision making opportunities of the AWID in areas of major life activity including living situation, education, vocation, leisure, health, and community access. Participants were interviewed with the interviewers taking note of their responses. In comparison the proxy-respondent questionnaire was self-administered. A major limitation of this study is that proxy-respondent questionnaires related to all residents residing in the community residential unit (CRU) and not specifically to the individual participant. The questionnaire was therefore more general and included open ended questions.

Comparable results have been reported between participants with an intellectual disability and proxy-respondents when a standardized approach has been used. This is illustrated by an Australian study investigating agreement on quality of life measures between 24 AWID and their proxy-respondents (female = 21; male = 3) (McVilly, Burton-Smith, & Davidson, 2000). Participants nominated a person who knew them well enough to answer questions on what they owned and what made them both happy and sad. Proxy-respondents included parents (n = 8) and support workers that took on a caring role (n = 16). Participants and proxy-respondents completed a parallel version of the Comprehensive Quality of Life Scale for people with an intellectual disability (ComQol-ID4) (Cummins, 1993). The ComQol-ID4 asked participants questions with definitive answers about life domains including material well-being, health productivity, intimacy, safety, participation in the community and emotional well-being. The subjective domain asked participants how they rate the importance of these same domains (how
satisfied are you). Proxy-respondents self-reported using the questionnaires five-point likert scale, whereas participants completed a structured interview. For participants a pictograph scale replaced the five-point likert scale used with the proxy-respondents. The authors reported that an analysis of agreement for both objective and subjective QOL revealed moderate to very strong correlations. Although many correlations were non-significant, correlations were stronger for objective in comparison to subjective QOL measures. Results of this study are not dissimilar to a replicated study using the Com-QOL-A4 (Cummins, 1993) with AWOID and their proxy-respondents (immediate family members) (McVilly, Burton-Smith, & Davidson, 2000).

Greater levels of agreement in proxy-respondent QOL reports have been found between participants with an intellectual disability and proxy-respondents who have a close relationship with regular contact with the participant, when a standardised approach is used (McVilly, Burton-Smith, & Davidson, 2000; Stancliffe, 2000). Studies that report low levels of agreement have various methodological flaws. Common to these studies is the lack of a standardised approach. This is important in minimising confounding effects that having an intellectual disability can potentially have on agreement (McVilly, Burton-Smith, & Davidson, 2000).

Studies investigating the use of proxy-respondents for measures of physical activity among AWOID are limited in number. Information regarding physical activity behaviour is often obtained through self-report recall surveys. This is problematic as investigators report that AWOID are unable to accurately recall and provide the necessary information on their own physical activity behaviour (Temple, Anderson, & Walkley, 2000). Subsequently, proxy-respondents are used to gain information on physical activity behaviours of AWOID (Stanish, Temple, & Frey, 2006). Despite this there is a lack of indicators regarding the validity in researcher’s attempts to indirectly measure the physical activity of AWOID.

Questions are raised over the methodological quality of studies investigating the physical activity of AWOID through proxy-respondents. As discussed in detail in section 2.5.2 and illustrated in Table 2 and Table 4, studies in this area tend only to report the use of proxy-respondents and rarely provide evidence of the accuracy of the information provided by proxy-respondents (Temple, Frey, & Stanish, 2006). This is illustrated in a large scale study investigating health risk factors among 1371 participants with a mild to moderate (50.3%) or severe to profound intellectual disability (47%) (Janicki et al., 2002). A non-standardised mail-back questionnaire on the health risk factors of participants was distributed to all group homes.
in the state. The authors did not discuss the questions used to determine physical activity levels of participants or report details of validity and reliability of the measure. This is a common flaw, with other recent studies failing to report such information (Emerson, 2005).

This occurrence is seen in studies investigating medical disorders in AWID where physical activity questionnaires have been completed by participants and/or a proxy-respondent (Beange, McElduff, & Baker, 1995; Wells, Turner, Martin, & Roy, 1997). These studies merely mention the use of the questionnaires and do not substantiate the use of a valid or reliable instrument for use with proxy-respondents. In contrast, Temple and Walkley (2003) study is one of the few known studies to use a validated instrument for proxy-respondent reports on the physical activity of AWID. Validity of this instrument for use with AWID was previously demonstrated by Temple and colleagues (2000) who reported an intra-class correlation coefficient of 0.83 between activity diaries and Caltrac® accelerometers. Temple and Walkley (2003) reported a significant relationship between the two data sources, with an intra-class correlation coefficient of 0.78. These results are higher than found for adults. Investigators concluded that for AWID, proxy-respondents could provide meaningful reports on the physical activity behaviours of AWID.

2.7.8 Summary of Literature

A review of the literature indicated that Australian adults engage in insufficient physical activity to achieve a health benefit (Australian Institute of Health and Welfare, 2006). Data collected between 2002 and 2005 from the Victorian population health surveys indicated that over the year’s males and females have increased the amount of time and number of sessions they are engaged in physical activity (Department of Human Services, 2006). Participation in regular moderate-intensity physical activity has been shown to have many influential and preventative characteristics, including reduced risk of cardiovascular disease, obesity, diabetes, some cancers, enhanced bone and psychological health (Armstrong, Bauman, & Davies, 2000; Bauman, Bellew, Vita, Brown, & Owen, 2002; Hassmen, Koivula, & Uutela, 2000; Warburton, Nicol, & Bredin, 2006). Studies into the physical activity of adults with an intellectual disability (AWID) are limited. Cognitive impairments of AWID have made it difficult for investigators to obtain physical activity data through recall questionnaires with this population (Koch, Marks, & Tooke, 2001). In an attempt to overcome these challenges investigators have used proxy-respondents to obtain information on the physical activity behaviours of AWID (Stanish, Temple, & Frey, 2006). Studies investigating the use of proxy-respondents in the
measurement of physical activity are limited. A major methodological limitation of studies using proxy-respondents has been their reliance on measurement tools and/or procedures that have been shown to be either valid or reliable when used with this population (Temple, Frey, & Stanish, 2006). Available information have regularly indicated that AWID engage in insufficient physical activity to achieve health benefits. A recent review of the physical activity of AWID, identified the pressing research need for valid and reliable procedures for proxy-respondents to report on the physical activity behaviours of AWID (Temple, Frey, & Stanish, 2006).

The lack of standardised approaches and instruments to the measurement of physical activity has made population comparisons difficult (Craig et al., 2003). In the absence of a simple, low cost, valid and reliable instrument for the measurement of physical activity among AWID on a population scale, researchers, epidemiologist and public health personnel have been prevented from gaining sufficient evidence to confidently estimate the participation of this population in physical activity. A direct consequence of this situation has been the inability of advocates to inform government and non-government agencies about the participation levels of AWID in physical activity. This has in turn prevented advocates from influencing the decisions of policy makers or from determining if there is a need to focus intervention efforts towards AWID.

It is well understood that substantial health inequality exists for AWID (VicHealth, 2005). Research indicates that in comparison to the general population AWID experience higher rates of sickness, including diabetes, hypertension and obesity, and early death associated with a sedentary lifestyle (Draheim, McCubbin, & Williams, 2002; Janicki et al., 2002; Sutherland, Couch, & Iacono, 2002) yet little is known about the role physical activity can play in preventing or mediating this outcome for this large segment of society (Temple, Frey, & Stanish, 2006). Lack of information about the physical activity engagement of and promotion to AWID is significant as the direct and indirect health costs, based on international estimates (Honeycutt, Dunla, Chen, & et al., 2004), are likely to be high and substantiate the need for urgent action but the evidence to support action, and to what areas any action should be targeted, is not available. Physical inactivity and associated ill-health may in turn impact on independence and social engagement as physical activity is a significant medium for community and social inclusion (Stanish, Temple, & Frey, 2006) Without appropriate
instrumentation, it is not possible to address the inadequacies that currently exist in the area of physical activity and AWID.
CHAPTER 3

ENERGY EXPENDITURE DURING ACTIVITIES OF DAILY LIVING AMONG ADULTS WITH AND WITHOUT AN INTELLECTUAL DISABILITY

3.1 Introduction

Reports on the physical activity of Australian adults indicate low levels of regular participation in moderate-intensity to vigorous-intensity intensity physical activity (Australian Institute of Health and Welfare, 2006; Bauman, Bellew, Vita, Brown, & Owen, 2002; Department of Human Services, 2004). National surveys report that in 2000, 57% of Australians were sufficiently physically active to achieve a health benefit (Department of Human Services, 2004). Evidence from the 2005 Victorian Population Health survey reports that in the week prior to the survey 6% of adults did not engage in any physical activity and 27% participated in an insufficient amount and/or time of physical activity to achieve a health benefit (Department of Human Services, 2006).

Australian physical activity guidelines recommend that adults should accumulate 30 minutes of moderate-intensity physical activity (3-6 metabolic equivalents [METs]) on most, preferably all, days of the week to achieve a health benefit. Outward signs of moderate-intensity activity include a noticeable increase in breathing and possible light sweating (Commonwealth Department of Health & Aged Care, 1999). Examples of moderate-intensity physical activity include brisk walking, swimming at a regular pace and fast social dancing.

In large scale population based research, estimates of the energy expended by respondents during physical activity are commonly derived through recall questionnaires (Sirard & Pate, 2001). Energy expenditure estimates are commonly sourced from the Compendium of Physical Activities (CPA). Information from questionnaires is converted to estimates of energy expenditure. The energy cost (METs) of a large number of activities of daily living (ADL) is reported in the CPA (Ainsworth et al., 2000). Many of the MET estimates in the CPA were derived from laboratory based studies with a small number of adults without an intellectual disability (AWOID), of which most were male (Brown, Ringuet, Trost, & Jenkins, 2001) or where by physical activities were not objectively measured, but were assigned an estimated value (Ainsworth et al., 2000). Repeatedly, concerns have been expressed regarding the accuracy of the reported MET values assigned to various household, lawn and garden, walking
and some occupational activities for some population sub-groups (i.e. older adults, people of different race, and women) (Brooks et al., 2004; Brown, Ringuet, Trost, & Jenkins, 2001).

Little direct evidence is available to establish if adults with an intellectual disability (AWID) are meeting the public health recommendations of 30 minutes of moderate-intensity physical activity on most, preferably all, days of the week. Studies have used various techniques to measure the physical activity of AWID, such as motion sensors and participant and/or caregiver completed questionnaires and activity diaries. However, various measurement limitations negatively impacts on the confidence that can be linked to the results (Temple, Frey, & Stanish, 2006). Few studies have relied on multiple data sources including the use of an objective, direct measurement source such as accelerometers (Frey, 2004; Stanish & Draheim, 2005; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003). While acknowledging the small sample size of all except one of these studies as a disadvantage, the use of objective data sources being supplemented with additional sources of evidence is a strength of these studies in comparison to studies that have used single, indirect data sources (Draheim, Williams, & McCubbin, 2002; Emerson, 2005; Janicki et al., 2002; Rimmer, Braddock, & Marks, 1995; Robertson et al., 2000).

A methodological limitation of studies that have used multiple and single data sources to investigate the physical activity of AWID has been their failure to provide evidence of the accuracy or reliability of the measurement instrument used with the population (Temple, Frey, & Stanish, 2006). A number of studies rely on either reports from AWID with assistance from a proxy-respondent, such as a caregiver, or reports solely from a proxy-respondent (Temple, Frey, & Stanish, 2006). While not reported, it appears that in an effort to collect comparable data, questions developed and/or used in large-scale studies with AWOID have been used with AWID in an almost expedient manner. However, the accuracy of the various measurement instruments used with AWID and/or proxy-respondents remain unknown.

Accepting the weakness of reported research studies consistently reveal that AWID do not engage in sufficient moderate-intensity physical activity to achieve a health benefit. Studies investigating the physical activity of AWID using activity diaries or questionnaires and accelerometers all report that less than 33% of AWID meet the health-related criterion of 30 minutes or more of moderate-vigorous physical activity on most days of the week (Frey, 2004; Stanish & Draheim, 2005; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003).
Epidemiological evidence indicates that regular participation in at least moderate-intensity physical activity reduces the risk of developing many sedentary lifestyle diseases (Bauman, Bellew, Vita, Brown, & Owen, 2002). Engagement of AWID in predominately sedentary behaviours increases their risk of developing sedentary lifestyle diseases. In comparison to their non-disabled counterparts, AWID have been reported to have lower levels of cardiovascular fitness, strength and higher levels of obesity (Fernhall & Pitetti, 2001; Rimmer & Yamaki, 2006).

To effectively reduce the incidence of sedentary lifestyle diseases among AWID there is a need to accurately evaluate the type, amount and intensity of physical activity AWID engage in (Temple, Frey, & Stanish, 2006). Accurate information assists in the evaluation of physical activity related public health promotion campaigns (Stanish, Temple, & Frey, 2006; Temple, Frey, & Stanish, 2006) that are based on surveillance information that estimates population sub-group energy expenditure and activity intensity. During times of injury and disease it is known that energy requirements of individuals alter (Reeves & Capra, 2003). However, to date there has been insufficient research to confirm whether the levels of energy expenditure observed among AWID differ to their non-disabled counterparts during ADL.

Emerging research suggests that differences exist between adults with and without a disability in energy expended during common ADL. A study investigating characteristics of energy expenditure among male AWID during sitting, standing and walking found significantly higher energy costs for AWID than for matched controls without a disability (Iwaoka et al., 1998). Similarly, an Australian study investigating energy expenditure of seven common ADL among ambulatory, community living AWID report differences in energy expenditure derived from indirect calorimetry to the energy expenditure values reported in the CPA (Lante, Walkley, & Temple, 2005). Available but limited research suggests that the energy expenditure estimates derived from research with the general population and reported in the CPA are misleading and not valid for use with AWID.

The purpose of this study was to determine the energy expended by adult men and women with and without an intellectual disability during seven common ADL and determine if the metabolic equivalent (MET) values reported in the CPA for these ADL are accurate in respect to AWID and a matched sample of AWOID.
3.2 Methodology

Prior to the commencement of this study approval was gained from the RMIT Human Research Ethics Committee. Ambulatory adults exhibiting no mobility abnormalities or using any mobility device, with a mild to moderate intellectual disability and ambulatory adults without an intellectual disability (AWOID) were recruited to participate in the study. The recruitment and inclusion criterion of all participants and the study procedure is outlined in the following sections.

3.2.1 Adults With an Intellectual Disability

Participants with an intellectual disability were adult residents of Community Residential Units (CRU) or residing in family homes in the Northern metropolitan region of Melbourne, Australia. At the time of this study individuals were required to be registered with Intellectual Disability Services to reside in CRU accommodation. To be eligible for intellectual disability services, an individual must be over the age of 5 years of age and assessed as having an intellectual disability, or be under 6 years of age and assessed as being developmentally delayed (Department of Human Services, 2000). There are 450 residents of CRU’s in the Northern Region. Three-hundred of these residents were ambulatory and considered low-support. Previous studies of populations who did not have a disability demonstrated that women had lower energy expenditure than men (Astrand & Rodahl, 1970). Consequently, sample size (Levy & Lemeshow, 1991) was calculated on the anticipated mean and standard deviation of the energy cost of walking at 50 meters per minute. Energy expenditure was derived from data published by Iwaoka and colleagues (1998). Therefore, for men, energy expenditure was estimated to be: $0.23 \pm 0.04 \text{ kJ/kg body wt}^{-1}$, and for women $0.21 \pm 0.03 \text{ kJ/kg body wt}^{-1}$. Sample size, with accuracy set at 90%, was calculated to be 36. A drop-out rate of 10% was anticipated, therefore the target sample became $36 \times 100/90 = 40$.

Most adults with an intellectual disability (AWID) living in a CRU in the catchment area attended a day placement or supported employment agency in the Northern metropolitan region of Melbourne, Australia. Initial distribution of information and subsequent contact with potential participants and their primary caregiver occurred through the assistance of day agencies in the Northern metropolitan region of Melbourne, Australia, who supported the project. Distributed information consisted of a plain language statement and a form requesting
permission from the AWID next of kin or guardian to allow the investigator to approach the person in their care (AWID) about participating in the study (See Appendix 1).

Day agencies reported using a variety of methods to distribute and receive information on behalf of the investigators. In some instances, plain language statements, accompanied by a supporting letter from a day agency, were sent to caregivers of all AWID within the agency. In other instances, agencies distributed information to a select group of AWID and their caregivers through personal contact and/or a mail out. In some cases, caregivers, in turn passed information about the study to the AWID next of kin or legal guardian. Upon receipt of this information, potential participants, their caregiver, next of kin and/or legal guardian communicated directly with the investigator. The investigator also kept the day agency of the AWID informed. Figure 1 illustrates the distribution and retrieval process, which on average took five weeks.

Upon receipt of advice from the AWID next of kin or legal guardian that the AWID was interested in participating in the study, the investigator arranged to meet and discuss the study with the AWID. This meeting occurred in the presence of a caregiver known to the AWID. The meeting allowed the AWID to meet and become familiar with the investigator, discuss the study procedures and ask questions. Where time and equipment allowed, the AWID was shown a video that depicted an AWID visiting RMIT University and undertaking the research activities involved in the project. At the conclusion of the meeting the AWID was read a verbal plain language statement \( (n = 54) \), or read for themselves \( (n = 1) \) a plain language statement (See Appendix 2). The investigator then asked the AWID if they were willing to participate in the study. Upon verbal agreement to participate in the study, each prospective AWID participant and their caregiver were given a medical clearance form (See Appendix 3) and a
consent form (See Appendix 4). A self-addressed, reply paid envelope was provided for return of the forms to the investigator.

It was the responsibility of caregivers to organise an appointment with a medical practitioner for medical clearance to be obtained for the AWID. Medical clearance fees were paid for from funds set aside for the study. Where a medical form had not been returned within four weeks from the time of distribution to the AWID, the investigator followed-up with a reminder phone call to the primary caregiver and prompted the return of the forms. AWID were excluded from the study if the investigator did not receive a signed medical clearance and consent form within four weeks of the reminder phone call.

**3.2.2 Adults Without an Intellectual Disability**

A matched comparison group of ambulatory adults without a disability (AWOID) were recruited to participate in the study. Recruitment of AWOID occurred through advertisements and information circulated at RMIT University and local community noticeboards, through local companies, email distribution lists, letterbox drops, newspapers and through presentations to undergraduate students enrolled in disability studies, nursing, physical education or human movement courses on the Bundoora West campus of RMIT University (See Appendix 5).

The comparison group of AWOID participants were individually matched to AWID participants for gender, age (± 3yrs) and weight (± 5kg). Additionally, AWOID who reported participating in leisure time physical activity on more than two occasions each week over the past six months were ineligible to participate in the study. Additionally, as smoking affects metabolism and no AWID in the study smoked, AWOID who were smokers (n = 2) agreed to refrain from smoking on the morning of the testing (Hultquist et al., 1995).

The AWOID recruitment advertisements generated significant interest. A large number of individuals made inquiries but did not meet the inclusion criteria. Being too active or not being the appropriate age or weight to be matched to an AWID participant were common reasons for ineligibility. Despite extensive effort and resources devoted to recruitment of AWOID participants over a 2 year period, only 15 AWOID were able to be matched to an AWID and were subsequently included in the study.
3.2.3 Procedure

Published reports (Modell, Rider, & Menchetti, 1997; Neumayer & Bleasdale, 1996; Sparrow & Sharp, 1991; Temple, Anderson, & Walkley, 2000) and parents and professionals working in the disability industry (Brennan, personal communication, January 21, 2001; Edwards, personal communication, June 8, 2001; Guatta, personal communication, May 10, 2001; Grubb, personal communication, May 10, 2001) were consulted to identify the activities of daily living (ADL) commonly engaged in by AWID. Available evidence and advice revealed that the common ADL for AWID included sitting quietly, sitting to listen to music or watch television, undertaking minor assembly tasks, and walking for transport. In light of the identification of common ADL of AWID, energy expenditure data in this study was collected on seven activities, in the order listed overleaf;

Activity 1: Sitting quietly on a high backed, lounge type chair with armrests (SitQ)

Activity 2: Sitting watching television on a high backed, lounge type chair with armrests (SitTV). The television segment participants watched during the testing was a sitcom named ‘Friends’.

Activity 3: Assembly task – Sitting on a stool, at a table, assembling three piece tea-light candles (SitAT).

Activity 4: Assembly task – Standing, at a table, assembling three piece tea-light candles (StaAT)

Activity 5: Walking on a motorised treadmill at 3.0 km/hr (WalkS)

Activity 6: Walking on a motorised treadmill at 6.0 km/hr (WalkQ)

Activity 7: Walking on a motorised treadmill at 9.0 km/hr (WalkF)

# This activity was chosen to represent a number of fine motor manipulative activities that AWID in the catchment area commonly undertake while attending a day centre or supported employment service.
3.2.4 Equipment

Indirect calorimetry was used to measure energy expenditure through a MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA). While undertaking each ADL, participants wore a facemask that was attached by a netted head piece and was fitted securely to create a seal over the nose and mouth. Preparatory trials demonstrated many AWID were more able and willing to wear a facemask than a mouthpiece during testing and for consistency a standard apparatus was used. Additionally, participants wore a heart rate monitor (Polar Electro OY, Kempele, Finland) throughout the testing.

Equipment used by participants while engaged in the ADL’s included a high backed, lounge type chair with armrests, a stool, television and video player, videotapes of popular entertainment, sport and contemporary television shows and a 10 minute segment of the sitcom ‘Friends’; candle making equipment (a small, round, three piece [wick, cup, tray] tea-light waxed candle); a motorised calibrated (Repco) treadmill and a standalone ¾ length mirror.

3.2.5 Participant Inclusion and Familiarisation

There is some evidence that levels of energy expenditure by AWID with Down syndrome differ to their peers without Down syndrome (Fernhall et al., 1996). Consequently, AWID with Down syndrome have been excluded from research studies or have had results reported separately. Recognising a potential issue, the investigator undertook preliminary data analysis to determine if any difference in energy expenditure between AWID with Down syndrome (n = 10) and AWID without Down syndrome (n = 21) existed in this study. Descriptive statistics for the energy expenditure for each ADL for AWID with and without Down syndrome are presented in Table 5.
Table 5: Descriptive statistics of AWID with and without Down syndrome for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>AWID with Down Syndrome</th>
<th>AWID without Down Syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample</td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>(n = 10)</td>
<td>(n = 5)</td>
</tr>
<tr>
<td>SitQ</td>
<td>1.61</td>
<td>0.46</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.67</td>
<td>0.83</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.88</td>
<td>0.67</td>
</tr>
<tr>
<td>StaAT</td>
<td>2.32</td>
<td>1.08</td>
</tr>
<tr>
<td>WalkS</td>
<td>6.02</td>
<td>1.99</td>
</tr>
<tr>
<td>WalkQ</td>
<td>6.78</td>
<td>1.21</td>
</tr>
<tr>
<td>WalkF</td>
<td>8.59</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Key

Activity 1: Sitting quietly on a high backed, lounge type chair with armrests (SitQ)
Activity 2: Sitting watching television on a high backed, lounge type chair with armrests (SitTV)
Activity 3: Assembly task – Sitting on a stool, at a table, assembling three piece tea-light candles (SitAT)
Activity 4: Assembly task – Standing, at a table, assembling three piece tea-light candles (StaAT)
Activity 5: Walking on a motorised treadmill at 3.0 km/hr (WalkS)
Activity 6: Walking on a motorised treadmill at 6.0 km/hr (WalkQ)
Activity 7: Walking on a motorised treadmill at 9.0 km/hr (WalkF)
Exploratory data analysis, using a Levene test found that the assumption of homogeneity of variance was met for all except one ADL (SitTV). Therefore, two-tailed independent groups t-tests based on equal variances for six of the seven ADL’s and unequal variances for one of the ADL’s (SitTV) were performed. No significant difference in energy expenditure between the samples of AWID with and without Down syndrome was found for any ADL; SitQ, \( t (29) = 0.42, p = .68 \); SitTV, \( t (10.95) = 0.42, p = .68 \); SitAT, \( t (29) = 0.023, p = 0.98 \); StaAT, \( t (29) = 1.33, p = .19 \); WalkS, \( t (29) = 0.78, p = .44 \); WalkQ, \( t (29) = 0.26, p = .80 \); WalkF, \( t (29) = 0.49, p = .62 \). Data was therefore pooled for all subsequent analysis.

Fifty-five AWID participants (male = 31 & female = 24) were recruited to participate in the study. One AWID participant did not return a medical consent form so was not progressed in the study. Five AWID withdrew or were withdrawn by their primary caregiver due to a lack of interest. An additional 15 AWID participants were withdrawn by the investigator. Participants were withdrawn due to a lack of co-operation and not being able to satisfactorily and safely complete the required testing protocol in the required time-frame. For example, some participants became anxious on the treadmill and consequently were unable to safely maintain the walking cadence in the centre of the treadmill for more than three of the 8 to 10 minutes required to complete the task. Other participants were not able to wear the face mask for the required length of time. Thirty-four AWID participants satisfactorily completed the testing phase. The data of three participants was unable to be used due to equipment malfunction, bringing the final sample of AWID participants to 31 (male = 20 & female = 11). The sample of AWOID participants comprised of 15 adult men and women (male = 6 & female = 9). The recruitment and matching criteria of AWOID is described in Section 3.2.2. No AWOID participant withdrew from the study. Descriptive statistics for AWID and AWOID are presented in Table 6.
Males with and without an intellectual disability were found to be significantly taller (AWID, $t(29) = 5.55, p < .001$; AWOID $t(13) = 4.07, p = .001$) than their female counterparts. The females with and without an intellectual disability had a higher body mass index (BMI), however this was not found to be significantly different to that of their male counterparts, AWID, $t(29) = -1.25, p = .22$; AWOID $t(12.96) = 1.28, p = .22$. BMI values indicate that all groups except female AWOID are overweight according to recommendations for BMI (Centers for Disease Control and Prevention, n.d.).

Prior to the testing all AWID participants took part in an extensive familiarisation process. This process was a lengthy but important process which helped to facilitate adjustment to the testing procedures (Seidl, Reid, & Montgomery, 1987). Although many participants were already known to the investigator, the process allowed a closer rapport to develop between the AWID and the investigator so that the AWID felt relaxed, safe and comfortable in an unfamiliar environment.

To assist the familiarisation of AWID participants, a video depicting an AWID visiting RMIT University and undertaking the research activities was shown to all AWID on their initial familiarisation visit. The video introduced the AWID to the various tasks they were required to

---

Table 6: Descriptive statistics for age, height, weight and BMI of participants

<table>
<thead>
<tr>
<th>Sample</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n$</td>
<td>$M$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AWID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>31</td>
<td>29.03</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>35.00</td>
</tr>
<tr>
<td>Height (m)</td>
<td>31</td>
<td>164.48</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>151.52</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>31</td>
<td>74.18</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>65.82</td>
</tr>
<tr>
<td>BMI</td>
<td>31</td>
<td>27.31</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>28.60</td>
</tr>
<tr>
<td>AWOID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>15</td>
<td>30.40</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>34.44</td>
</tr>
<tr>
<td>Height (m)</td>
<td>15</td>
<td>170.33</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>163.96</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>15</td>
<td>74.57</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>65.33</td>
</tr>
<tr>
<td>BMI</td>
<td>15</td>
<td>25.55</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>24.40</td>
</tr>
</tbody>
</table>
undertake and promoted comfort and reduced anxiety. A secondary purpose of the video was to promote the comfort and allay concerns of parents and/or primary caregivers.

Familiarisation sessions occurred until the AWID participant could confidently and independently complete the seven research activities. Familiarisation visits were capped at a maximum of six for each AWID participant. If after six visits it was determined that the AWID could not comfortably, satisfactorily or safely complete the testing protocol, the investigator withdrew the AWID participant from the study. On average AWID engaged in four (range 2 - 6) familiarisation visits. Each familiarisation visit ranged from 45 to 120 minutes per AWID. Some AWID attended the same day placement agency and attended familiarisation sessions together in a small group during the day with a caregiver from the day placement agency. On these occasions the caregiver provided the investigator with assistance to familiarise and encourage the AWID.

Throughout the familiarisation process AWID participants were shown how the equipment functioned (MedGraphics Metabolic Measurement Cart, facemask and netted head piece and heart rate monitor, treadmill), introduced to and encouraged to participate in each ADL. Videos watched during the familiarisation visits included various sitcoms, infotainment and sport shows, but did not include the video segment used during testing. The familiarisation videos were not used during the testing phase. Over the familiarisation sessions each AWID participant developed a comfortable and safe walking gait on the treadmill at the fastest speed (9.0 km/hr) for an 8 to 10 minute period.

AWOID participants attended a 30 to 60 minute familiarisation session. The session allowed AWOID participants to use and become familiar with the equipment and testing procedures. At the beginning of the session, AWOID participants received a plain language statement (See Appendix 6) and consent form (See Appendix 4) and were asked to complete a physical activity readiness questionnaire (PAR-Q) (See Appendix 7). To ensure the safety of AWOID participants, any individual that answered yes to one or more of the questions on the PAR-Q were required to gain clearance from their medical practitioner before participating in the study. No AWOID answered yes to any PAR-Q question and therefore a medical clearance was not a necessary step for any AWOID participant.
3.2.6 Testing

To control for thermogenesis, participants were asked not to consume any food or drink (other than water) from the time of retiring to bed on the night before testing. All AWID participants were provided with transport to and from RMIT University. AWID were picked up from their place of residence within 30 minutes of the time they were reported to regularly rise from bed. This reduced the risk of AWID participants consuming food or drink prior to testing as it removed them from their primary food source. All participants were provided with breakfast upon completion of the testing session and all were aware that breakfast would be provided at completion of the testing.

Participants weight and height (lightly clothed, but without footwear) was measured using a calibrated digital scale (Tanitia, model BWB-620), with a maximum load of 200kg and a tolerance of 0.05kg and a calibrated wall-mounted stadiometer (Holtain). The metabolic measurement cart was calibrated for room temperature, atmospheric pressure and humidity immediately prior to testing. Metabolic data was collected for each ADL with expired air being analysed for carbon dioxide (CO$_2$), oxygen (O$_2$) and volume expired. Data was collected for 8 - 10 minutes. For analysis purposes expired air collected during the last 5 minutes of each ADL was used. Throughout each activity the participant’s heart rate was recorded at 2 minute intervals. In-between each ADL test participants removed the facemask and rested on a high backed, lounge type chair with armrests. Participants did not commence the next ADL test until their heart rate had fallen to within 10% of their heart rate at the conclusion of the previous ADL test. For the walking activities testing stopped if a participant reached volitional fatigue, a respiratory exchange ratio greater than 1.1 (RER > 1.1), a heart rate within 10% of the predicted maximum heart rate, or was unable to maintain the walking cadence to remain in the centre of the treadmill (Fernhall, 1997).

3.3 Data Analysis

Raw data obtained from the MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA) was imported into a Microsoft Access 2003 database to allow for energy expenditure calculations, expressed as metabolic equivalents (MET), for each of the seven ADL. A MET can be expressed as VO$_2$, with 1 MET equal to a VO$_2$ of 3.5 ml/kg/min (Gunn et al., 2004). VO$_2$ data was averaged over minute
intervals from the last 5 minutes for each ADL. An average VO\(_2\) was then computed before obtaining an average MET value per ADL.

To enable statistical analysis to occur energy expenditure values were imported into SPSS (Version 13). A small amount of data was missing for each of the seven ADL for both AWID and AWOID participants. Inspection revealed missing data to be random in nature. Data was therefore estimated through a missing value analysis for each population, with the group means (estimated means) being substituted for the missing data (Tabachnick & Fidell, 1989). The complete data set was then subjected to exploratory data analysis followed by a series of descriptive and inferential statistical analyses.

As exploratory data analysed revealed no major anomalies, a series of two-tailed one sample t-tests were used to analyse energy expenditure estimates for each of the seven ADL, for all possible combinations, against the standard measure commonly used in the physical activity and exercise sciences field, the Compendium of Physical Activities (CPA). Within the analysis the CPA value for each ADL was entered as the test value. These values are reported in Table 7. Exact MET values for WalkQ and WalkF (6.0 and 9.0 km/hr respectively) are not reported in the CPA therefore values reported in the CPA were used to calculate interpolated MET values for these ADL based on the procedures used by Lante and colleagues (2005). The values for various walking speeds reported in the CPA were converted from mph to km/hr and plotted onto a basic line graph. This indicated a linear relationship between the various walking speeds. Accepting a linear trend for energy expenditure by walking speed, the values for WalkQ and WalkF were then determined from the graph. To determine if there was a difference in energy expended based on disability and gender, data were analysed using a 7 x 2 x 2 mixed factorial ANOVA.
Table 7: MET values and intensity level for seven ADL

<table>
<thead>
<tr>
<th>Activity of Daily Living</th>
<th>Compendium (MET) Value</th>
<th>Activity Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>1.0</td>
<td>Light</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.0</td>
<td>Light</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>Light</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>Light</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.0</td>
<td>Light</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6*</td>
<td>Moderate</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1*</td>
<td>Vigorous</td>
</tr>
</tbody>
</table>

* From interpolated calculations

3.4 Results

3.4.3 Comparison of Energy Expenditure between Populations

The impact of gender and disability status on the energy expended on seven ADL was analysed using a 7 x 2 x 2 mixed factorial ANOVA. The within subjects factor consisted of the seven ADL’s (SitQ, SitTV, SitAT, StaAT, WalkS, WalkQ, WalkF), and the between subjects factors were disability (AWID, AWOID) and gender. The interaction between gender, disability and activity was not significant (Wilks’ ? 0.90, F (6, 37) = 0.71, p = .646, partial ?^2 = .10). The interactions between gender and disability (F (1, 42) = 0.14, p = .708, partial ?^2 = .13), gender and activity (Wilks’ ? 0.95, F (6, 37) = .32, p = .925, partial ?^2 = .05), and disability and activity (Wilks’ ? 0.81, F (6, 37) = 1.45, p = .222, partial ?^2 = .19) were also non significant.

The main effect of gender was not significant (F (1, 42) = 0.95, p = .336, partial n = .002). The main effect of activity (Wilks’ ? 0.076, F (6, 37) = 75.30, p < .001, partial ?^2 = .924) was significant. Subsequent post hoc analysis (a = .05) demonstrated that the generally energy expenditure increased from SitQ, SitTV, SitAT, StaAT, WalkS, WalkQ, to WalkF, however the energy expenditure for SitAT and StaAT, WalkS and WalkQ, and WalkQ and WalkF were not significantly different.
The main effects of disability ($F(1, 42) = 6.22, p = .017$, partial $\eta^2 = .13$) was significant with AWID expending more energy than AWOID. Subsequent post hoc analysis ($\alpha = .05$) demonstrated that AWID expended more energy than AWOID when completing SitQ, WalkS, WalkQ, to WalkF, energy expended in SitTV, SitAT and StaAT did not differ by disability status. These data are displayed in, Figure 2, Figure 3 and Figure 4.

Figure 2: Population energy expenditure levels for seven ADL

Figure 3: Male energy expenditure levels for seven ADL
3.4.1 Comparison of Energy Expenditure among Adults with an Intellectual Disability and the Compendium of Physical Activities

Mean MET values and 95% confidence intervals were used to characterise the intensity level of the seven ADL for both AWID and AWOID participants. This enabled comparisons to be made between the values obtained through indirect calorimetry and the MET values reported in the CPA. The following interpretations were applied to the effect sizes of the results: < 0.2, small; 0.3 – 0.5, medium; 0.6 – 0.8, large and > 0.9, very large (Cohen, 1988).

A comparison of the observed mean MET values for AWID to those reported in the CPA is reported in Table 8. The CPA significantly underestimates energy expenditure for AWID for five of the seven ADL (SitQ, \( p < .001 \); SitTV, \( p < .001 \); WalkS, \( p < .001 \); WalkQ, \( p < .001 \); SitAT \( p = .003 \)). StaAT was also underestimated by the CPA, however this was not significant (\( p = .097 \)) but noteworthy. In contrast the CPA significantly overestimates energy expenditure for one of the seven ADL (WalkF, \( p < .001 \)). The CPA correctly estimates energy expenditure for one of the seven ADL (StaAT). A moderate to very large effect size for energy expenditure levels between AWID and the CPA was found for all seven ADL (\( d = -0.85 - 2.34 \)).
Table 8: Levels of energy expenditure among AWID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Compendium Value</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>1</td>
<td>1.56</td>
<td>0.43</td>
<td>7.25</td>
<td>&lt;.001</td>
<td>1.30</td>
</tr>
<tr>
<td>SitTV</td>
<td>1</td>
<td>1.59</td>
<td>0.56</td>
<td>5.86</td>
<td>&lt;.001</td>
<td>1.05</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>1.88</td>
<td>0.65</td>
<td>3.26</td>
<td>.003</td>
<td>0.59</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>2.05</td>
<td>0.80</td>
<td>1.71</td>
<td>.097</td>
<td>0.31</td>
</tr>
<tr>
<td>WalkS</td>
<td>2</td>
<td>5.70</td>
<td>1.58</td>
<td>13.03</td>
<td>&lt;.001</td>
<td>2.34</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6**</td>
<td>6.68</td>
<td>1.54</td>
<td>7.51</td>
<td>&lt;.001</td>
<td>1.35</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1**</td>
<td>8.32</td>
<td>2.10</td>
<td>-4.73</td>
<td>&lt;.001</td>
<td>-0.85</td>
</tr>
</tbody>
</table>

n = 31
** From interpolated calculations

Table 9 reports the observed mean MET values for male and female AWID compared to the values reported in the CPA. A strong statistically significant difference is seen for six of the seven ADL for male AWID (SitQ, p <.001; SitTV, p <.001; WalkS, p <.001; WalkQ, p <.001; WalkF p = .004, SitAT p = .008). The CPA underestimates energy expenditure for male AWID for all except one ADL (WalkF), which was overestimated by the CPA value. A large difference between energy expenditure levels for male AWID and the CPA was found for six of the seven ADL, with a moderate effect size for SitAT. Results for female AWID show a strong statistically significant difference for SitQ, p = .005; SitTV, p = .041; WalkS, p <.001; WalkQ, p = .002 and WalkF, p = .006. No statistically significant difference was seen between the observed mean and the CPA for the assembly task activities (SitAT, p = .188; StaAT, p = .387). The CPA underestimates energy expenditure for female AWID for all ADL except WalkF, for which the interpolated CPA value was overestimated. A small effect size difference between energy expenditure levels for female AWID and the CPA was found for StaAT, a moderate effect size difference was found for SitAT and large effect size differences were found for all other ADL.
Table 9: Levels of energy expenditure by gender among AWID for seven ADL

| Activity | Compendium Value | M   | SD  | t    | p    | d   | M   | SD  | t    | p    | d   |
|----------|------------------|-----|-----|------|------|-----|-----|-----|------|------|-----|-----|
| SitQ     | 1                | 1.57| 0.40| 6.44 | <.001| 1.44| 1.54| 0.51| 3.54 | .005 | 1.07|
| SitTV    | 1                | 1.64| 0.47| 6.08 | <.001| 1.36| 1.51| 0.72| 2.34 | .041 | 0.71|
| SitAT    | 1.5              | 1.95| 0.69| 2.95 | .008 | 0.66| 1.74| 0.57| 1.41 | .188 | 0.43|
| StaAT    | 1.8              | 2.02| 0.63| 1.57 | .134 | 0.35| 2.10| 1.09| 0.90 | .387 | 0.27|
| WalkS    | 2                | 5.85| 1.28| 13.40| <.001| 3.00| 5.42| 2.06| 5.52 | <.001| 1.66|
| WalkQ    | 4.6**            | 6.92| 1.62| 6.38 | <.001| 1.43| 6.24| 1.33| 4.09 | .002 | 1.23|
| WalkF    | 10.1**           | 8.69| 1.90| -3.32| .004 | 0.74| 7.63| 2.36| 3.47 | .006 | 1.05|

** From interpolated calculations
3.4.2 Comparison of Energy Expenditure among Adults without an Intellectual Disability and the Compendium of Physical Activities

A comparison of the observed mean MET values for AWOID to those reported in the CPA is provided in Table 10. The CPA significantly underestimates energy expenditure for AWOID for five of the seven ADL (SitQ, $p = .003$; SitTV, $p < .001$; SitAT, $p = .003$; WalkS, $p < .001$; WalkQ, $p = .018$). The energy expenditure estimate for WalkF is significantly overestimated ($p < .001$) and the energy expenditure estimate for StaAT is correctly estimated by the CPA. A small, non significant difference ($p = .30$) is seen between the observed mean MET values and the CPA for StaAT. A moderate to very large effect size for energy expenditure levels between AWID and the CPA was found for all seven ADL.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Compendium Value</th>
<th>$M$</th>
<th>$SD$</th>
<th>$t$</th>
<th>$p$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>1</td>
<td>1.19</td>
<td>0.20</td>
<td>3.66</td>
<td>.003</td>
<td>0.95</td>
</tr>
<tr>
<td>SitTV</td>
<td>1</td>
<td>1.29</td>
<td>0.24</td>
<td>4.74</td>
<td>&lt;.001</td>
<td>1.22</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>1.75</td>
<td>0.27</td>
<td>3.64</td>
<td>.003</td>
<td>0.94</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>1.68</td>
<td>0.44</td>
<td>-1.08</td>
<td>.298</td>
<td>-0.28</td>
</tr>
<tr>
<td>WalkS</td>
<td>2</td>
<td>4.64</td>
<td>1.06</td>
<td>9.60</td>
<td>&lt;.001</td>
<td>2.48</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6**</td>
<td>5.45</td>
<td>1.23</td>
<td>2.67</td>
<td>.018</td>
<td>0.69</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1**</td>
<td>6.77</td>
<td>1.74</td>
<td>-7.42</td>
<td>&lt;.001</td>
<td>-1.92</td>
</tr>
</tbody>
</table>

$n = 15$

** From interpolated calculations
Table 11 reports the observed mean MET values for male and female AWOID compared to the values reported in the CPA. A strong statistically significant difference is seen for six of the seven ADL for male AWID, SitQ, $p = .016$; SitAT, $p = .01$; SitAT, $p = .018$; WalkS, $p < .001$; WalkQ $p = .035$; WalkF $p < .001$. The CPA underestimates energy expenditure for male AWOID for all ADL’s except StaAT, which is correctly estimated and WalkF which is overestimated by the CPA. A very large effect size difference between energy expenditure levels for male AWID and the CPA was found for six of the seven ADL, with a small effect size for StaAT. Energy expenditure results for female AWOID are reported in Table 11. The CPA significantly underestimates energy expenditure for female AWOID for two ADL, SitTV, $p = .014$; WalkS, $p = .002$. Although not significantly different, the CPA also underestimates SitQ, $p = .079$; SitAT, $p = .076$; and WalkQ, $p = .16$ for female AWOID. In comparison, the CPA overestimates StaAT, $p = .092$ and WalkF, $p = .002$ energy expenditure for female AWOID. A medium to very large effect size difference in energy expenditure between female AWOID and the CPA was revealed for the ADL ($d = 0.52 – 2.08$).
Table 11: Levels of energy expenditure by gender among AWOID for seven ADL

| Activity | Compendium Value | M     | SD    | t     | p     | d     | M     | SD    | t     | p     | d     |
|----------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| SitQ     | 1                | 1.28  | 0.19  | 3.58  | .016  | 1.46  | 1.14  | 0.20  | 2.01  | .079  | 0.67  |
| SitTV    | 1                | 1.38  | 0.25  | 3.69  | .014  | 1.50  | 1.23  | 0.22  | 3.14  | .014  | 1.05  |
| SitAT    | 1.5              | 1.87  | 0.27  | 3.45  | .018  | 1.41  | 1.67  | 0.25  | 2.04  | .076  | 0.68  |
| StaAT    | 1.8              | 1.89  | 0.42  | 0.54  | .612  | 0.22  | 1.53  | 0.42  | -1.92 | .092  | -0.64 |
| WalkS    | 2                | 4.56  | 0.71  | 8.90  | <.001 | 3.63  | 4.69  | 1.29  | 6.25  | <.001 | 2.08  |
| WalkQ    | 4.6**            | 5.56  | 0.82  | 2.88  | .035  | 1.18  | 5.37  | 1.48  | 1.56  | .158  | 0.52  |
| WalkF    | 10.1**           | 6.87  | 0.97  | -8.14 | <.001 | -3.32 | 6.71  | 2.16  | -4.71 | .002  | -1.57 |

** From interpolated calculations
3.5 Discussion

The Compendium of Physical Activities (CPA) is a highly regarded tool. The CPA is extensively used as a source of energy expenditure values for many activities of daily living (ADL) as well as in the interpretation and data calculation of information obtained from physical activity surveys used with a variety of populations (Ainsworth et al., 2000). A major limitation of the CPA is that it does not differentiate among population sub-groups such as older adults, women, or people with a disability (Ainsworth et al., 2000). As energy expenditure estimates published in the CPA were derived from research with healthy adults it is possible that the energy expenditure estimates are misleading when used with various sub-populations, such as AWID. This limitation of the CPA has important consequences when estimating population levels of health enhancing physical activity and in recommending activities that will be health enhancing.

Few studies have investigated the energy expenditure of different sub-populations including AWID. This study extends Iwaoka and colleagues (1998) investigation of the energy expenditure of male AWID. The energy expenditure of common ADL for AWID was also explored and the energy expenditure of AWID and matched AWID were investigated and compared to the values reported in the CPA. Overall data for AWID suggests that the mean MET values for some ADL reported in the CPA may not be accurate for use with AWID.

The MET values reported in the CPA indicate that for adults the SitQ, SitTV, SitAT, StaAT and WalkS activities are each of light-intensity (<3 METs). The observed mean MET values in this study revealed that four of these five activities were correctly classified for AWID as light-intensity activities. However, energy expended by AWID during the WalkS activity was revealed to be within the moderate-intensity range and not a light-intensity activity as reported in the CPA. The two fastest walking activities in this study (WalkQ and WalkF) were found to be of vigorous-intensity (>6 METs) for AWID. The calculated interpolated MET values reported in the CPA for adults indicated that WalkQ should be categorised as a moderate intensity activity and WalkF as vigorous intensity activity. The MET values for six of the seven ADL engaged in by AWID were found to be higher, ranging from 14% higher for StaAT to 185% higher for WalkS, than the MET values reported in the CPA. The exception to this was for the WalkF activity where the mean MET value for WalkF for AWID was 18% lower than the MET values reported in the CPA.
For male AWID, ADL requiring less effort (SitQ, SitTV, SitAT, StaAT) are correctly classified as light-intensity activities in accordance with the CPA. This is despite statistically significant differences between the observed energy expenditure levels and CPA for SitQ, SitTV and SitAT. In contrast, the observed energy expenditure values for WalkS classifies this activity as moderate-intensity (3-6 METs) and WalkQ and WalkF as vigorous intensity (>6 METs). These values differ to the values reported in the CPA which classify WalkS as light-intensity activity (<3 METs) and WalkQ as moderate-intensity (3-6 METs). WalkF is correctly classified as a vigorous-intensity activity. The observed mean MET values for six of the seven ADL engaged in by male AWID were higher, ranging from 12% higher for StaAT to 192% higher for WalkS, than the MET values reported in the CPA. The exception to this was for WalkF where the mean MET value for WalkF for male AWID was 14% lower than the calculated value from the CPA.

These results are consistent with Iwaoka and colleagues (1998) investigation of the energy expenditure of male AWID. Iwaoka and colleagues (1998) found male AWID expended more energy during walking at 30 metres per minute (1.8 km/hr) and 50 meters per minute (3 km/hr) than gender, age, height and weight matched male AWOID. A strength of the study described herein is that, unlike Iwaoka and colleagues (1998), participants included both males and females. Further, the current study included a more representative sample of the population of AWID as it included participants with and without Down syndrome. A limitation of the current study and Iwaoka and colleagues (1998) study is the relatively small sample sizes used in both investigations; however, the sample in this study was sufficient to permit the revelation of several statistically significant findings.

Similar to male AWID, the activity intensity classification for female AWID for the ADL requiring less effort (SitQ, SitTV, SitAT, StaAT) are correctly classified as light-intensity activities. The observed MET values for female AWID for WalkS and WalkQ fall within the moderate-intensity and vigorous-intensity category of physical activity. In comparison, the CPA classifies WalkS and the calculated value for WalkQ as light-intensity and moderate-intensity activity respectively. The observed MET values for six of the seven ADL engaged in by female AWID were higher than the MET values reported in the CPA, ranging from 16% higher for SitAT to 171% higher for WalkS. The exception was for WalkF, which the CPA overestimated energy expended for by 24%. It must be recognised that values reported in the
CPA were used to calculate interpolated MET values for WalkQ and WalkF, assuming a linear relationship.

Noteworthy is the finding that in comparison to the female AWID, the mean difference between the observed values for the male AWID and the values reported in the CPA are greater for five of the seven ADL. The smallest mean differences between observed and reported energy expenditure for both male and female AWID are for the ADL requiring less effort (SitQ, SitTV, SitAT, StaAT), ranging from 0.22 to 0.64 METs for males and 0.24 to 0.54 METs for females. The CPA does not report separate MET values for males and females. These results may however suggest that, at least for AWID, this approach needs to be reconsidered.

Results indicate that some ADL commonly engaged in by male and female AWID, including walking at or above a pace of 3.0 km/hr (WalkS, WalkQ, WalkF) requires levels of energy expenditure consistent with the classifications of moderate-intensity and vigorous-intensity activities. This suggests that for this population these activities could contribute to the recommended 30 minutes of at least moderate-intensity activity required to obtain a health benefit.

Evidence gathered through the current study has shown that AWID expend more energy for each ADL in comparison to AWOID. It was found that as the energy demand of the ADL increased there was an increase in the difference between energy expended between the two populations. This difference was more evident in males than females. Reasons for this trend remain uncertain. However, recent evidence reported in a Japanese study revealed that the walking step rate of male AWID was higher than age, height and weight matched AWOID (Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). Thus, it may be that AWID and AWOID exhibit different levels of biomechanical efficiency, and hence energy cost, while undertaking various ADL. This is an area that warrants further investigation.

Overall, data for AWOID suggests that the mean MET values for all except one ADL reported in the CPA correctly classify activity intensity as light, moderate or vigorous. The MET values reported in the CPA indicate that WalkS is of light-intensity (<3 METs) yet the observed mean MET value indicated that for AWOID WalkS was of moderate-intensity (3-6 METs). It is possible the lab based replication of the ADL may have elicited a different biomechanical response and subsequently a different amount of energy expended to that in the field. As the CPA is designed for estimates of field based energy expenditure lab based estimates could be
expected to be overestimated. To investigate this, further studies exploring lab and field based estimates of energy expenditure among AWID are required. Nonetheless, the observed MET values differ significantly to the values reported in the CPA for six of the seven ADL. Not dissimilar to the findings for AWID, the one exception was for StaAT. The observed mean MET values for five of the seven ADL engaged in by AVOID were higher than that reported in the CPA, ranging from 17% higher for SitAT to 132% higher for WalkS. In contrast, the observed mean MET values for two ADL engaged in by AVOID were 7% lower for StaAT and 33% lower for WalkF.

The MET values reported in the CPA indicate that AVOID walking at a pace of 3.0 km/hr (WalkS) would not achieve a sufficient activity intensity to contribute to the recommended 30 minutes of moderate-intensity activity required to obtain a health benefit. This is in opposition to findings from this study that indicated walking at 3.0 km/hr was of moderate-intensity for AVOID. This study is consistent with findings by Brooks and colleagues (2004) and Reeves and Capra (2003) who report inaccuracies in the CPA energy expenditure estimates for walking at various speeds among different groups.

For male AVOID, ADL requiring less effort (SitQ, SitTV, SitAT, StaAT) and the two fastest walking speeds (WalkQ, WalkF) are correctly classified by the CPA as light-intensity, moderate-intensity or vigorous-intensity activities respectively. This is despite statistically significant differences between the observed energy expenditure levels and the CPA values for the three sitting activities. In contrast, the observed energy expenditure values for the slowest walking speed (WalkS) classifies this activity as moderate-intensity (3-6 METs), whereas the CPA classifies this activity as light-intensity (<3 METs). WalkQ is correctly classified in the moderate-intensity activity level, however the observed MET value is close to the vigorous-intensity activity classification threshold (<6 METs). As a group, the walking activities for the male AVOID have one of the strongest effects \(d = 3.63\) for WalkS, \(d = 1.18\) for WalkQ and \(d = -3.32\) for WalkF. The mean MET values for six of the seven ADL’s engaged in by male AVOID, with the exception being the WalkF (-32%), were higher, ranging from 5% higher for StaAT to 128% higher for WalkS, than the MET values reported in the CPA.

For female AVOID all except one ADL were correctly classified in activity intensity categories in accordance with the CPA. The one exception was found for WalkS where the observed mean MET value would classify this activity as moderate-intensity (3-6 METs), whereas the CPA classifies this activity as light-intensity (<3 METs). No statistically significant difference
exists for most of the ADL requiring less effort (SitQ, SitAT, StaAT). A significant and strong effect was observed for SitTV ($p = .014$), WalkS ($p < .001$) and WalkF ($p = .002$). The mean MET values for five of the seven ADL engaged in by female AWOID, with the exceptions being StaAT (-15%) and WalkF (-34%), were higher, ranging from 11% higher for SitAT to 134% higher for WalkS, than the MET values reported in the CPA.

In comparison to male AWOID, there is a greater number of ADL that are not significantly different to the CPA for female AWOID. This suggests differences in energy expenditure exist between genders for this population. A limitation of the CPA is that the energy expenditure values are based on studies that included a small number of adults, and few of these adults were women (Brown, Ringuet, Trost, & Jenkins, 2001). Given the CPA does not report separate MET values for different genders, the results in this study suggest that there is a need to reconsider this approach. Another possible or contributing explanation for differences in energy expenditure between male and female AWOID in this study and the CPA is that although AWOID participants consisted of healthy adults, they did not regularly engage in physical activity. It is possible that this may have an impact on energy expenditure levels and is an area requiring further investigation.

Findings of this study add significantly to the limited research investigating energy expenditure among AWOID. AWOID typically spend a large proportion of their time sitting, watching TV, listening to music and typically walk for transport (Stanish & Draheim, 2005; Temple & Walkley, 2003). Although sedentary activities commonly engaged in by AWOID will not contribute to the recommended 30 minutes of moderate-intensity activity to obtain a health benefit, a benefit can be gained from walking at 3.0 km/hr for this population.

A small sample size and difficulties in the recruitment of matched AWOID participants are limitations of this study. Although small in number the matched controls reduced the possibility of measurement error. Notwithstanding the limitations, results of this study and the work of Iwaoka and colleagues (1998) suggest that several of the MET values reported in the CPA for ADL are inaccurate for AWOID.

To substantiate or refute these findings further research is required on the energy expenditure of AWOID, including the effect of walking gait. The current research can be used to help validate physical activity measurement tools and appropriately target health promotion towards this population. It is anticipated that results from this study can be used in order to cross validate
the energy expenditure values used in epidemiological surveys with the reported energy values (METs) reported in the CPA.
4.1 Introduction

Accurate measurement of physical activity is a major issue in physical activity research (Speck & Looney, 2006). There is no one, gold standard, for assessing physical activity behaviour in free living populations (Stanish, Temple, & Frey, 2006). Various techniques, including physical activity diaries, questionnaires, observation, and motion sensors are used to measure the physical activity behaviour of population sub-groups (Tudor-Locke & Myers, 2001). Motion sensors, including pedometers and accelerometers, are commonly used in validation studies of physical activity questionnaires.

Accurate measurement of physical activity participation allows for the collection of up-to-date information on population physical activity levels. This in turn enables a greater understanding of the relationship between physical activity and health and enables researchers to identify those in need of physical activity intervention programs (Timperio & Salmon, 2003). The lack of an adequate criterion to which measurement techniques can be compared is an obstacle to measuring field based methods of physical activity (Westerterp, 1999). The most accurate approach to the measurement of physical activity in free living populations remains an ongoing quest for researchers (Stanish, Temple, & Frey, 2006). Indirect calorimetry has increasingly become the preferred approach for field based physical activity validation studies (Dale, Welk, & Matthews, 2002; Westerterp, 1999).

Adults with an intellectual disability (AWID) have not typically been included in large scale population based studies (Temple, Frey, & Stanish, 2006). Studies investigating the physical activity of AWID have used various techniques, including motion sensors, participant and/or caregiver completed questionnaires and activity diaries to measure the physical activity of the population. A small number of studies (Frey, 2004; Stanish & Draheim, 2005; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003) have relied on multiple data sources including the use of an objective, direct measurement sources (i.e. accelerometers). In contrast, other studies (Beange, McElduff, & Baker, 1995; Draheim, Williams, & McCubbin, 2002;
Emerson, 2005; Janicki et al., 2002; Rimmer, Braddock, & Marks, 1995; Robertson et al., 2000) have relied on indirect measurement techniques which have not been validated for use with AWID or caregivers acting as proxy-respondents for AWID. Research limitations, including the absence of information relating to the reliability and validity of measurement instruments, have negatively impacted on the confidence that can be linked to the results from the majority of studies investigating the physical activity of AWID (Temple, Frey, & Stanish, 2006).

Motion sensors are a suitable instrument to measure the physical activity behaviour of relatively large populations (Westerterp, 1999). The relatively simple devices provide an objective estimate of physical activity and can be worn with minimal discomfort to participants (Stanish, Temple, & Frey, 2006; Westerterp, 1999). The use of motion sensors with AWID is advantageous as they eliminate the need for recall demand which is placed on participants when asked to complete recall and self-report questionnaires (Stanish, Temple, & Frey, 2006). Studies of the physical activity behaviour of AWID have shown that AWID can successfully wear motion sensors (Frey, 2004; Stanish & Draheim, 2005; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003).

A recent study used pedometers (Yamax Digiwalkers; SW-500 and SW-700) and physical activity questionnaires to assess the walking activity of AWID (Stanish & Draheim, 2005). Yamax Digiwalkers have been shown to be reliable when used with AWID (Stanish, 2004). AWID wore the pedometer during waking hours, for one week. AWID, and where required their caregivers, completed an interviewer administered physical activity questionnaire, the National Health and Nutrition Examination survey III (NHANES III). A non-significant relationship was found between pedometer counts (steps) and the questionnaire data. The authors report that measurement issues including inaccurate reporting, tampering with the motion sensors and the AWID’s walking speed and gait may have contributed to this non-significant relationship.

An Australian study explored the physical activity of six community living AWID using direct observation and a Caltrac® accelerometer (Temple, Anderson, & Walkley, 2000). Participants wore the Caltrac® in a small bag during waking hours for seven consecutive days. Data from the Caltrac® was used to validate measurement of physical activity intensity derived from direct observation. The authors report an intra-class correlation of .83 between the Caltrac® accelerometer and data obtained from direct observation. The investigators found that on average per day, AWID spent 10 hours lying down, 6 hours sitting involved in activities such as...
A follow-up study utilized Caltrac® accelerometers and caregiver physical activity diary entries to investigate the concurrence between proxy and accelerometer generated estimates of physical activity among 37 AWID (Temple & Walkley, 2003). Data was collected over three consecutive days, two weekdays and one day of the weekend. Caregivers were trained on how to complete the 3 day physical activity diary and were requested to complete the diary at set intervals throughout each day. An intra-class correlation of .78 was reported between caregiver physical activity diary entries and the Caltrac® accelerometer.

Validation studies of motion sensors, including the Caltrac® accelerometer, indicate inaccuracies in the assessment of energy expenditure among AWID (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Welk, Blair, Wood, Jones, & Thompson, 2000; Westerterp, 1999). Investigators report an underestimation in energy expenditure, with an inability for the Caltrac® accelerometer to accurately detect upper body movements (Hendelman, Miller, Baggett, Debold, & Freedson, 2000).

The Caltrac® accelerometer has been used as a field based measure to monitor the physical activity of AWID. Evidence is required before any firm conclusions can be drawn on the validity of the energy expenditure algorithms that underpin the energy estimates of the Caltrac® accelerometer for AWID. The aim of this study was therefore to establish if the energy expenditure values derived from the Caltrac® accelerometer for measurement of seven common activities of daily living (ADL) among adults with and without an intellectual disability are different to that derived by indirect calorimetry.

### 4.2 Methodology

Prior to the commencement of this study approval was gained from the RMIT Human Research Ethics Committee. To investigate the validity of energy expenditure measurements of seven ADL derived from the Caltrac® accelerometer, energy expenditure values derived by the Caltrac® accelerometer were compared with the energy expenditure values derived from indirect calorimetry. Data for this study was collected concurrently with that of study 1 and study 3.
As participants were recruited for study 1, 2 and 3 simultaneously, the final sample for all three studies consisted of the same participants. Thirty-one AWID (male = 20 & female = 11) and fifteen adults without an intellectual disability (AWOID) (male = 6 & female = 9) completed the testing phase. Further information on the exclusion and drop out rates of AWID are discussed in Section 3.2.5 of Chapter 3. No AWOID withdrew from the study.

4.2.1 Participant Recruitment

Ambulatory, community living adults with an intellectual disability (AWID) were recruited from day agencies, including day placement, supported employment and accommodation centres in the Northern metropolitan region of Melbourne, Australia. Adults without an intellectual disability (AWOID) were recruited through advertisements and information circulars (See Appendix 5). Descriptive statistics for AWID and AWOID are reported in Table 6 in Section 3.2.5.

Before participating in this study informed consent from participants and/or legal guardians was obtained. To promote the safety of all participants, AWID were required to obtain a medical clearance to engage in exercise from a medical practitioner (See Appendix 3) and AWOID were required to complete a Physical Activity Readiness Questionnaire (PAR-Q) (See Appendix 7).

Further information on the recruitment of participants is described in depth in Section 3 of Chapter 3.

4.2.2 Procedure

Indirect calorimetry and Caltrac® accelerometer data was collected for seven ADL. The ADL selected are activities commonly engaged in by AWID (Frey, 2004; Sparrow & Sharp, 1991; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003) and included sitting quietly (SitQ), sitting watching television (SitTV), sitting and standing while doing an assembly task (SitAT and StaAT) and a slow (3.0 km/hr), quick (6.0 km/hr) and fast (9.0 km/hr) walk (WalkS, WalkQ and WalkF). The selection of and a description of the seven ADL are discussed in greater detail in Section 3.2.3 of Chapter 3.
4.2.3 Equipment

The equipment used by participants while engaged in the seven ADL included a high backed, lounge type chair with arm rests, stool, television and video, videotapes of popular entertainment, sport and contemporary television shows, a 10 minute segment of the sitcom ‘Friends’; candle making equipment, comprising of a small, round, tea-light waxed candle, wick, cup, and tray; a motorised (Repco) treadmill and a standalone mirror.

Indirect calorimetry was used to determine energy expenditure through a MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA). While undertaking each ADL participants wore a facemask which was attached by a netted head piece and was fitted securely over the nose and mouth. All instrumentation was calibrated according to manufacturer’s instructions.

While undertaking each ADL, participants wore a Caltrac® accelerometer at the hip in accordance with manufacturer’s directions. The Caltrac® accelerometer is a battery operated device (7 x 7 x 2 cm) that displays estimates of energy expenditure based on participant’s age, height, weight and gender. The device updates energy expenditure estimates every 2 minutes (Bassett et al., 2000). A heart rate monitor (Polar Electro OY, Kempele, Finland) was also worn by participants during the testing.

4.2.4 Participant Inclusion and Familiarisation

Some evidence has suggested that levels of energy expenditure among AWID with Down syndrome differ to AWID without Down syndrome (Fernhall et al., 1996). To investigate if a difference in energy expenditure for each ADL existed between AWID participants with (n = 10) and without Down syndrome (n = 21), the investigator undertook preliminary data analysis.

Exploratory data analysis was conducted using a Levene test revealed the assumption of homogeneity of variance was met for all except one ADL (SitTV) for the energy expenditure values derived from indirect calorimetry. Therefore, two-tailed independent groups t-tests based on equal variances for six of the seven ADL and unequal variances for one ADL (SitTV) was performed. No significant difference in energy expenditure between the samples of AWID with and without Down syndrome was found for any ADL; SitQ, $t (29) = 0.42, p = .68$; SitTV, $t (10.95) = 0.42, p = .68$; SitAT, $t (29) = 0.023, p = .98$; StaAT, $t (29) = 1.33, p = .19$; WalkS, $t (29) = 0.78, p = .44$; WalkQ, $t (29) = 0.26, p = .80$; WalkF, $t (29) = 0.49, p = .62$. Descriptive
statistics for energy expenditure values derived by indirect calorimetry for adults with and without Down syndrome are presented in Table 5. A two-tailed independent groups t-tests based on equal variances was performed to determine if a difference existed between AWID with and without Down syndrome for energy expenditure values derived from the Caltrac® accelerometer. No significant difference in energy expenditure between the sample of AWID with and without Down syndrome was found for any ADL; SitQ, \( t(29) = -.58, p = .57 \); SitTV, \( t(29) = 1.67, p = .11 \); SitAT, \( t(29) = -1.37, p = .18 \); StaAT, \( t(29) = -.18, p = .86 \); WalkS, \( t(29) = .43, p = .67 \); WalkQ, \( t(29) = .47, p = .64 \); WalkF, \( t(29) = .13, p = .18 \). Analysis between genders for AWID with and without Down syndrome found one significant difference for male AWID (SitTV, \( t(18) = 2.28, p = .035 \)). The difference in energy expenditure values derived from the Caltrac® accelerometer for SitTV was not deemed sufficiently meaningful and robust to warrant further analysis. Descriptive statistics for energy expenditure values derived by the Caltrac® accelerometer for adults with and without Down syndrome are presented in Table 12. Given the consistent lack of significant differences found for the analyses, data was pooled for all subsequent analysis.
Table 12: Descriptive statistics for energy expenditure of AWID with and without Down syndrome for seven ADL derived from the Caltrac<sup>®</sup> accelerometer

<table>
<thead>
<tr>
<th>Activity</th>
<th>AWID with Down syndrome</th>
<th>AWID without Down syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample</td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>(n = 10)</td>
<td>(n = 5)</td>
</tr>
<tr>
<td>SitQ</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>0.94</td>
<td>0.25</td>
<td>1.05</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.06</td>
<td>0.27</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.89</td>
<td>0.24</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.00</td>
<td>0.18</td>
</tr>
<tr>
<td>WalkS</td>
<td>3.40</td>
<td>1.66</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.49</td>
<td>2.58</td>
</tr>
<tr>
<td>WalkF</td>
<td>6.82</td>
<td>4.63</td>
</tr>
</tbody>
</table>
Prior to the testing session all participants took part in a familiarisation process at RMIT University, Bundoora West campus. Testing of participants did not occur until they could demonstrate confidence in completing each ADL. On average AWID visited the laboratory on four occasions (range 2 - 6) in order to become familiar with the environment, ADL, equipment, investigator and testing protocols. Each visit ranged from 45 to 120 minutes per AWID. AWID who could not demonstrate confidence after six familiarisation visits were withdrawn from the study. AWOID attended one, 30 to 60 minute familiarisation session. The Caltrac® accelerometer was introduced to all participants during the familiarisation process. The familiarisation process is described in Section 3.2.5 of Chapter 3.

4.2.5 Testing

The procedures used in this study have been described previously in Chapter 3. In addition to the procedures described therein, participants wore a Caltrac® accelerometer while undertaking each ADL. The Caltrac® accelerometer was worn on the participant’s hip, in accordance with manufacturer’s directions. Metabolic data was collected for each ADL with expired air being analysed for carbon dioxide (CO²), oxygen (O²) and volume expired. Data was collected for 8 - 10 minutes.

Participants were fasted from the time of retiring to bed on the night before testing. Upon arrival participants height (to the nearest 0.1cm) and weight (to the nearest 0.1kg) was measured (clothed, but without footwear) using calibrated digital scales (Tanitia, model BWB-620) and a calibrated wall-mounted stadiometer (Holtain). Anthropometric measurements (weight, height) and the participant’s age and gender were entered into the Caltrac® accelerometer in accordance with manufacturer’s directions. At the commencement of each ADL the Caltrac® accelerometer was reset to zero.

Participants undertook each ADL for 8 – 10 minutes and in sequence, commencing with the least energy demanding activity (SitQ) and concluding with the most energy demanding activity (WalkF). For analysis purposes indirect calorimetry data collected during the last 5 minutes of each ADL was used. As the Caltrac® accelerometer updates at 2 minute epochs a reading from the Caltrac® accelerometer and participant’s heart rate was recorded at 2 minute intervals and data collected during the last 6 minutes of each ADL was used for analysis purposes. Upon
completing each ADL test, participants rested on a high backed, lounge type chair with arm rests. Participants did not commence the next ADL test until their heart rate had returned to within 10% of their heart rate at the conclusion of the previous activity. For the walking activities testing stopped if a participant reached volitional fatigue, a respiratory exchange ratio greater than 1.1 (RER > 1.1), a heart rate within 10% of the predicted maximum heart rate, or was unable to maintain the walking cadence to remain in the centre of the treadmill (Fernhall, 1997).

4.3 Data Analysis

Raw data obtained from the MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA) was imported into a Microsoft Access 2003 database to allow for energy expenditure calculations, expressed as metabolic equivalents (MET), to occur for each of the seven ADL. VO\textsubscript{2} data was averaged over minute intervals for the last 5 minutes for each ADL. An average VO\textsubscript{2} was then computed before obtaining an average MET value per ADL.

The Caltrac\textsuperscript{®} accelerometer displays energy expenditure as kilocalories. Values derived from the Caltrac\textsuperscript{®} accelerometer were converted to an average total MET. This was achieved through the following steps.

Step 1: Using the last 6 minutes of data, cumulative gross energy expenditure was determined.

\[
\text{Gross kilocalories} = \text{last minute Caltrac\textsuperscript{®} accelerometer reading} - 6^{th} \text{last minute 4 Caltrac\textsuperscript{®} accelerometer reading}.
\]

Step 2: The average Caltrac\textsuperscript{®} accelerometer energy expenditure was computed.

\[
\text{Average kilocalories} = \text{Gross energy expenditure} / 6 \text{ minutes}
\]

Step 3: Caloric values were transformed into METs using standardised constants (1 LO\textsubscript{2} = 4.8 kcal, 1 MET = 3.5 ml.kg\textsuperscript{-1}.min\textsuperscript{-1}) reported by Bassett and colleagues (2000)

\[
\text{MET} = \text{Average kcal ml.min}\textsuperscript{-1} / 4.8 \times 3.5 \times \text{weight (kg)}
\]

A small amount of data was missing for each of the seven ADL for both AWID and AWOID. Inspection revealed this to be of a random nature, missing data was imputed through missing
value analysis procedures in SPSS (Version 13) for each population (Tabachnick & Fidell, 1989). The group means generated by the analysis were substituted for any missing data. The complete data set was then subjected to exploratory data analysis and followed by the appropriate descriptive and inferential statistical analysis.

A comparison of energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry were established through paired samples correlation co-efficients. To establish if a difference existed between the energy expenditure derived values from the Caltrac® accelerometer and indirect calorimetry, two tailed paired samples t-tests based on equal variances were performed for each of the seven ADL. A series of t-tests were performed instead of a repeated measures MANOVA due to a small sample. Paired samples statistics for population; adults with an intellectual disability (AWID), and adults without an intellectual disability (AWOID) and gender; males, and female between the two measures are reported in Table 13.
Table 13: Paired samples statistics derived from the Caltrac® accelerometer and indirect calorimetry for the seven ADL by population and gender

<table>
<thead>
<tr>
<th>Activity</th>
<th>Adults with an intellectual disability</th>
<th>Adults without an intellectual disability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample ((n = 31)) M SD</td>
<td>Males ((n = 20)) M SD</td>
</tr>
<tr>
<td>Indirect calorimetry data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SitQ</td>
<td>1.56 0.43</td>
<td>1.57 0.40</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.59 0.56</td>
<td>1.64 0.47</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.88 0.65</td>
<td>1.95 0.69</td>
</tr>
<tr>
<td>StaAT</td>
<td>2.05 0.80</td>
<td>2.02 0.63</td>
</tr>
<tr>
<td>WalkS</td>
<td>5.70 1.58</td>
<td>5.85 1.28</td>
</tr>
<tr>
<td>WalkQ</td>
<td>6.68 1.54</td>
<td>6.92 1.62</td>
</tr>
<tr>
<td>WalkF</td>
<td>8.32 2.10</td>
<td>8.69 1.90</td>
</tr>
<tr>
<td>Caltrac® accelerometer data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SitQ</td>
<td>0.97 0.20</td>
<td>1.04 0.19</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.97 0.21</td>
<td>1.02 0.22</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.97 0.25</td>
<td>1.06 0.23</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.01 0.22</td>
<td>1.05 0.21</td>
</tr>
<tr>
<td>WalkS</td>
<td>3.25 1.35</td>
<td>3.31 1.65</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.25 1.94</td>
<td>4.20 2.25</td>
</tr>
<tr>
<td>WalkF</td>
<td>5.78 2.99</td>
<td>5.90 3.65</td>
</tr>
</tbody>
</table>
4.4 Results

Mean MET values and 95% confidence intervals were used to establish if the energy expenditure values derived from the Caltrac® accelerometer for seven ADL were different to that derived from indirect calorimetry for gender and disability. The following interpretations were applied to effect sizes within the results; <0.2, small; 0.3 – 0.5, medium; 0.6 – 0.8, large; and >0.9, very large (Cohen, 1988).

A significant positive correlation was found for two ADL for the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for adults with an intellectual disability (AWID) for SitQ, \( r (N = 31) = 0.46, p = .009 \); and SitTV, \( r (N = 31) = 0.42, p = .020 \). Correlations are reported in Table 14. Correlation coefficients reveal that as the amount of effort required for each activity in the group of sedentary based activities (SitQ, SitTV, SitAT and StaAT) and in the group of walking activities (WalkS, WalkQ and WalkF) increased, the strength of the relationship between the Caltrac® accelerometer and indirect calorimetry decreased.

Table 14: Paired samples correlation coefficients between the Caltrac® accelerometer and indirect calorimetry of AWID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>0.46</td>
<td>.009</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.42</td>
<td>.020</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.26</td>
<td>.161</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.18</td>
<td>.335</td>
</tr>
<tr>
<td>WalkS</td>
<td>0.50</td>
<td>.422</td>
</tr>
<tr>
<td>WalkQ</td>
<td>0.25</td>
<td>.178</td>
</tr>
<tr>
<td>WalkF</td>
<td>0.13</td>
<td>.486</td>
</tr>
</tbody>
</table>

\( n = 31 \)

Table 15 reports the paired samples correlation co-efficients between the Caltrac® accelerometer and indirect calorimetry for AWID by gender. A significant positive correlation
was found between the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for male AWID for SitTV, \( r (N = 20) = 0.50, p = .025 \); and for female AWID for SitQ, \( r (N = 11) = 0.71, p = .014 \).

Table 15: Paired samples correlation coefficients between the Caltrac® accelerometer and indirect calorimetry by gender for AWID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Males (n = 20)</th>
<th>Females (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( r )</td>
<td>( p )</td>
</tr>
<tr>
<td>SitQ</td>
<td>0.42</td>
<td>.064</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.50</td>
<td>.025</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.16</td>
<td>.512</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.02</td>
<td>.944</td>
</tr>
<tr>
<td>WalkS</td>
<td>0.33</td>
<td>.161</td>
</tr>
<tr>
<td>WalkQ</td>
<td>0.34</td>
<td>.141</td>
</tr>
<tr>
<td>WalkF</td>
<td>0.28</td>
<td>.237</td>
</tr>
</tbody>
</table>

The difference between energy expenditure values derived from indirect calorimetry and the Caltrac® accelerometer are reported in Table 16. Two-tailed repeated measures t-tests found a significant difference between the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for each of the seven ADL for AWID at \( p < .001 \) level.
Table 16: Comparison of energy expenditure values between the Caltrac\textsuperscript{®} accelerometer and indirect calorimetry of AWID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>MD</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>0.60</td>
<td>0.38</td>
<td>0.46</td>
<td>0.74</td>
<td>8.67</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.62</td>
<td>0.51</td>
<td>0.44</td>
<td>0.81</td>
<td>6.81</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.90</td>
<td>0.64</td>
<td>0.67</td>
<td>1.14</td>
<td>7.86</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.04</td>
<td>0.80</td>
<td>0.75</td>
<td>1.33</td>
<td>7.29</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.45</td>
<td>1.86</td>
<td>1.76</td>
<td>3.13</td>
<td>7.30</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkQ</td>
<td>2.42</td>
<td>2.09</td>
<td>1.66</td>
<td>3.19</td>
<td>6.45</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkF</td>
<td>2.54</td>
<td>3.42</td>
<td>1.28</td>
<td>3.79</td>
<td>4.13</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

\( n = 31, \) MD= mean difference

Data for AWID by gender are reported in Table 17. Two-tailed repeated measures t-tests found a significant difference between the energy expenditure values derived from the Caltrac\textsuperscript{®} accelerometer and indirect calorimetry for male AWID for each of the seven ADL at the \( p < .05 \) level. A significant difference was found for female AWID between the Caltrac\textsuperscript{®} accelerometer and indirect calorimetry for six of the seven ADL’s at \( p < .05 \) level, with WalkF the exception (\( p = .053 \)).

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Table 17: Comparison of energy expenditure values between the Caltrac® accelerometer and indirect calorimetry by gender of AWID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>MD</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
<th>MD</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>0.54</td>
<td>0.36</td>
<td>0.37</td>
<td>0.71</td>
<td>6.63</td>
<td>&lt;.001</td>
<td>0.70</td>
<td>0.41</td>
<td>0.43</td>
<td>0.98</td>
<td>5.64</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.62</td>
<td>0.41</td>
<td>0.43</td>
<td>0.81</td>
<td>6.84</td>
<td>&lt;.001</td>
<td>0.63</td>
<td>0.69</td>
<td>0.17</td>
<td>1.09</td>
<td>3.05</td>
<td>.012</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.90</td>
<td>0.69</td>
<td>0.57</td>
<td>1.22</td>
<td>5.80</td>
<td>&lt;.001</td>
<td>0.92</td>
<td>0.57</td>
<td>0.54</td>
<td>1.30</td>
<td>5.37</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.97</td>
<td>0.66</td>
<td>0.66</td>
<td>1.28</td>
<td>6.54</td>
<td>&lt;.001</td>
<td>1.17</td>
<td>1.02</td>
<td>0.49</td>
<td>1.85</td>
<td>3.81</td>
<td>.003</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.54</td>
<td>1.73</td>
<td>1.73</td>
<td>3.35</td>
<td>6.57</td>
<td>&lt;.001</td>
<td>2.28</td>
<td>2.17</td>
<td>0.82</td>
<td>3.74</td>
<td>3.48</td>
<td>.006</td>
</tr>
<tr>
<td>WalkQ</td>
<td>2.71</td>
<td>2.28</td>
<td>1.64</td>
<td>3.78</td>
<td>5.32</td>
<td>&lt;.001</td>
<td>1.90</td>
<td>1.67</td>
<td>0.78</td>
<td>3.02</td>
<td>3.77</td>
<td>.004</td>
</tr>
<tr>
<td>WalkF</td>
<td>2.79</td>
<td>3.62</td>
<td>1.10</td>
<td>4.49</td>
<td>3.45</td>
<td>.003</td>
<td>2.08</td>
<td>3.14</td>
<td>-0.04</td>
<td>4.19</td>
<td>2.19</td>
<td>.053</td>
</tr>
</tbody>
</table>

MD= mean difference
Paired samples correlation coefficients between the two measures, Caltrac® accelerometer and indirect calorimetry for AWOID are reported in Table 18. There was a significant positive correlation between energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for SitAT for AWOID, $r (N = 15) = 0.54$, $p = .039$.

Table 18: Paired samples correlation coefficients between the Caltrac® accelerometer and indirect calorimetry of AWOID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>$r$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>0.02</td>
<td>.950</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.43</td>
<td>.114</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.54</td>
<td>.039</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.21</td>
<td>.454</td>
</tr>
<tr>
<td>WalkS</td>
<td>0.43</td>
<td>.106</td>
</tr>
<tr>
<td>WalkQ</td>
<td>0.41</td>
<td>.126</td>
</tr>
<tr>
<td>WalkF</td>
<td>0.55</td>
<td>.194</td>
</tr>
</tbody>
</table>

$n = 15$

Table 19 reports the paired samples correlation co-efficients between the Caltrac® accelerometer and indirect calorimetry for AWOID by gender. A significant positive correlation was found between the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for male AWID for SitAT, $r (N = 6) = 0.88$, $p = .019$; and for female AWID for WalkS, $r (N = 9) = 0.82$, $p = .006$; WalkQ, $r (N = 9) = 0.79$, $p = .010$ and WalkF, $r (N = 9) = 0.79$, $p = .011$. 

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Table 19: Paired samples correlation coefficients between the Caltrac® accelerometer and indirect calorimetry by gender of AWOID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Males (n = 6)</th>
<th>Females (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>SitQ</td>
<td>-0.71</td>
<td>.114</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.05</td>
<td>.919</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.88</td>
<td>.019</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.44</td>
<td>.376</td>
</tr>
<tr>
<td>WalkS</td>
<td>-0.70</td>
<td>.123</td>
</tr>
<tr>
<td>WalkQ</td>
<td>-0.44</td>
<td>.382</td>
</tr>
<tr>
<td>WalkF</td>
<td>-0.53</td>
<td>.283</td>
</tr>
</tbody>
</table>

Two-tailed repeated measures t-tests found a significant difference between the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for each of the seven ADL for AWOID at the $p < .05$ level. Data is reported in Table 20.

Table 20: Comparison of energy expenditure values between the Caltrac® accelerometer and indirect calorimetry of AWOID for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>M</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SitQ</td>
<td>0.25</td>
<td>0.24</td>
<td>0.12</td>
<td>0.39</td>
<td>4.09</td>
<td>.001</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.43</td>
<td>0.24</td>
<td>0.30</td>
<td>0.56</td>
<td>7.03</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.80</td>
<td>0.23</td>
<td>0.67</td>
<td>0.92</td>
<td>13.35</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>StaAT</td>
<td>0.83</td>
<td>0.44</td>
<td>0.58</td>
<td>1.07</td>
<td>7.27</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.08</td>
<td>1.07</td>
<td>1.48</td>
<td>2.67</td>
<td>7.51</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkQ</td>
<td>2.12</td>
<td>1.21</td>
<td>1.45</td>
<td>2.79</td>
<td>6.77</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkF</td>
<td>2.12</td>
<td>1.80</td>
<td>1.13</td>
<td>3.12</td>
<td>4.57</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

$n = 15$
Data for AVOID by gender are reported in Table 21. Two-tailed repeated measures t-tests found a significant difference between the energy expenditure values derived from the Caltrac® accelerometer and indirect calorimetry for male AVOID for six of the seven ADL’s at the $p < .05$ level. A significant difference was found for female AVOID between the Caltrac® accelerometer and indirect calorimetry for each of the seven ADL at the $p < .05$ level.
Table 21: Comparison of energy expenditure values between the Caltrac\textsuperscript{®} accelerometer and indirect calorimetry by gender of AWOID for seven ADL

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
<th>M</th>
<th>SD</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>0.36</td>
<td>0.29</td>
<td>0.06</td>
<td>0.67</td>
<td>3.04</td>
<td>.029</td>
<td>0.18</td>
<td>0.18</td>
<td>0.04</td>
<td>0.32</td>
<td>2.97</td>
<td>.018</td>
</tr>
<tr>
<td>SitTV</td>
<td>0.54</td>
<td>0.26</td>
<td>0.26</td>
<td>0.81</td>
<td>5.01</td>
<td>.004</td>
<td>0.36</td>
<td>0.21</td>
<td>0.20</td>
<td>0.52</td>
<td>5.27</td>
<td>.001</td>
</tr>
<tr>
<td>SitAT</td>
<td>0.94</td>
<td>0.15</td>
<td>0.79</td>
<td>1.10</td>
<td>15.58</td>
<td>&lt;.001</td>
<td>0.70</td>
<td>0.23</td>
<td>0.52</td>
<td>0.87</td>
<td>9.17</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.12</td>
<td>0.37</td>
<td>0.72</td>
<td>1.51</td>
<td>7.34</td>
<td>.001</td>
<td>0.64</td>
<td>0.39</td>
<td>0.34</td>
<td>0.94</td>
<td>4.9</td>
<td>.001</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.17</td>
<td>1.53</td>
<td>0.57</td>
<td>3.78</td>
<td>3.48</td>
<td>.018</td>
<td>2.02</td>
<td>0.73</td>
<td>1.45</td>
<td>2.58</td>
<td>8.24</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WalkQ</td>
<td>2.77</td>
<td>1.37</td>
<td>1.34</td>
<td>4.21</td>
<td>4.96</td>
<td>.004</td>
<td>1.68</td>
<td>0.93</td>
<td>0.97</td>
<td>2.40</td>
<td>5.43</td>
<td>.001</td>
</tr>
<tr>
<td>WalkF</td>
<td>2.49</td>
<td>2.37</td>
<td>0.01</td>
<td>4.97</td>
<td>2.58</td>
<td>.050</td>
<td>1.88</td>
<td>1.41</td>
<td>0.79</td>
<td>2.97</td>
<td>3.99</td>
<td>.004</td>
</tr>
</tbody>
</table>
4.5 Discussion

The ability to obtain accurate and immediate field based information on energy expended by adults with an intellectual disability (AWID) during activities of daily living (ADL) is advantageous to caregivers in the pursuit of monitoring and maintaining health behaviour changes among the population. Investigators have used motion sensors, including the Caltrac® accelerometer, as an objective criterion measure in studies investigating the physical activity of AWID (Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003). Use of the Caltrac® accelerometer is beneficial as the device is less invasive, relatively cost effective and suitable for population based studies. A downfall of studies using the Caltrac® accelerometer to investigate the physical activity of AWID is that the validity of the Caltrac® accelerometer for use with this population has not been established. This study sought to investigate if the energy expenditure values derived from indirect calorimetry differed to the energy expenditure values derived from the Caltrac® accelerometer for seven common ADL among AWID and adults without an intellectual disability (AWOID).

Results of this study suggest that when used with AWID, the Caltrac® accelerometer does not accurately measure energy expenditure for seven common ADL. A comparison of the energy expenditure values between the two measures of energy expenditure; indirect calorimetry and the Caltrac® accelerometer, revealed significant differences for each of the seven ADL. Mean values revealed that the energy expenditure values derived from indirect calorimetry were consistently higher than the energy expenditure values derived from the Caltrac® accelerometer. This indicates that the Caltrac® accelerometer underestimates energy expenditure of AWID for the seven ADL. The same pattern was observed for a comparison group of AWOID.

A comparison of the energy expenditure values derived for both genders through indirect calorimetry and the Caltrac® accelerometer revealed similar results to that found for the population of AWID. Results revealed a significant difference in energy expenditure values for all seven ADL for male AWID and six of the seven ADL for female AWID, with energy expenditure values derived from indirect calorimetry being consistently higher than the energy expenditure values derived from the Caltrac® accelerometer. Findings suggest that the Caltrac® accelerometer is inaccurate and not appropriate for use in studies investigating the physical activity energy expenditure among male and female AWID. Results also raise questions over the accuracy of the Caltrac® accelerometer when used with AWOID. This is consistent with results of Hendelman and colleagues (2000) who found that accelerometers, including the
Caltrac® accelerometer, could not accurately assess energy expenditure among adults without a disability. Combined, these findings indicate the Caltrac® accelerometer underestimates energy expenditure across common, light, moderate and vigorous intensity ADL for male and female ambulatory adults.

An interesting finding of the study was that as the intensity of the ADL increased the size of the energy expenditure difference between indirect calorimetry and the Caltrac® accelerometer also increased. This was observed for both AWID and AWOID, indicating that the type of activity engaged in may have an impact on the reported difference in energy expenditure values derived from indirect calorimetry and the Caltrac® accelerometer. Correlation coefficients revealed an interesting trend for the group of sedentary based activities (SitQ, SitTV, SitAT and StaAT) and the walking activities (WalkS, WalkQ and WalkF) for the sample of AWID. As the activities required greater effort, the strength of the relationship between the Caltrac® accelerometer and indirect calorimetry decreased. This suggests that as the intensity of each group of activities increases, the more variable the energy expenditure values from the Caltrac® accelerometer. An explanation for this phenomenon is not readily available given that the same trend did not appear among male and female AWID as separate groups nor among AWOID.

Evidence suggests that the accuracy of motion sensors including the Caltrac® accelerometer vary depending on the type of activity and/or placement of the motion sensor (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Speck & Looney, 2006; Westerterp, 1999). Motion sensors can detect movement in single or multiple planes (Stanish, Temple, & Frey, 2006). Results of a study that measured energy expenditure using a portable metabolic system and different (single and multiple plane) motion sensors (Yamax Digiwalker pedometer, MTI accelerometer [formally CSA accelerometer] and a Tritrac accelerometer) among AWOID found that the motion sensors were unable to detect an increase in energy expenditure for activities predominately involving upper body movements (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). Further investigation is required to determine if this impacted on the results found in this study.

Temple and colleagues (2000) used the Caltrac® accelerometer as a criterion measure to validate estimates of activity intensity derived from direct observation. Data from the Caltrac® accelerometer indicated that trained observers could adequately use the Bouchard Physical Activity Scale to report on the physical activity behaviours of AWID. Using the Caltrac® accelerometer, a more recent study by Temple and Walkley (2003) reported that trained
caregivers can provide meaningful data through physical activity diaries. Although being one of the most appropriate and best field-based alternatives available at the time, results of this study question the validity of the Caltrac® accelerometer, bringing into doubt the accuracy of the Caltrac® accelerometer data reported in these previous studies.

Motion sensors are an objective field based device that can be used in an attempt to improve the assessment of physical activity (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). They are advantageous for populations, including AWID, who have reduced cognitive capacity, as use of an objective measure eliminates the recall demand required to complete self-report or proxy-report physical activity questionnaires. However, results of this study cast doubt over the accuracy of the Caltrac® accelerometer as a measure of physical activity energy expenditure among AWID and AWOID. There is a need for the existing equations that underpin the energy expenditure calculations of the Caltrac® accelerometer to be further explored and possibly modified to enable accurate energy expenditure estimates among AWID. Additionally, there is a need to explore appropriate, alternative, low cost, easy to use devices to objectively measure the physical activity of AWID.
CHAPTER 5

COMPARISON OF ENERGY EXPENDITURE DERIVED FROM THE CALTRAC® ACCELEROMETER TO THE COMPENDIUM OF PHYSICAL ACTIVITIES IN ACTIVITIES OF DAILY LIVING AMONG ADULTS WITH AND WITHOUT AN INTELLECTUAL DISABILITY

5.1 Introduction

It is well documented that a lack of engagement in regular, moderate-intensity physical activity increases the risk of sedentary lifestyle diseases. A growing body of evidence suggests that adults with an intellectual disability (AWID) engage in predominantly sedentary behaviour (Temple, Frey, & Stanish, 2006). It is postulated that sedentary lifestyles led by AWID lead to low levels of cardiovascular fitness, overweight and obesity, low levels of muscular strength, hypertension, hypolipidemia, insulin resistance and, with the exception of people with Down syndrome, poor flexibility (Draheim, Williams, & McCubbin, 2002; Graham & Reid, 2000; Pitetti, Rimmer, & Fernhall, 1993; Yamaki, 2005).

Evidence of the health characteristics of AWID illustrates the need to modify the health-related behaviours of this population. Appropriate dietary intake and participation in moderate intensity physical activity is a key recommendation. To date research into the implementation of health related programs and interventions for AWID have been minimal (Heller, Hsieh, & Rimmer, 2004). The implementation of health related programs are vital in the fight to decrease the risk of developing sedentary lifestyle diseases and increase the quality of life among this population.

Education and support of AWID and their caregivers is important to improve and maintain health behaviour changes (Mann, Zhou, McDermott, & Poston, 2006). Implementing changes to the health related behaviours of AWID proves difficult with many caregivers not in constant daily contact with AWID. Poor staffing ratios and parental restrictions further limit opportunities available to AWID (Messent, Cooke, & Long, 1998) with additional responsibilities and duties of caregivers exacerbating issues, making it difficult to successfully implement and maintain health related programs and interventions among AWID.

Use of simple, mechanical devices such as motion sensors like accelerometers and pedometers, enables AWID and their caregivers to objectively monitor physical activity behaviours. The
use of motion sensors with AWID are advantageous because they negate the need for recall demand required with self-report and proxy-report physical activity questionnaires.

The Caltrac® accelerometer allows individuals to easily determine one aspect of the energy balance equation, expenditure, in turn assisting with percentage body fat changes and fat loss. The Caltrac® accelerometer is a direct, objective measure that calculates the number of calories used when at rest and during activity (Ellis, 1993). Older forms of accelerometers and pedometers are of little value, as unlike the Caltrac® accelerometer many do not provide calorie estimates which can be used in physical activity programming with this population. Newer accelerometer versions provide this information however they can be expensive and may not be widely available for this population.

To explore the physical activity of Australian AWID investigators have used the Caltrac® accelerometer. The Caltrac® accelerometer was successfully used to validate estimates of energy expenditure derived from direct observation (Temple, Anderson, & Walkley, 2000). The authors reported an intra-class correlation of 0.83 between the Caltrac® accelerometer and data obtained from direct observation. Results suggested that AWID engaged in predominately sedentary activities. A follow-up study utilised the Caltrac® accelerometer to investigate physical activity of AWID and this data source was supplemented by proxy-respondent reports (Temple & Walkley, 2003).

Although previously unexplored among AWID, results of previous laboratory and field based studies using accelerometers with adults without an intellectual disability (AWOID) have found their accuracy to be dependent on the type of activity under investigation and individual differences in performing the activity (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). A study by Bassett and colleagues (2000) assessed the validity of four motion sensors (MTI [formally CSA], Caltrac®, Kenz, Yamax) in moderate-intensity activity among 81 healthy adults across a wide range of ages (19 – 74 yrs) and ethnic backgrounds. Unlike previous studies which commonly assess walking and running, this study examined a wide variety of moderate-intensity activities including yardwork, occupation, housework, family care, conditioning and recreational activities. Bassett and colleagues (2000) report that the four motion sensors overestimated the energy expenditure of slow and brisk walking and underestimated the energy expenditure of other lifestyle activities, including gardening, and household activities, caring for and playing with children and sports such as light callisthenics, golf and doubles tennis. The authors found that motion sensors underestimate energy expended
for most lifestyle activities, with the energy expended for walking overestimated in both the field and laboratory based settings (Bassett et al., 2000).

No evidence exists to either substantiate or refute the accuracy of the energy expenditure algorithms that underpin the energy estimates reported by the Caltrac® accelerometer for AWID. The purpose of this study was therefore to determine the accuracy of the Caltrac® accelerometer among AWID and AWOID in common activities of daily living (ADL) comparing the metabolic equivalent (MET) values derived from the Caltrac® accelerometer to the values reported in the Compendium of Physical Activities (CPA).

5.2 Methodology

Prior to the commencement of this study approval was gained from the RMIT Human Research Ethics Committee. Ambulatory AWID and AWOID were recruited to participate in this study. The sample for this study is the same as used for previous studies described in this thesis. Thirty-one AWID (male = 20 & female = 11) and fifteen AWOID (male = 6 & female = 9) completed the testing phase. Further information on the exclusion and drop out rates of AWID are discussed in Section 3.2.5 of Chapter 3. No AWOID withdrew from the study.

5.2.1 Participant Recruitment

Ambulatory, community living AWID were recruited from day placement, supported employment and accommodation centres in the Northern metropolitan region of Melbourne, Australia. AWOID were recruited through advertisements and information circulars (See Appendix 5). Descriptive statistics for AWID and AWOID are presented in Table 6 in Section 3.2.5.

Before participating in this study, informed consent from participants and/or legal guardians was obtained. To promote the safety of all participants, AWID were required to obtain a medical clearance to engage in exercise from a medical practitioner (See Appendix 3) and AWOID were required to complete a Physical Activity Readiness Questionnaire (PAR-Q) (See Appendix 7).

Further information on the recruitment of participants is described in depth in Section 3 of Chapter 3.
5.2.2 Procedure

Caltrac® accelerometer data was collected from AWID and AVOID while participants undertook seven activities of daily living (ADL) in a laboratory. The activities selected are activities commonly engaged in by AWID (Temple, Anderson, & Walkley, 2000). The selection and a description of the seven ADL are discussed in greater detail in Section 3.2.3 of Chapter 3. The ADL included; sitting quietly (SitQ), sitting watching television (SitTV), sitting and standing while doing an assembly task (SitAT and StaAT) and slow (3.0 km/hr), quick (6.0 km/hr) and fast (9.0 km/hr) walking (WalkS, WalkQ and WalkF).

5.2.3 Equipment

The equipment used by participants while engaged in the seven ADL included a high backed, lounge type chair with armrests, stool, television and video, videotapes of popular entertainment, sport and contemporary television shows, a 10 minute segment of the sitcom ‘Friends’, candle making equipment (a small, round, tea-light waxed candle, wick, cup, tray); a calibrated motorised (Repco) treadmill and a ¾ length stand alone mirror.

While undertaking each ADL, participants wore a Caltrac® accelerometer at the hip, following manufacturer’s instructions. The Caltrac® accelerometer is a battery operated device (7 x 7 x 2 cm) that displays estimates of energy expenditure based on participant’s age, height, weight, gender and activity behaviour. The device updates energy expenditure estimates every 2 minutes (Bassett et al., 2000). A heart rate monitor (Polar Electro OY, Kempele, Finland) was also worn by participants according to manufacturers instructions during the testing.

5.2.4 Participant Inclusion and Familiarisation

Some evidence has suggested that levels of energy expenditure among AWID with Down syndrome differ to AWID without Down syndrome (Fernhall et al., 1996). To investigate if a difference in energy expenditure for each ADL existed between AWID participants with (n = 10) and without Down syndrome (n = 21), the investigator undertook preliminary data analysis. Descriptive statistics for Caltrac® accelerometer derived energy expenditure for each ADL for AWID with and without Down syndrome are presented in Table 12 of Chapter 3.

Prior to the testing all participants took part in a familiarisation process at RMIT University, Bundoora West campus. On average, AWID visited the laboratory on four occasions (range 2-
6) in order to become familiar with the environment, activities, equipment, investigator and testing protocols. Each visit ranged from 45 to 120 minutes per AWID. AWIND attended a single 30 to 60 minute familiarisation session. The Caltrac® accelerometer was introduced to all participants during the familiarisation process.

Testing of participants did not occur until they could confidently and independently complete the seven ADL. AWID who could not comfortably, adequately or safely complete the testing protocol after six familiarisation visits were withdrawn from the study. The familiarisation process is described in Section 3.2.5 of Chapter 3.

Exploratory data analysis, using a Levene test found that the assumption of homogeneity of variance was met for all ADL. Therefore, two-tailed independent groups t-tests based on equal variances were performed to determine if a difference existed between AWID with and without Down syndrome for energy expenditure estimates derived from the Caltrac® accelerometer. A series of t-tests were performed instead of a repeated measures MANOVA due to a small sample. No significant difference in energy expenditure between AWID with and without Down syndrome was found for any ADL; SitQ, $t(29) = -0.58, p = .57$; SitTV, $t(29) = 1.67, p = .11$; SitAT, $t(29) = -1.37, p = .18$; StaAT, $t(29) = -0.18, p = .86$; WalkS, $t(29) = 0.43, p = .67$; WalkQ, $t(29) = 0.47, p = .64$; WalkF, $t(29) = 0.13, p = .18$. Analysis of energy expenditure values between genders for AWID with and without Down syndrome found one exception for male AWID (SitTV, $t(18) = 2.28, p = .035$). The difference in energy expenditure values derived from the Caltrac® accelerometer for SitTV was not deemed sufficiently meaningful and robust to warrant further analysis. Data was therefore pooled for all subsequent analysis.

5.2.5 Testing

The procedures used in this study have been described previously in Chapter 3. In addition to the procedures described therein, participants wore a Caltrac® accelerometer while undertaking each ADL. The Caltrac® accelerometer was worn on the participant’s hip, in accordance with manufacturer’s directions. The testing protocols of this study are summarised below.

Participants were fasted from the time of retiring to bed on the night before the testing. Upon arrival at the testing laboratory participants height and weight was measured (lightly clothed, but without footwear) using calibrated digital scales (Tanitia, model BWB-620) and a calibrated wall-mounted stadiometer (Holtain). Anthropometric measurements (weight, height) and the
participant’s age and gender were entered into the Caltrac® accelerometer in accordance with manufacturer’s directions. At the commencement of each ADL, the Caltrac® accelerometer was reset to zero.

Participants undertook each ADL for 8 – 10 minutes and in sequence, commencing with the least energy demanding activity (SitQ) and concluding with the most energy demanding activity (WalkF). For analysis purposes data collected during the last 6 minutes of each ADL was used. As the Caltrac® accelerometer updates at 2 minute epochs a reading from the Caltrac® accelerometer and participant’s heart rate were recorded at 2 minute intervals. Upon completing each ADL test, participants rested on a high backed, lounge type chair with armrests. Participants did not commence the next ADL until their heart rate had returned to within 10% of their heart rate at the conclusion of the previous ADL. During the walking activities testing stopped if a participant reached volitional fatigue, a respiratory exchange ratio greater than 1.1 (RER > 1.1), a heart rate within 10% of the predicted maximum heart rate, or was unable to maintain the walking cadence to remain in the centre of the treadmill (Fernhall, 1997).

5.3 Data Analysis

The Caltrac® accelerometer displays energy expenditure as kilocalories. To compare the energy expenditure values derived from the Caltrac® accelerometer with the energy expenditure values (METs) reported in the CPA, the value obtained from the Caltrac® accelerometer was converted to an average total MET. This was achieved through the following steps.

Step 1: Using the last 6 minutes of data cumulative gross energy expenditure was determined.

\[
\text{Gross kilocalories} = \text{last minute Caltrac® accelerometer reading} - 6^{th} \text{ last minute Caltrac® accelerometer reading.}
\]

Step 2: The average Caltrac® accelerometer energy expenditure was computed.

\[
\text{Average kilocalories} = \frac{\text{Gross energy expenditure}}{6 \text{ minutes}}
\]

Step 3: Caloric values were transformed into METs using standardised constants (1 LO₂ = 4.8 kcal, 1 MET = 3.5 ml.kg⁻¹.min⁻¹) reported by Bassett and colleagues (2000)

\[
\text{METs} = \frac{\text{Average kcal ml.min}^{-1}}{4.8 \text{ kcal x 3.5 x weight (kg)}}
\]
A small amount of data was missing for each of the seven ADL for both AWID and AWOID. As inspection revealed this to be of random nature, missing data was imputed through missing value analysis procedures in SPSS (Version 13) for each population (Tabachnick & Fidell, 1989). The group means generated by the analysis were substituted for any missing data. The complete data set was then subjected to exploratory data analysis followed by the appropriate descriptive and inferential statistical analysis.

As exploratory data analysed revealed no major anomalies, a series of two-tailed one sample t-tests were used to analyse the energy expenditure estimates for the seven ADL from the Caltrac® accelerometer against the mean MET values in the CPA. A series of t-tests were performed instead of a repeated measures MANOVA due to a small sample.

5.4 Results

Mean MET values and 95% confidence intervals were used to characterise the intensity level of the seven ADL for both AWID and AWOID participants. This enabled comparisons to be made between the values obtained from the Caltrac® accelerometer and the mean MET values reported in the CPA. The following interpretations were applied to effect sizes within the results, <0.2, small; 0.3 – 0.5, medium; 0.6 – 0.8, large and >0.9, very large (Cohen, 1988).

5.4.1 Comparison of Energy Expenditure among Adults with an Intellectual Disability and the Compendium of Physical Activities

A comparison of the observed mean MET values for AWID derived from the Caltrac® accelerometer to those reported in the CPA is reported in Table 22. A statistically significant difference was found for four of the seven ADL (SitAT, $p < .001$; StaAT, $p < .001$; WalkS, $p < .001$ and WalkF $p < .001$). Small effect sizes were detected for both sitting activities and WalkQ, whereas all other activities were revealed to have a large effect size with the largest being SitAT ($d = -2.12$) and StaAT ($d = -3.63$).
Table 22: Energy expenditure values for AWID derived from the Caltrac® accelerator for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Compendium Value</th>
<th>$M$</th>
<th>$SD$</th>
<th>$t$</th>
<th>$p$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>1.0</td>
<td>0.97</td>
<td>0.20</td>
<td>-0.92</td>
<td>.363</td>
<td>-0.17</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.0</td>
<td>0.97</td>
<td>0.21</td>
<td>-0.88</td>
<td>.387</td>
<td>-0.16</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>0.97</td>
<td>0.25</td>
<td>-11.80</td>
<td>&lt;.001</td>
<td>-2.12</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>1.01</td>
<td>0.22</td>
<td>-20.21</td>
<td>&lt;.001</td>
<td>-3.63</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.0</td>
<td>3.25</td>
<td>1.35</td>
<td>5.17</td>
<td>&lt;.001</td>
<td>0.93</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6**</td>
<td>4.25</td>
<td>1.94</td>
<td>-0.99</td>
<td>.327</td>
<td>-0.18</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1**</td>
<td>5.78</td>
<td>2.99</td>
<td>-8.05</td>
<td>&lt;.001</td>
<td>-1.44</td>
</tr>
</tbody>
</table>

$n = 31$

** From interpolated calculations

Table 23 reports the observed mean MET values derived from the Caltrac® accelerometer for AWID by gender. The observed mean MET value for four of the seven ADL for male AWID were found to be statistically significantly different (SitAT, $p < .001$; StaAT, $p < .001$ WalkF, $p < .001$; and WalkS, $p = .002$) to those reported in the CPA. A weak, non-significant difference was observed for SitQ ($p = .409$); SitTV ($p = .744$) and WalkQ ($p = .440$). As illustrated in Table 23 the strongest effect for male AWID was found for the assembly task activities (SitAT, $d = -1.91$; StaAT, $d = -3.50$).
Table 23: Energy expenditure value (MET) for AWID by gender derived from the Caltrac® accelerometer for seven ADL

| Activity | Compendium Value | M       | SD     | t     | p    | d     | M       | SD     | t     | p    | d     |
|----------|------------------|---------|--------|-------|------|-------|---------|--------|-------|------|-------|-------|
| SitQ     | 1                | 1.04    | 0.19   | 0.84  | .409 | 0.19  | 0.84    | 1.54   | -3.48 | .006 | -1.05 |
| SitTV    | 1                | 1.02    | 0.22   | 0.33  | .744 | 0.07  | 0.88    | 0.18   | -2.25 | .048 | -0.68 |
| SitAT    | 1.5              | 1.06    | 0.23   | -8.54 | <.001| -1.91 | 0.82    | 0.21   | -10.79| <.001| -3.25 |
| StaAT    | 1.8              | 1.05    | 0.21   | -15.64| <.001| -3.50 | 0.93    | 0.21   | -13.61| <.001| -4.10 |
| WalkS    | 2                | 3.31    | 1.65   | 3.56  | .002 | 0.80  | 3.14    | 0.51   | 7.36  | <.001| 2.22  |
| WalkQ    | 4.6**            | 4.20    | 2.25   | -0.79 | .440 | -0.18 | 4.34    | 1.31   | -0.66 | .526 | -0.20 |
| WalkF    | 10.1**           | 5.90    | 3.65   | -5.14 | <.001| -1.15 | 5.56    | 1.18   | -12.78| <.001| -3.85 |

** From interpolated calculations
A statistically significant difference is seen for female AWID between the observed mean MET value and the CPA for SitAT, \( p < .001 \); StaAT, \( p < .001 \); WalkS, \( p < .001 \); WalkF \( p < .001 \), SitQ, \( p = .006 \) and SitTV \( p = .048 \). The strongest of the effects was found for the two assembly task activities (SitAT, \( d = 3.25 \); StaAT, \( d = 4.10 \)) and two of the three walking speeds (WalkS, \( d = 2.22 \); WalkF, \( d = -3.85 \)). Data is reported in Table 23.

5.4.2 Comparison of Energy Expenditure among Adults without an Intellectual Disability and the Compendium of Physical Activities

A comparison of the observed mean MET values to the values reported in the CPA, for adults without a disability (AWOID), are reported in Table 24. A statistically significant difference was found for six of the seven ADL (SitAT, \( p < .001 \); StaAT, \( p < .001 \); WalkQ, \( p < .001 \); WalkF, \( p < .001 \); SitTV, \( p = .017 \); WalkS, \( p = .038 \)). The strongest effect for AWOID was found for WalkF and the two assembly task activities with a Cohen’s \( d \) of -3.92, -2.85 and -4.89 respectively.

Table 24: Energy expenditure values for AWOID derived from the Caltrac\textsuperscript{®} accelerometer for seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Compendium Value</th>
<th>( M )</th>
<th>( SD )</th>
<th>( t )</th>
<th>( p )</th>
<th>( d )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SitQ</td>
<td>1.0</td>
<td>0.94</td>
<td>0.13</td>
<td>-1.80</td>
<td>.093</td>
<td>-0.46</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.0</td>
<td>0.86</td>
<td>0.21</td>
<td>-2.69</td>
<td>.017</td>
<td>-0.70</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>0.96</td>
<td>0.19</td>
<td>-11.04</td>
<td>&lt;.001</td>
<td>-2.85</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>0.85</td>
<td>0.19</td>
<td>-18.94</td>
<td>&lt;.001</td>
<td>-4.89</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.0</td>
<td>2.56</td>
<td>0.94</td>
<td>2.30</td>
<td>.038</td>
<td>0.59</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6**</td>
<td>3.33</td>
<td>0.97</td>
<td>-5.05</td>
<td>&lt;.001</td>
<td>-1.30</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1**</td>
<td>4.65</td>
<td>1.39</td>
<td>-15.18</td>
<td>&lt;.001</td>
<td>-3.92</td>
</tr>
</tbody>
</table>

\( n = 15 \)

** From interpolated calculations

The observed mean MET values for male AWOID for five of the seven ADL are significantly lower than the CPA. A significant and strong effect is seen for most ADL, with the exception of SitQ (\( p = .159 \)) and WalkS (\( p = .360 \)). The two assembly task activities for the male AWOID have the strongest effect (SitAT, \( d = -3.72 \); StaAT \( d = -3.25 \)) and (StaAT, \( d = -4.10 \); StaTV, \( d = -4.89 \)). Data is reported in Table 23.
A large and significant effect is also seen for SitTV, $d = -1.79$; WalkQ, $d = -2.28$ and WalkF $d = -3.36$. A significant and strong effect is seen for four of the seven ADL (SitAT, StaAT, WalkF, $p < .001$; WalkQ $p = .021$) for female AWOID. A non significant difference was found for SitQ $p = .357$; SitTV $p = .167$ and WalkS $p = .073$. The strongest of the effects for female AWOID was for the two assembly task activities ($d = -2.40$ for SitAT; $d = -4.88$ for StaAT) and for the fastest walking speed ($d = -4.34$ for WalkF). Data is reported in Table 25.
Table 25: Energy expenditure values for AWOID by gender derived from the Caltrac® for the seven ADL

<table>
<thead>
<tr>
<th>Activity</th>
<th>Compendium Value</th>
<th>Males (n = 6)</th>
<th>Females (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>SitQ</td>
<td>1.0</td>
<td>0.92</td>
<td>0.12</td>
</tr>
<tr>
<td>SitTV</td>
<td>1.0</td>
<td>0.84</td>
<td>0.09</td>
</tr>
<tr>
<td>SitAT</td>
<td>1.5</td>
<td>0.93</td>
<td>0.15</td>
</tr>
<tr>
<td>StaAT</td>
<td>1.8</td>
<td>0.78</td>
<td>0.20</td>
</tr>
<tr>
<td>WalkS</td>
<td>2.0</td>
<td>2.39</td>
<td>0.95</td>
</tr>
<tr>
<td>WalkQ</td>
<td>4.6**</td>
<td>2.79</td>
<td>0.79</td>
</tr>
<tr>
<td>WalkF</td>
<td>10.1**</td>
<td>4.38</td>
<td>1.70</td>
</tr>
</tbody>
</table>

** From interpolated calculations
5.5 Discussion

The use of psychometrically sound measurement tools is an important, underlying issue in the measurement of physical activity. Obtaining accurate information on the physical activity levels of AWID is important from both a long term outlook and an immediate perspective. The ability to obtain accurate, immediate field based information on energy expended by AWID is advantageous to caregivers in the pursuit of monitoring and maintaining health behaviour changes among the population. Various methods and techniques are used to measure the energy expended during ADL. Common field based measures include the use of accelerometers such as the Caltrac® accelerometer. In comparison to laboratory based measures accelerometers are less invasive, more cost effective and suitable for population based studies and have been shown to be successfully used by AWID (Frey, 2004; Temple & Walkley, 2003).

Despite researchers using accelerometers in an attempt to validate other measures of physical activity (i.e. observation, diaries and proxy reports) among AWID, the accuracy of the equations that estimate energy expenditure that underpin these accelerometers when used with AWID remains unexplored. The validation (i.e. determination of accuracy) of accelerometers, as a measure of energy expenditure, typically occurs in a laboratory setting with healthy adults and usually focuses on walking and running (Bassett et al., 2000). Emerging evidence suggests that the energy expenditure estimates of AWID differ to their non disabled peers (Iwaoka et al., 1998; Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). This evidence questions the validity of the algorithms that underpin energy estimates used in accelerometers, including the Caltrac® accelerometer. Recognising this, this study sought to investigate the algorithms that underpin the energy estimates reported by the Caltrac® accelerometer to determine their accuracy for use with AWID.

Results of this study suggest that the Caltrac® accelerometer when compared to the energy estimates reported in the CPA (described in Chapter 3), underestimates the energy expended by AWID for most ADL. Values ranged from a 3% underestimation of energy expended for SitQ through to 43% underestimation of energy expended for WalkF (9.0 km/hr). The one exception was for walking at 3.0 km/hr (WalkS) where energy expended was overestimated by 62%. The energy expended by male AWID was underestimated for the two assembly task activities and two of the walking speeds (WalkQ and WalkF), ranging from 9% of energy expended underestimated for WalkQ through to 42% of energy expended for StaAT underestimated. The Caltrac® accelerometer underestimated the energy expended by female AWID for six of the
seven ADL, ranging from a 6% underestimation of energy expended for WalkQ through to 48% underestimation of energy expended for StaAT.

The underestimation of energy expenditure, particularly for the sedentary based ADL in this study (range 3% - 44% for AWID and 6% - 54% for AWOID) is similar to previous findings. The estimation of energy expenditure using motion sensors have been found previously to be underestimated, with differences in the estimation of energy expenditure using motion sensors of between 31% - 67% (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Welk, Blair, Wood, Jones, & Thompson, 2000). This may in part be explained by the placement of the Caltrac® accelerometer at the hip. There is an inability for motion sensors worn at the hip, including the Caltrac® accelerometer, to detect an increased energy cost of upper body movement (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). Two of the seven ADL engaged in by AWID in this study involved limited movement (SitQ and SitTV) and another two ADL involved predominately upper body movement (SitAT, StaAT).

Although statistically significant differences and underestimation of the energy expended by AWID for most ADL were found, MET values derived from the Caltrac® accelerometer were found to fall within the correct light activity intensity classification for the ADL requiring less effort (sitting and assembly task activities). This was not found to be the case for the slow walking activity (3.0 km/hr), which the CPA underestimated in comparison to the Caltrac® and fast walking (9.0 km/hr), which the CPA overestimated in comparison to the Caltrac® for AWID. A similar pattern was seen for AWOID in this study. One anomaly identified between the three walking activities for AWID is that when walking at 6.0 km/hr (WalkQ), the Caltrac® accelerometer accurately classifies activity intensity, with only a small difference found between energy estimates from the CPA and the Caltrac® accelerometer (0.59 METs). Results for AWOID indicate only small differences between energy estimates from the CPA and the Caltrac® accelerometer for slow walking, 3.0 km/hr (0.56 METs) and quick walking, 6.0 km/hr (1.27 METs), however there was a large difference found for fast walking, 9.0 km/hr (5.45 METs) These results are contradictory to recent findings with AWOID that found that in comparison to the CPA, when used with AWOID, the Tritrac and MTI (formally CSA) accelerometers and Yamax Digiwalker pedometer tended to underestimate intensity when walking at 3.2 km/hr and overestimate intensity for walking at 6.4 km/hr (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). Hendelman and colleagues (2000) did not however assess the validity of the Caltrac® accelerometer, the type of accelerometer used in this study.
The statistically significant differences found between the observed MET values and the CPA in this study suggests that the Caltrac® accelerometer energy expenditure estimates for AWID are meaningfully different to those reported in the CPA. Findings from this study raise doubt about the results of Temple and colleagues (2000) and Temple and Walkley (2003) studies using the Caltrac® accelerometer to validate AWID physical activity through observation and proxy-respondent completed physical activity diaries. Although the Caltrac® accelerometer was one of the best available field based alternatives at the time of Temple and colleagues (2000) and Temple and Walkley (2003) studies, advancements in technology have introduced instruments that provide more detailed information such as activity intensity. With evidence gathered through the current study suggesting that the energy expenditure algorithms and/or instrumentation that underpin the Caltrac® accelerometer are not appropriate for use with AWID, it is possible this may also be true for newer accelerometers and is an area requiring further investigation.

It is possible that results of this study may reflect or be partly attributed to other characteristics, including fidgeting, body composition and the type of activity regularly engaged in, however this remains unclear. Recent evidence suggests that excess body movements among male AWID accounts for differences in energy expenditure between adults with and without an intellectual disability (Ohwada, Takeo, Suzuki, Yokoyama, & Ishimaru, 2005). The impact of such characteristics was not explored in this study. Overall, results of this study indicate inconsistencies in the accuracy of the Caltrac® accelerometer between sedentary and active ADL. Results suggest there is a need to further explore possible differences in energy expenditure between AWID and AWOID and the use of and possible modifications required to the algorithms and/or instrumentation that underpin the energy estimates by the Caltrac® accelerometer when used with AWID. Notwithstanding this, results indicate that the Caltrac® accelerometer can accurately classify ADL requiring less effort but the utility of this information is limited as health producing physical activity occurs at higher intensities than the Caltrac® accelerometer can measure accurately. As the intensity of activities increase, the accuracy of the Caltrac® accelerometer decreases. It is interesting to note that a similar pattern was observed for age and gender matched AWOID.

Despite its downfalls the Caltrac® accelerometer may be a useful instrument in assisting caregivers to identify and monitor health behaviour changes across time among the population. It is a practical device that can be easily used, understood and provides immediate feedback to
caregivers. The ease in which the Caltrac® accelerometer can be read combined with the use of simple recording procedures from caregivers of AWID can assist in providing an overall understanding of physical activity behaviours and enable caregivers to easily identify a change in energy expenditure and health related behaviours of AWID.

There is a need for this study to be followed up with further research, addressing some of the limitations of this study. Future studies should include larger samples and explore in greater depth differences between genders, active and sedentary groups, and differences in energy expenditure estimates from the Caltrac® accelerometer when worn on both the hip and wrist. Future studies also need to investigate possible reasons as to why reported differences in more passive and active ADL found in this study exist. Considering the introduction of accelerometers that provide more detailed information, the algorithms that underpin these accelerometers should be disclosed so as to permit investigation for use with AWID.
CHAPTER 6

DEVELOPMENT OF A PROXY RESPONSE INSTRUMENT TO MEASURE THE
PHYSICAL ACTIVITY BEHAVIOURS OF ADULTS WITH AN INTELLECTUAL
DISABILITY (IPAQ-ID)

6.1 Introduction

Self-report recall questionnaires are a common, inexpensive approach used to assess population
based physical activity behaviour (Sirard & Pate, 2001). This is problematic for adults with an
intellectual disability (AWID) as AWID are unable to accurately recall and provide the
necessary information about their physical activity behaviour (Temple, Anderson, & Walkley,
2000). Subsequently, investigators have used proxy-respondents to gain information on
physical activity behaviours of AWID (Stanish, Temple, & Frey, 2006).

While preferable, it is not always possible to collect information directly from the person under
investigation. Various barriers prevent this, including response bias or cognitive limitations that
can limit the ability of a person to adequately report their own physical activity behaviours. In
an effort to address these barriers and include in research, participants who are not able to self-
report, proxy-respondents have been used. While a seemingly simple approach, the use of
proxy-respondent responses as an alternate source of information is justifiable only if the
accuracy of responses from the proxy-respondent is shown to be high (Magaziner, Zimmerman,
Gruber-Baldini, Hebel, & Fox, 1997).

Investigations into the physical activity of AWID have varied considerably with respect to the
type of measurement approach used, with a strong reliance on information provided by proxy-
respondents (Temple, Frey, & Stanish, 2006). In spite of the regular use of proxy-respondents
in questionnaires with AWID, the validity and reliability of proxy-respondents for AWID
physical activity behaviour has received little attention. A major methodological limitation of
such studies has been their reliance on measurement tools and/or procedures that have not been
shown to be either valid or reliable when used with this population (Temple, Frey, & Stanish,
2006). Studies using indirect physical activity measures have relied on proxy-respondents or a
combination of proxy-respondents and an AWID to complete an interview or questionnaire
(See Table 4). However, reports rarely describe the degree of assistance provided by proxy-

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respondents nor the evidence of the proxy-respondents ability to provide accurate and reliable information (Temple, Frey, & Stanish, 2006).

Three British studies have used the physical activity scale from the Health Survey for England to investigate the physical activity of AWID (Emerson, 2005; Robertson et al., 2000; Wells, Turner, Martin, & Roy, 1997). The scale collects data on the intensity level of activity, focusing on moderate-intensity and vigorous-intensity physical activity and the number of occurrences activity was engaged in at this intensity. Emerson (2005), Robertson and colleagues (2000) and Wells and colleagues (1997) all fail to provide evidence of the accuracy or reliability of the questionnaire with this population and the ability of the proxy-respondents to accurately and reliably use this questionnaire. In two of the three studies the questionnaire was fully completed by proxy-respondents (Emerson, 2005; Robertson et al., 2000). The questionnaire in the third study was completed by caregivers as proxy-respondents and/or the AWID (Wells, Turner, Martin, & Roy, 1997). It was not possible to ascertain to what extent the questionnaire was completed by the AWID, caregivers or a combination of both.

A similar methodology to that used by Emerson (2005) was used in Australia (Beange, McElduff, & Baker, 1995). The purpose of the study was to investigate the frequency of medical disorders in 202 adults with a mild to profound intellectual disability residing in institutions, group homes, at home with family members or independently (Beange, McElduff, & Baker, 1995). As part of the investigation AWID and their caregivers were asked if they had engaged in vigorous exercise in the past 2 weeks. This was defined as exercise “which made you breathe harder or puff and pant.” It is unclear to what extent the AWID, caregiver or a combination of AWID and caregiver completed the questionnaire. The authors do not provide evidence of the accuracy or reliability of the questionnaire used.

Investigations into the general health characteristics and behaviours of AWID have included a explanation of the physical activity of AWID (Janicki et al., 2002; Rimmer, Braddock, & Marks, 1995). Nursing staff and service co-ordinators completed a questionnaire on the health status of 1371 adults with a mild to profound intellectual disability residing in group homes in two regions of New York State, United States of America (Janicki et al., 2002). Investigators used a non-standard questionnaire requiring yes/no responses. The questions used to investigate the physical activity behaviours of AWID were not reported by the authors. The authors did report that a request was made for the proxy-respondents to be familiar with the AWID,
however the definition of ‘familiar’ was not explained. No reliability checks were made nor is the validity of the measure reported.

An investigation into the health behaviours of 329 ambulatory adults with a mild to severe intellectual disability residing in institutions, group or family homes examined participants health behaviours through a questionnaire (Rimmer, Braddock, & Marks, 1995). The authors failed to describe characteristics of the proxy-respondents other than that they were parents, guardians or staff members. Not dissimilar to the studies by Emerson (2005); Janicki and colleagues (2002); Robertson and colleagues (2000) and Wells and colleagues (1997), no information was provided about the questionnaire and the accuracy and reliability for use with proxy-respondents was not discussed. No direct measures such as accelerometers, pedometers or direct observation, were used in any of these studies to validate the accuracy of the proxy-respondent reports.

A physical activity questionnaire, the NHANES III, was used in an American study to report on the frequency and intensity of activities engaged in by 150 adults with a mild to moderate intellectual disability (Draheim, Williams, & McCubbin, 2002). AWID had been volunteered and resided in community based residences. The questionnaire was interviewer administered and where necessary, direct care providers supported the AWID to answer questions. The validity of the instrument when used with caregivers of AWID was not reported. Additionally, the authors reported that results possibly overestimated the level of physical activity engagement as the duration of participant’s activity involvement was not measured.

A recent study has used the National Health and Nutrition Examination Survey III (NHANES III) supplemented by pedometers (Yamax Digiwalkers; SW-500 and SW-700) to assess the walking activity of AWID (Stanish & Draheim, 2005). Yamax Digiwalkers have been shown to be reliable when used with AWID (Stanish, 2004). The NHANES III was interviewer administered to 103 AWID and their direct caregivers. The authors reported that caregivers assisted AWID with questions as required, but the type or amount of assistance AWID required was not reported. The relationship between pedometer counts and physical activity behaviour of AWID as measured by the NHANES III was not significant. The authors report that measurement issues including inaccurate reporting, tampering with the pedometers and the participants walking speed and gait may have contributed to the lack of association.
Accelerometers and physical activity diaries were used by Frey (2004) in an attempt to compare the physical activity levels of 22 adults with a mild intellectual disability and 26 adults without an intellectual disability. The investigator found that the quality of the physical activity diaries varied, and overall were unsuccessful. It was reported that AWID had difficulties recalling effort and duration of activity. Proxy-respondent reports of this information was found to be speculative and therefore only used to provide a contextual understanding of activity engaged in and not as a measure of activity.

Temple and Walkley (2003) managed to show that trained caregivers can accurately report physical activity among AWID. Investigators used the Caltrac® accelerometer and caregiver physical activity diary entries to investigate the concurrence between proxy and accelerometer generated estimates of physical activity among 37 adults with a mild to moderate intellectual disability living in supported accommodation. A standardised approach was used to train caregivers on how to complete the 3-day activity diary. Data was collected over three consecutive days, including two weekdays and one day of the weekend. Caregivers were requested to complete the physical activity diary at set intervals throughout each day. An intra-class correlation of 0.78 was reported between caregiver physical activity diary entries and the Caltrac® accelerometer. However, results of an earlier study discussed in this thesis, that investigated the accuracy of the Caltrac® accelerometer in activities of daily living among adults with and without an intellectual disability (See Chapter 4), raises doubts about the accuracy of the Caltrac® accelerometer when used with AWID.

Many of the studies investigating physical activity behaviour of AWID have used proxy-respondents to complete physical activity questionnaires. A flaw of these studies is their small number of participants, and their use of non standard questionnaires. Additionally, investigators fail to describe the degree of assistance provided by proxy-respondents and evidence of the respondent’s ability to provide accurate and reliable information (Stanish, Temple, & Frey, 2006).

The lack of a standardised approach to the measurement of physical activity has made universal and population comparisons difficult (Craig et al., 2003). This has led to the development of the International Physical Activity Questionnaire (IPAQ). The IPAQ provides a standardised instrument to assess and monitor national and international estimates of population physical activity. A 12-country reliability and validity study of the IPAQ revealed the instrument had valid and reliable measurement properties for adults without a disability between the ages of 24
and 49 years (Craig et al., 2003). However, the reliability and validity of the IPAQ as a measurement tool of physical activity for AWID has not been investigated.

Algorithms used in the calculation of energy expenditure in physical activity surveys have used estimates based on values derived from research with the non-disabled population. Emerging research indicates that the energy expenditure of AWID may be different from that of the general population for some activities of daily living, suggesting that when used with AWID these algorithms are incorrect. Results of studies one, two and three reported in this thesis (See Chapters 3, 4, 5) found that the energy expended by AWID for seven common activities of daily living (ADL) is different from that of their non-disabled counterparts and to the values reported in the Compendium of Physical Activities (CPA). These findings are supported by Iwaoka and colleagues (1998) who report that adult men with an intellectual disability expend more energy and are less biomechanically economical than their same gender, age, height and weight matched counterparts without a disability. It is likely therefore that the equations used to assess and categorise the physical activity of AWID may yield inaccurate information.

The absence of a valid, reliable and low cost instrument to accurately measure the physical activity behaviour of AWID on a population scale prevents researchers from gaining sufficient evidence to confidently estimate the participation of this population in physical activity. A lack of available population based data on the physical activity levels of AWID greatly impedes this aspect of health promotion among AWID. The aim of this study was therefore to develop a valid and reliable, cost effective, telephone proxy response instrument (IPAQ-ID) to measure the physical activity behaviour of AWID.

6.2 Methodology

Prior to commencement of this study approval was gained from both the RMIT Human Research Ethics Committee and Department of Human Services Ethics Committee. Participants included ambulatory AWID living in the family home or in a community residential unit (CRU) in the Northern and Western metropolitan regions of Melbourne, Australia. To participate in the research study, AWID were required to have two people willing to act as proxy-respondents on their behalf. Proxy-respondents were recruited from both the residence lived at by the AWID and the day agency attended by the AWID.
6.2.1 Adults With an Intellectual Disability

Recruitment of potential AWID participants initially occurred through the distribution of expression of interest and a plain language statement (See Appendix 8). Day agencies in the Northern and Western metropolitan regions of Melbourne, Australia mailed the information to caregivers of AWID attending their service on behalf of the investigator. In addition, information was circulated by undergraduate students studying disability studies at RMIT University during 2003 to 2005. The disability studies students were working in the field or were on field placement. The students circulated information to potential AWID participants and/or their caregivers at their own discretion. Participants recruited for studies 1, 2 and 3 described in this thesis were also sent an expression of interest and plain language statement. Distribution and retrieval of information followed the same process described in Chapter 3.

Upon return of an expression of interest form the AWID primary caregiver was contacted by phone. A suitable time for the investigator to visit both the AWID and their primary caregiver was arranged to discuss the study. During the visit the investigator answered questions the AWID and their primary caregiver had about the study. The AWID was given the opportunity to handle the accelerometer that would be worn by them for seven consecutive days. At the completion of the visit the AWID was asked if they were willing to participate in the study. If an affirmative response was given, a consent form was left with the primary caregiver to be completed and returned in a supplied, reply paid envelope as soon as possible (See Appendix 9).

A total of 52 AWID were recruited to participate in this study. Consent could not be obtained from four AWID due to participants having no parent or legal guardian to consent to their participation and their primary caregiver deeming the AWID incapable of providing informed consent. Data from three AWID was unusable due to accelerometer equipment failure and the participants being unwilling to wear the accelerometer a second time. The final sample consisted of 45 AWID (19 males & 26 females).

The majority of AWID (70%) attended a day agency five days a week, engaging in activities between the hours of 9am to 3pm. For the purposes of this study day agencies included day placement centres and supported employment agencies. If participants attended the day agency between the hours of 9am and 3pm this was defined as full time. With the exception of one participant, all participants who did not attend a day agency full time (n = 14) attended a
combination of services over the week, including day agency, supported employment and/or community facilities. In this case proxy-respondents were recruited from the day agency the AWID was at for the greater portion of the week. Eleven AWID attended day agencies 4 days a week and two AWID attended day agencies 3 days a week. One AWID was of retirement age and therefore did not attend or access any type of day agency. This person was included in the study however data was only obtained from one proxy-respondent for this participant.

6.2.2 **Proxy-respondents**

Proxy-respondents were selected through consultation with both the AWID’s primary caregiver and staff from the day agency attended by the AWID. All proxy-respondents were required to have known the AWID for a minimum of three months. Where the AWID resided in a CRU, the key worker was deemed to be the primary caregiver of the AWID and was the preferred proxy-respondent. In a CRU each AWID is assigned a key worker. Key workers have the greatest familiarity with their assigned AWID, their habits and ADL. If the key worker was unable to act as a proxy-respondent, another staff member identified by the house supervisor or key worker was approached and acted as the AWID proxy-respondent. Parents of AWID living in the family home were the preferred proxy-respondent. If a parent was not available the preferred proxy-respondents were adult siblings living at the family home (n = 1), followed by adult siblings living away from the family home but taking on a care-giving role for the AWID (n = 1) and then other adult relatives (n = 2).

The day agency the AWID attended was initially contacted by telephone to inform them that the AWID was participating in a study that required the AWID to wear an accelerometer over a seven-day period. A request was made that appropriate staff at the day agency be notified of the AWID willingness to participate in the study. The day agency contact was informed that the study protocol required a staff member from the agency who had regular contact with the AWID to be a proxy-respondent and that the proxy-respondent would complete a short telephone questionnaire about the physical activity behaviours of the AWID once the AWID had worn an accelerometer. A plain language statement and consent form were sent to the identified day agency proxy-respondent for completion and return in a reply paid envelope (See Appendix 9 & Appendix 10).

Upon receipt of consent forms from both proxy-respondents, the investigator contacted the home of the AWID to organise a typical week during which the AWID would wear the
accelerometer. A typical week was defined as a week during which the AWID participated in activities which were normal in their routine. Weeks during which an AWID was to be on vacation, away from their day agency, away from home or involved in special events were deemed not to be a typical week. All proxy-respondents for the AWID were informed of the dates the AWID would be wearing the accelerometer and that the investigator would contact them during this period to arrange a suitable time during which the telephone questionnaire would occur.

The sample included 83 proxy-respondents from the AWID’s day agency (n = 41) and home environment (n = 42). Six proxy-respondents, three from the AWID home environment and three from the AWID day agency, did not complete the questionnaire due to not being available at the prearranged or any subsequent times. Home-based proxy-respondents were parents (mothers n = 21; fathers n = 4), siblings (sister n = 1; brother n = 1), other family members (grandmother n = 1; brother-in-law n = 1) and CRU staff (n = 13). Day agency proxy-respondents were either full time staff working at the day placement centre (n = 36) or for AWID working in supported employment, their work supervisor (n = 5).

Data on the number of years proxy-respondents had known the AWID is reported in Table 26. On average, home-based proxy-respondents had known the AWID for 19.80 years (SD = 13.07, range 6 months - 47 years) and reported being with the AWID for 50.24 hrs per week, inclusive of sleepovers (SD = 41.52, range = 3 - 140 hrs). In comparison, day agency proxy-respondents reported having known the AWID for an average of 3.95 years (SD = 3.29, range 6 months - 17 years) and were with the AWID 14.17 hrs per week (SD = 11.50, range = 1 - 38 hrs).

Table 26: Years AWID known by proxy-respondent

<table>
<thead>
<tr>
<th></th>
<th>Home Proxy Respondent</th>
<th>Day agency Proxy Respondent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 42)</td>
<td>(n = 41)</td>
</tr>
<tr>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>1</td>
<td>2.20</td>
</tr>
<tr>
<td>1 – 3 years</td>
<td>6</td>
<td>13.30</td>
</tr>
<tr>
<td>3 – 5 years</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>&gt; 5 years</td>
<td>35</td>
<td>77.80</td>
</tr>
</tbody>
</table>
6.2.2 Materials

Physical activity recall questionnaires are commonly used to assess population based physical activity (Sirard & Pate, 2001). The International Physical Activity Questionnaire (IPAQ) has been designed as a standardised instrument to obtain comparable estimates of population levels of physical activity of adults aged 18 – 69 years, within and between countries (Craig et al., 2003). However, no valid or reliable instrument is available to measure the physical activity of AWID.

This research project used the long telephone response version of the IPAQ and modified it to create the IPAQ-ID (See Appendix 11). The IPAQ-ID is a proxy-respondent physical activity questionnaire designed to measure the physical activity of AWID. It collects detailed information across the domains of job related, active transportation, home and leisure based physical activity. To make the IPAQ-ID suitable for use with proxy-respondents and specific to AWID, activities that were not culturally or population relevant were replaced with culturally and population relevant examples. The Compendium of Physical Activities (CPA) (Ainsworth et al., 2000) was used to establish if culturally and population relevant activities were of the same intensity level as the activities listed in the IPAQ. To make the instrument suitable for use with proxy-respondents, the IPAQ was reworded so that it referred to the third party (i.e. the AWID). The reference week referred to in the IPAQ-ID was the week the actigraph was worn by the AWID, as opposed to the past 7-days which is the reference week used with the IPAQ.

A draft of the reworded IPAQ-ID was piloted with parents of, and staff working with AWID. Staff included disability services personnel working in the residence of an AWID and staff members working in local day agencies that offered programs to AWID. Parents and staff members were asked to complete a draft version of the IPAQ-ID and provide feedback to the investigator. Specifically, feedback was sought on the suitability of examples used and ease of understanding the questionnaire. After consultation, minor changes were considered and made when supported by several parents or staff.

To collect physical activity data an accelerometer (MTI actigraph, Models 7167-2.2 or 7164-2.2) was used. An accelerometer is a small, lightweight self-contained monitor that can be used to directly and accurately measure physical activity in the field. It provides for direct 24-hour collection of information. Accelerometers are one of the least invasive techniques used to
directly measure physical activity in free living conditions and have been shown to be able to be used with AWID (Frey, 2004; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003).

6.3 Validity of the IPAQ-ID

The validity of the IPAQ-ID was assessed through comparing data on AWID participants free-living physical activity behaviours, measured using the accelerometer and IPAQ-ID proxy-respondent reports.

6.3.1 Protocol and Data Management

6.3.1.1 Accelerometer Data.
Data from the accelerometer was used as the criterion measure to validate the reported physical activity levels of the AWID derived from the IPAQ-ID. To limit interference with the accelerometer from participants and avoid potential loss, the accelerometer was worn on a belt secured in a small pouch by two cable ties. The adjustable length belt allowed the accelerometer to be placed in the correct position at the hip of the AWID. Attached to the accelerometer was a sticker on which an informative note explained the purpose of the accelerometer and included a phone number and return address in the event of loss. No accelerometers were misplaced or lost during the study.

Prior to the AWID wearing the accelerometer it was calibrated according to manufacturer’s directions with a Manufacturing Technology, Inc (MTI) calibrator, CAL71. The accelerometer was then initialised using a reader interface unit (RIU256K). All accelerometers were initialised to begin data collection at 6am on the first day of data collection and collect data at one minute intervals. Data collection began on a Saturday to enable the primary caregiver of the AWID to closely supervise the AWID wearing the accelerometer over two days and before the AWID was required to wear the accelerometer to their day placement or supported employment where the AWID would have less direct supervision.

The accelerometer and three copies of an information sheet (See Appendix 12) were distributed to the AWID in the two to three days preceding commencement of data collection. The information sheet was made available to all caregivers within the household of the AWID and distributed to staff at the day agency attended by the AWID. The main caregiver of the AWID was also asked to keep a copy of this in the AWID’s communication diary.
The AWID was requested to wear the accelerometer during waking hours for 7 consecutive days, beginning at the time they woke on Saturday morning to when the AWID retired to bed on the following Friday evening. It was reinforced to the AWID that the only occasions the accelerometer was to be removed was when they (1) went to bed, and (2) participated in any water-based activities, such as swimming and showering. The AWID was instructed to re-fit the accelerometer at the conclusion of any water based activity. Caregivers were requested to note the occasions the accelerometer was not worn for any reason including swimming, showering or because the AWID forgot or refused to wear the accelerometer or was requested to remove it for a particular activity. The primary caregiver was asked to provide this information to the investigator upon collection of the accelerometer but this information was not always available at this time.

On the fourth day of data collection a phone call was made to both the AWID place of residence and the AWID day placement agency to check on progress and identify any related issues regarding wearing of the accelerometer. Concerns raised by proxy-respondents included the positioning and movement of the belt that held the accelerometer and the wearing of the accelerometer while playing sports including basketball and Australian football. Some participants (n = 2) indicated that they were asked to remove the accelerometer by a coach or referee during competitive sports. The investigator reinforced to the proxy-respondent the correct position of the accelerometer and the proxy-respondent was asked to reinforce this to the AWID and all appropriate staff in their agency. The investigator offered the proxy-respondent additional copies of the information sheets on how to wear the accelerometer. The proxy-respondent was also reminded to record when the accelerometer was removed by the AWID and to give this information to the investigator when the accelerometer was collected. At the conclusion of this phone call a suitable time was identified when the IPAQ-ID would be completed via telephone interview.

The accelerometer was collected within 5-days of the data collection period concluding. Data was downloaded into Microsoft Excel (2003) using a reader interface unit (RIU256K). The default setting in the MTI actigraph software (Freedson equation) was used in the downloading of data. A standardised and automated approach to data management and scoring of the accelerometer data was followed. Data was imported from the Excel file into a Microsoft Access (2003) database. To be included in analysis a minimum of 600 minutes of time was required on each of the five days, of which one day had to be a weekend day. The guideline of
600 minutes of time per day was recommended (Trost, personal communication, April 14, 2005) and used by Craig and colleagues (2003).

### 6.3.1.2 IPAQ-ID.

Within 6 days of the AWID having worn the accelerometer the home and day agency proxy-respondents were phoned at the pre-arranged time in order to complete the IPAQ-ID. Proxy-respondents were not always available to complete the IPAQ-ID at the prearranged time. In this situation proxy-respondents were called within 24 hours of the prearranged time and, where possible, an alternate time established. All proxy-respondent questionnaires were completed within 12 days of the conclusion of the AWID wearing the accelerometer.

The investigator began the telephone interview by asking the proxy-respondents for supplementary information. This included how long they had known the AWID, how many contact hours they were with the AWID during the week the accelerometer was worn, if they considered it to be a typical week for the AWID and if not why not. Proxy-respondents were also questioned on when the AWID did not wear the accelerometer and the home proxy-respondents were asked to indicate what time the AWID typically went to bed and arose on each morning the actigraph was worn.

The investigator found that when completing the IPAQ-ID, proxy-respondents found it useful to refer to the AWID’s daily timetable. Proxy-respondents were found to use the AWID’s timetable to discuss with the investigator the activities the AWID participated in, what the activity involved and to what extent the proxy-respondent believed the AWID to engage in the activity. Home proxy-respondents gave the investigator the impression of having more time available to complete the IPAQ-ID and often wanted to discuss the AWID daily routine and activities with the investigator in depth.

A standard method for data management and scoring of the IPAQ was established by the IPAQ development team (Craig et al., 2003). Data cleaning and processing recommendations as described in the ‘Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)’ were followed (International Physical Activity Questionnaire, n.d.-b).

Some evidence suggests that the responses of a team of caregivers acting as proxy-respondents may be more representative than the responses of a single proxy-respondent (Santos-Eggimann,
Zobel, & Berod, 1999; Stancliffe, 1999). To investigate whether any one proxy-respondent or both proxy-respondents combined were more accurate, data from the IPAQ-ID was analysed for each proxy-respondent and the combined group to help establish if any one proxy-respondent group could more adequately report on the physical activity behaviours of AWID.

6.3.2 Scoring and Data Reduction

6.3.2.1 Accelerometer Data.

To enable comparisons between proxy-respondent reports and the measured physical activity of the AWID, the accelerometer data was segmented into three broad categories; day agency, home and total physical activity. For each of these categories moderate, vigorous and total activity was determined. These categories are the same as used in the IPAQ-ID.

Day agency hours were defined as between 9am and 3pm, the standard time day agency agencies run program activities in Melbourne, Australia (Grubb, personal communication, March 21, 2003; Guatta, personal communication, March 28, 2003). Hours outside these times were categorised as home hours. For analysis purposes additional domains included in the IPAQ-ID (housework / house maintenance and caring for others, recreation, sport and leisure time physical activity) were included in the home category. Without more extensive and detailed reporting of AWID physical activity behaviour through physical activity diaries or similar, it was not possible to determine from the accelerometer data when the AWID were participating in home or leisure based physical activities.

The total amount of physical activity recorded by the accelerometer was summed and reported as the total number of minutes of moderate and vigorous physical activity per week and the total number of counts per week, for each category. Moderate-intensity and vigorous-intensity activities were determined using Freedson cut-points for movement counts per minute (Manufacturing Technology Inc, n.d.). The cut-points are reported in Table 27. A recent study has demonstrated that for classifying moderate and vigorous physical activity, the Freedson cut-points are suitable for use with adults with acquired brain injury (Tweedy & Trost, 2005), a cognitive impairment that has some similarity to intellectual disability. Accelerometer counts per minute that fell within the hard or very hard intensity range were reported as vigorous-intensity activity. All statistical analysis was conducted using SPSS (Version 13).
Table 27: Freedson equation cut points

<table>
<thead>
<tr>
<th>Accelerometer Counts Min⁻¹</th>
<th>Activity Intensity Classification</th>
<th>Associated MET Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1952</td>
<td>Light</td>
<td>&lt; 3 METs</td>
</tr>
<tr>
<td>1952 – 5724</td>
<td>Moderate</td>
<td>3.00 – 5.99 METs</td>
</tr>
<tr>
<td>5725 – 9498</td>
<td>Hard*</td>
<td>6.00 – 8.99 METs</td>
</tr>
<tr>
<td>&gt; 9498</td>
<td>Very Hard*</td>
<td>&gt; 8.99 METs</td>
</tr>
</tbody>
</table>

* Vigorous activity = Hard + Very Hard activity

6.3.2.2 IPAQ-ID.

Consistent with the accelerometer data, each category in the IPAQ-ID was segmented into two further sub-categories; moderate activity and vigorous activity. This created nine categories, day agency total activity; day agency moderate-intensity activity; day agency vigorous-intensity activity; home total activity; home moderate-intensity activity; home vigorous-intensity activity; total activity; total moderate-intensity activity, and total vigorous-intensity activity.

After data management and cleaning of the IPAQ-ID data, the reported total weekly physical activity was estimated. Reported weekly minutes for each activity category were weighted by MET energy expenditure estimates. The activity categories and their associated MET values are reported in Table 28. The MET values used were obtained from the CPA (Ainsworth et al., 2000) and followed the recommendations in the ‘Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)’ (International Physical Activity Questionnaire, n.d.-b)
Table 28: IPAQ-ID activity domain and associated MET value

<table>
<thead>
<tr>
<th>Activity Category</th>
<th>Activity Type or Intensity</th>
<th>Self-Reported Pace</th>
<th>MET Estimate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day agency</td>
<td>Vigorous</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Walking</td>
<td>Vigorous</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>3.3</td>
</tr>
<tr>
<td>Transport</td>
<td>Walking</td>
<td>Vigorous</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Cycling</td>
<td>Vigorous</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>6</td>
</tr>
<tr>
<td>Yard/Garden</td>
<td>Vigorous</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Household</td>
<td>Vigorous</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Leisure</td>
<td>Vigorous</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td>Vigorous</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>

* Based on the Compendium of Physical Activities.

The same standard equation (MET.min.wk^{-1} = duration x frequency per week x MET intensity) reported in the reliability and validity studies of the IPAQ (Craig et al., 2003) was used to calculate the weighted MET-minutes per week (MET.min.wk^{-1}), per category and sub-category. To calculate the total physical activity weighted MET-minutes per week (MET.min.wk^{-1}) all reported activities per week (MET.min.wk^{-1}) were summed. Details of the calculations are provided in Appendix 13. When a proxy-respondent answered don’t know or refused on any question in any category, the data for the whole category for this proxy-respondent was discarded because it was not possible to obtain a total physical activity score for that category.
6.3.3 Data Analysis

To assess criterion-related validity the free living physical activity data derived from the proxy-respondent IPAQ-ID reports was compared with the accelerometer measure of physical activity. As the proxy-respondent IPAQ-ID data were not normally distributed, non-parametric Spearman correlation coefficients (?) were calculated as a primary measure of agreement. This method is consistent with that used by Craig and colleagues (2003) in the original validation study for the IPAQ. As the primary purpose of the IPAQ was to allow for universal and population comparisons to be made the same methods of data analysis was used for the IPAQ-ID. The following interpretations were applied to correlation coefficients within the results; 0.1 – 0.3 = small; 0.3 – 0.5 = moderate; 0.5+ = large (Cohen, 1988).

Additionally, Z-scores were calculated to determine if any one, or the combination of, proxy-respondents were able to more accurately report on any one of the nine categories of physical activity for AWID.

6.4 Reliability Study

The reliability of the IPAQ-ID was assessed using the test-retest repeatability approach.

6.4.1 Protocol and Data Management

At the completion of the initial IPAQ-ID telephone questionnaire, proxy-respondents were informed of the need to collect reliability data and were asked if they were willing to assist in this process. Proxy-respondents willing to assist were asked to nominate a suitable time within two to five days, to complete the IPAQ-ID a second time, using the same reference week for the AWID. It is possible that this created a biased sample with only people confident in their memory agreeing to this request and as such caution should be used when interpreting the results.

The same standardised method for data management and scoring that is described in Section 6.3 was used for the reliability component of the IPAQ-ID.
6.4.2 Scoring and Data Management

The MET values for the IPAQ-ID were calculated from the same standard equation, where the weighted MET minutes per week (MET \( \text{min.wk}^{-1} \)) is equal to duration x frequency per week x MET intensity. Details of the calculations are provided in Appendix 13.

6.4.3 Data Analysis

To evaluate the test-retest reliability of the IPAQ-ID, nonparametric Spearman correlation coefficients (?) were calculated. This method is consistent with that used by Craig and colleagues (2003) in the 12 country reliability study of the IPAQ.

6.5 Results

The daily routines of AWID are structured and do not deviate from week to week during typical weeks (Draheim, Williams, & McCubbin, 2002). The caregiver of the AWID was asked to identify a typical week for the AWID to wear the accelerometer. Proxy-respondents reported that it was a typical week for 84% of AWID, with no major disruptions to their routine. The investigator found that for 16% of AWID, unanticipated changes in the normal routine of the AWID occurred while they were wearing the accelerometer. Appendix 14 provides information on why proxy-respondents considered the reference week to be atypical for the AWID. Where the AWID did not participate in a regular program, mainly due to school vacations disrupting the agencies normal programs, it was reported by the proxy-respondents that the AWID engaged in an alternative activity. One proxy-respondent reported that the AWID was more motivated to be involved in activities than usual.

Data in Table 29 reports the response rate of proxy-respondents per category and sub-category. Home proxy-respondents were always able to provide an answer for questions in the IPAQ-ID related to participation in home-based physical activity. In contrast, day agency proxy-respondents were able to provide an answer to participation in home-based physical activity on 80% of occasions, preferring to offer a ‘don’t know’ response on 18% of occasions. On 2% of occasions day agency proxy-respondents refused to answer a question relating to home-based physical activity. Day agency proxy-respondents provided an answer for questions in the
Table 29: Percentage of proxy-respondent response rates

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Answered Day</th>
<th>Don’t Know Day</th>
<th>Refused Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agency Proxy</td>
<td>Home Proxy</td>
<td>Agency Proxy</td>
</tr>
<tr>
<td>Day agency total activity</td>
<td></td>
<td>99.19</td>
<td>73.98</td>
<td>0.81</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>98.78</td>
<td>70.73</td>
<td>1.22</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>100.00</td>
<td>80.49</td>
<td>0.00</td>
</tr>
<tr>
<td>Home total activity</td>
<td></td>
<td>79.88</td>
<td>100.00</td>
<td>17.99</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>80.14</td>
<td>100.00</td>
<td>17.77</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>78.05</td>
<td>100.00</td>
<td>19.51</td>
</tr>
<tr>
<td>Total activity</td>
<td></td>
<td>85.14</td>
<td>92.97</td>
<td>13.30</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>84.28</td>
<td>93.55</td>
<td>14.09</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>89.02</td>
<td>90.36</td>
<td>9.76</td>
</tr>
</tbody>
</table>
IPAQ-ID related to participation in day agency based physical activity on 99% of occasions. In contrast, home proxy-respondents were able to provide an answer to participation in day agency based physical activity on 74% of occasions, preferring to offer a “don’t know” response on 26% of occasions. Overall, home proxy-respondents were found to provide answers across all questions on the IPAQ-ID on 93% of occasions. In contrast, day proxy-respondents were found to provide answers across all questions on the IPAQ-ID on 85% of occasions, preferring to offer “don’t know” as a response on 13% of occasions and refusing to answer on 2% of occasions.

The response rates per category and sub-category of the home proxy-respondents are displayed in Table 30. Community residential unit (CRU) and parent proxy-respondents provided an answer for questions in the IPAQ-ID related to participation in home-based physical activity on 99% of occasions. Proxy-respondents in the other category were always able to provide an answer for questions in the IPAQ-ID related to participation in home-based physical activity. The response rate of home proxy-respondents was not as high for the questions in the IPAQ-ID related to participation in day agency physical activity. CRU staff provided an answer for questions in the IPAQ-ID related to participation in day agency based physical activity on 77% of occasions, parents on 68% of occasions and proxy-respondents from the “other” category on 92% of occasions. Overall, CRU proxy-respondents were found to provide answers across all questions on the IPAQ-ID on 93% of occasions and other proxy-respondents on 98% of occasions. In contrast, parent proxy-respondents were found to provide answers across all questions on the IPAQ-ID on 90% of occasions, preferring to offer “don’t know” as a response on approximately 9% of occasions.

The response rates per category and sub-category of the day agency proxy-respondents are displayed in Table 31. Day agency proxy-respondents provided an answer for questions in the IPAQ-ID related to participation in home-based physical activity on 82% of occasions and work supervisors on 72% of occasions. Day placement staff proxy-respondents answered questions in the IPAQ-ID related to participation in day agency physical activity on 99% of occasions. Work supervisor proxy-respondents provided an answer for questions in the IPAQ-ID related to participation in day agency based physical activity on all occasions. Overall, day placement staff proxy-respondents were found to provide answers across all questions on the IPAQ-ID on 87% of occasions and work supervisor proxy-respondents on 80% of occasions.
Table 30: Percentage of home proxy-respondent response rates

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Answered</th>
<th>Don’t Know</th>
<th>Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Community</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>residential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unit staff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 25)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day agency total activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>76.92</td>
<td></td>
<td>23.08</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>67.57</td>
<td></td>
<td>29.73</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>91.67</td>
<td></td>
<td>8.33</td>
<td>0.00</td>
</tr>
<tr>
<td>Home total activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.04</td>
<td></td>
<td>0.96</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>98.50</td>
<td></td>
<td>1.50</td>
<td>0.00</td>
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<tr>
<td></td>
<td>100.00</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Total activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>93.01</td>
<td></td>
<td>6.99</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>90.15</td>
<td></td>
<td>9.12</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>97.73</td>
<td></td>
<td>2.27</td>
<td>0.00</td>
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<table>
<thead>
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<th>Sub-category</th>
<th>Answered</th>
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<tbody>
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<td></td>
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<tr>
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<tr>
<td></td>
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<tr>
<td></td>
<td>(n = 13)</td>
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<td>100.00</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Vigorous activity</td>
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<td></td>
<td>100.00</td>
<td></td>
<td>0.00</td>
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<td>0.00</td>
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</table>

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Answered</th>
<th>Don’t Know</th>
<th>Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Community</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>residential</td>
<td></td>
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<tr>
<td></td>
<td>unit staff</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>(n = 13)</td>
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<td>Parent</td>
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</tr>
<tr>
<td></td>
<td>(n = 4)</td>
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</tr>
<tr>
<td>Home total activity</td>
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<td></td>
<td>93.16</td>
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<td>6.84</td>
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<td></td>
<td>90.67</td>
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<td>8.44</td>
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<td></td>
<td>97.22</td>
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<td>2.78</td>
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<td>Total activity</td>
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<tr>
<td></td>
<td>92.31</td>
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<td>7.69</td>
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</tr>
<tr>
<td></td>
<td>87.76</td>
<td></td>
<td>12.24</td>
<td>0.00</td>
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<td>100.00</td>
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<td>0.00</td>
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Table 31: Percentage of day time proxy-respondent response rates

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Answered Day agency (n = 36)</th>
<th>Answered Work Supervisor (n = 5)</th>
<th>Don’t Know Day agency (n = 36)</th>
<th>Don’t Know Work Supervisor (n = 5)</th>
<th>Refused Day agency (n = 36)</th>
<th>Refused Work Supervisor (n = 5)</th>
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</thead>
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<td></td>
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<td>99.10</td>
<td>100.00</td>
<td>0.90</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>98.65</td>
<td>100.00</td>
<td>1.35</td>
<td>0.00</td>
<td>0.00</td>
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<td>100.00</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>82.43</td>
<td>71.87</td>
<td>15.54</td>
<td>28.13</td>
<td>2.03</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>83.02</td>
<td>67.86</td>
<td>14.67</td>
<td>32.14</td>
<td>2.31</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75.68</td>
<td>100.00</td>
<td>21.62</td>
<td>0.00</td>
<td>2.70</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>86.98</td>
<td>79.55</td>
<td>11.55</td>
<td>20.45</td>
<td>1.47</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>86.79</td>
<td>75.00</td>
<td>11.71</td>
<td>25.00</td>
<td>1.50</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>87.84</td>
<td>100.00</td>
<td>10.81</td>
<td>0.00</td>
<td>1.35</td>
<td>0.00</td>
</tr>
</tbody>
</table>
6.5.1 IPAQ-ID Validity

Criterion-related validity correlation coefficients are reported in Table 32. Overall poor to good agreement between the accelerometer data and all nine categories of the IPAQ-ID was found for the day agency, home, and combined proxy-respondents. Criterion-related validity correlations ranged from 0.06 to 0.68 for day agency proxies, 0.19 to 0.72 for home proxy-respondents, and 0.13 to 0.67 when the proxy-respondent groups were combined.

A large significant correlation was found between day agency total physical activity determined by the IPAQ-ID and the accelerometer data (range $\rho = 0.55 - 0.60$) for the three proxy-respondent groups. A greater degree of accuracy was seen by day agency proxy-respondents, $\rho (N = 40) = 0.60, \ p < .001$; and the combined proxy-respondents, $\rho (N = 26) = 0.60, \ p = .017$.

Large significant correlations were also found between home total physical activity determined by the IPAQ-ID and the accelerometer data (range $\rho = 0.60 - 0.62$) for the three proxy-respondent groups. The combined proxy-respondents exhibited a greater degree of accuracy ($\rho (N = 24) = 0.62, \ p = .001$), followed by the home proxy-respondents ($\rho (N = 22) = 0.61, \ p = .003$) and day agency proxy-respondents ($\rho (N = 22) = 0.60, \ p = .003$).

Overall, correlation validity co-efficients indicated a significant correlation between total physical activity determined by the IPAQ-ID for all three proxy-respondent groups and the accelerometer data (range $\rho = 0.54 - 0.72$). Home-based proxy-respondents exhibited a greater degree of accuracy, $\rho (N = 22) = 0.72, \ p < .001$; followed by the combined proxy-respondents, $\rho (N = 24) = 0.67, \ p < .001$; and day agency proxy-respondents, $\rho (N = 22) = 0.54, \ p = .009$.

This indicates that the IPAQ-ID exhibits good measurement properties in respect to use with proxy-respondents of AWID (Cohen, 1988).
Table 32: Criterion validity correlation coefficients between the IPAQ-ID and accelerometer data

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Day agency Proxy Respondent</th>
<th>Home Proxy Respondent</th>
<th>Combined Proxy Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>p</td>
<td>p</td>
</tr>
<tr>
<td>Day agency total activity</td>
<td></td>
<td>40</td>
<td>0.60</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>41</td>
<td>0.15</td>
<td>.047</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>41</td>
<td>0.46</td>
<td>.002*</td>
</tr>
<tr>
<td>Home total activity</td>
<td></td>
<td>22</td>
<td>0.60</td>
<td>.003*</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>24</td>
<td>0.45</td>
<td>.027**</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>32</td>
<td>0.06</td>
<td>.729</td>
</tr>
<tr>
<td>Total activity</td>
<td></td>
<td>22</td>
<td>0.54</td>
<td>.009*</td>
</tr>
<tr>
<td>Moderate activity</td>
<td></td>
<td>24</td>
<td>0.21</td>
<td>.314</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td></td>
<td>32</td>
<td>0.68</td>
<td>&lt;.001*</td>
</tr>
</tbody>
</table>

*significant at p <.01  
** significant at p <.05
Z-score statistics, reported in Table 33, were computed to determine if one proxy-respondent group was significantly more accurate in reporting the physical activity behaviours of AWID, for part or all of the IPAQ-ID. No significant difference was found between any proxy-respondent groups. Comparisons in reporting of physical activity behaviours of AWID across all possible groups regularly found the smallest differences to be among home based and combined proxy-respondent reports.

Table 33: Accuracy of proxy-respondent reports

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Day agency total activity</th>
<th>Day agency vs Home Proxy Respondents</th>
<th>Day agency vs Combined Proxy Respondents</th>
<th>Home vs Combined Proxy Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-category</td>
<td>z score</td>
<td>z score</td>
<td>z score</td>
<td></td>
</tr>
<tr>
<td>Day agency total activity</td>
<td>-1.13</td>
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<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>0.92</td>
<td>0.90</td>
<td>-0.03</td>
<td></td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>0.17</td>
<td>0.49</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>Home total activity</td>
<td>0.60</td>
<td>0.56</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>-0.45</td>
<td>-0.20</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>-0.03</td>
<td>-0.07</td>
<td>-0.05</td>
<td></td>
</tr>
<tr>
<td>Total activity</td>
<td>-1.26</td>
<td>-1.28</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>1.50</td>
<td>1.69</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>-0.64</td>
<td>-0.43</td>
<td>0.25</td>
<td></td>
</tr>
</tbody>
</table>

6.5.2 IPAQ-ID Reliability

Test-retest reliability data are presented in Table 34. Test-retest data were collected from 14 proxy-respondents; five home proxy-respondents and nine day agency proxy-respondents. Due to the small numbers reliability data was analysed for all proxy-respondents and not individual proxy-respondent groups. Data shows Spearman’s rho correlation coefficients ranging from 0.28 for total moderate activity to 0.84 for home vigorous activity, but most were above 0.50, indicating adequate repeatability. A significant correlation was found for day agency total activity, $\rho (N = 12) = 0.82, p = .001$; and home vigorous activity, $\rho (N = 11) = 0.84, p = .001$. 

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A non significant correlation was found between the IPAQ-ID proxy-respondent reports on total activity and accelerometer data \( (N = 6) = 0.71, p = .11 \).

Table 34: Test-retest reliability data for the IPAQ-ID

<table>
<thead>
<tr>
<th>Physical Activity Category</th>
<th>Sub-category</th>
<th>Combined Proxies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modality total activity</td>
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<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>13</td>
<td>0.52</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>13</td>
<td>0.53</td>
</tr>
<tr>
<td>Home total activity</td>
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<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>8</td>
<td>0.69</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>11</td>
<td>0.84</td>
</tr>
<tr>
<td>Total activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate activity</td>
<td>9</td>
<td>0.28</td>
</tr>
<tr>
<td>Vigorous activity</td>
<td>11</td>
<td>0.43</td>
</tr>
</tbody>
</table>

\* = significant at \( p < .01 \)

6.6 Discussion

Self-report recall questionnaires are commonly used to measure population based physical activity. They are relatively inexpensive, non-invasive and easy to administer among large populations (Friedenreich et al., 2006; Sirard & Pate, 2001). However, the acquiescence, cognitive demand and comprehension of some sub-populations, including AWID, is a major limitation to obtaining self-report physical activity data (Finlay & Lyons, 2001). To overcome these limitations investigators have used proxy-respondents to report on the physical activity behaviour of sub-populations, including AWID (Temple, Frey, & Stanish, 2006).

Thorough pre-testing or examination of the psychometric properties of physical activity questionnaires is limited (Friedenreich et al., 2006) and studies investigating the physical activity of AWID have been shown to rely on measurement tools and/or procedures that are either not valid or reliable when used with this population (Temple, Frey, & Stanish, 2006). The need for a psychometrically sound instrument to assess the daily physical activity of AWID has recently been identified by Temple and colleagues (2006). This study aimed to address this
need through the development of the IPAQ-ID, a proxy based questionnaire, adapted from the long telephone questionnaire version of the IPAQ, to measure the physical activity behaviour of AWID.

Validity and reliability testing of the IPAQ-ID found that this proxy-respondent physical activity questionnaire has good measurement properties. Reproducibility of the information collected with the IPAQ-ID was found to be comparable to the test-retest reliability results of commonly used, self-report and proxy-respondent physical activity questionnaires among youth, adults and older adults without a disability (Sallis & Saelens, 2000). The International Physical Activity Questionnaire (IPAQ) was developed to provide a common surveillance tool to collect comparable data on health-enhancing physical activity behaviours of adults within and between countries. A 12-country reliability and validity study found the IPAQ to have sound psychometrically properties (Craig et al., 2003). Although the reliability of the IPAQ-ID was not as high as the IPAQ, the IPAQ-ID was found to have good reproducibility and is a marked improvement on what is currently available for this population. The difference in reliability between the IPAQ and IPAQ-ID is possibly due to the way in which information was obtained. The IPAQ relies on self-report of the participant, whereas the IPAQ-ID relied on reports from proxy-respondents, and others have found proxy-respondents less reliable than self-report (Ronen, Streiner, Rosenbaum, & the Canadian Pediatric Epilepsy Network, 2003; Vogels et al., 1998; Whiteman & Green, 1997).

The long form of the IPAQ has been used to investigate physical activity among indigenous Australians (Marshall & Miller, n.d.). Results of Marshall’s and Miller (n.d.) study reports fair to excellent test-retest repeatability for occupational related activity, chore related activity and transport (\( r = .49, .69 \) and \(.86 \) respectively). Two of the three categories used in the IPAQ-ID; day agency and home physical activity, can be related to the categories used by Marshall and Miller (n.d.). Results of this study found that these categories have comparable, if not better, reproducibility than the IPAQ when used with indigenous Australians. This may be explained partly due to both the consistency in AWID’s weekly routine and reducing some of the difficulties encountered in the indigenous Australian study. This study found that it is possible to achieve reproducible results when proxy-respondents are used to report on the physical activity behaviours of AWID.

Validity correlation coefficients found that proxy-respondents reporting on the total physical activity of AWID using the IPAQ-ID has comparable validity as self-report and proxy physical
activity questionnaires for youth, adults and older adults without a disability (Sallis & Saelens, 2000). A comparison of the criterion validity of the 12-country reliability and validity study of the IPAQ among adults without a disability, and proxy-respondents using the IPAQ-ID, found that measurement properties of the IPAQ-ID were of a greater magnitude than the IPAQ. Future studies need to explore possible reasons for the difference in validity between the self-report IPAQ with adults without a disability and proxy-respondents for AWID using the IPAQ-ID.

It is not possible to draw parallels with the validity of the IPAQ validation study with indigenous Australians due to its abandonment. Marshall and Miller (n.d.) found it too difficult to use the IPAQ with indigenous Australians. This was not found to be a problem with the use of the IPAQ-ID with proxy-respondents. The investigator found that having a good knowledge of and experience in working in the disability field assisted in the successful implementation of the IPAQ-ID instrument.

The use of MTI accelerometers to measure physical activity, an instrument used in this study, has been explored among people with a brain injury (Tweedy & Trost, 2005). This is a population of interest as people with brain injury may have similar cognitive abilities to people with an intellectual disability. A notable difference in the sample in the study reported herein and that of Tweedy and Trost (2005) is the sample in the brain injury study comprised of people with ambulatory problems. The authors reported that the MTI actigraph could correctly estimate energy expenditure for light to moderate activities among this population, however the MTI actigraph was found to significantly underestimate higher intensity physical activity.

6.6.1 Response Rate of Proxy-respondents for the IPAQ-ID

The response rate of proxy-respondents in the IPAQ-ID is important information to be considered in determining who or what combination of people would be the best proxy-respondent to report on the physical activity of AWID. Few studies using proxy-respondents report on response rates (Jokovic, Locker, & Guyatt, 2004; Poulter, Chang, Farley, & Marmont, 1996).

It is preferable, from a pragmatic perspective, that only one caregiver report on the daily physical activity behaviour of AWID; reasons include ease of administration, accessibility, reduction of investigator and caregiver’s time and cost. The IPAQ-ID is divided into clear
domains; day agency activity, transportation related physical activity, housework, leisure time activity and recreational physical activity. Difficulties may therefore arise when asking a proxy-respondent, such as the home proxy-respondent, to report on an aspect of the AWID’s day that they are less familiar with, such as day agency activity which occurs away from the home and does not permit direct and indirect observation by the proxy-respondent.

The rate of response between the three home-based proxy-respondent groups in this study was similar. The number of “don’t know” responses from the other (relatives) home-based proxy-respondent group indicates that this group of proxy-respondents are as confident in answering questions on the routine and physical activity behaviours of the AWID as parents and CRU staff. This may be indicative of a similarity in the closeness of the relationship between the AWID and proxy-respondent, a comparable awareness and knowledge of the AWID’s daily routine or a combination of both of these reasons.

Jokovic and colleagues (2004) report that a proxy-respondent’s ability to accurately report on behalf of another person was limited to behaviours that commonly occur in the setting the proxy-respondent is able to observe the participant. Results of this study support this assertion with response rates indicating that day agency proxy-respondents answered a greater percentage of questions relating to day agency physical activity and opting to answer “don’t know” on a greater number of occasions for questions relating to home-based physical activity. To gain an insight into whether any one proxy-respondent is more able to report on all or a specific domain of the physical activity behaviours of AWID, results were analysed for each proxy-respondent group for each domain of the IPAQ-ID and are discussed below.

6.6.2 Day Agency Domain

The day agency and combined proxy-respondent groups were found to be more accurate than the home-based proxy-respondents when reporting total day agency physical activity behaviour. This is indicative of a combination of most AWID spending 30 hours a week (9am - 3pm, 5 days week) at day agency, where AWID engaged in a weekly routine as specified by a timetable. It was found that proxy-respondents from both the home and day agency environment would refer back to the AWID timetable when responding to the IPAQ-ID questions. In essence, these respondents used an existing physical activity ‘plan’ (i.e. timetable) to guide their responses to the IPAQ-ID questions.
Proxy-respondents commented that the AWID’s timetable was a helpful tool in identifying the type of activities AWID are involved in when at day agency. It is possible that reference to the timetable was more beneficial to day agency staff. A possible explanation as to why timetables were more beneficial when used by day agency proxy-respondents is because they would have greater knowledge and first person experience of what day agency programs involve and to what extent the AWID participate in the timetabled activities. This is demonstrated through the following, using the example of an AWID’s timetable that indicated an AWID was involved in a two hour walking activity on a Tuesday morning. Day agency proxy-respondents were found to be more realistic in their responses due to an awareness that the first 30-minutes of the activity was taken up with organisational issues, driving to where the program occurred and getting on and off the bus. This was followed by a 40-minute walk which involved regular stops. Part of this time was taken up by a break for morning tea. Before getting organised for the return trip, time was taken for a rest period. On the other hand, home-based proxy-respondents were more likely to report that a 2 hour walking program means that the AWID is engaged in that physical activity for most of the allocated time, with the remainder of the time taken up with travel and organisation.

Day agency proxy-respondents were less able to accurately report moderate-intensity activity with the same degree of accuracy as the home proxy-respondents. In contrast, day agency proxy-respondents were more accurate in reporting day agency vigorous-intensity activity at day agency than the home proxy-respondents. This may be attributed to AWID possibly engaging in a larger proportion of physical activity during the time they are at day agency. During this time it is the day agency proxy-respondents who are actually with the AWID. This gives the day agency proxy-respondents greater opportunities to observe outward signs of physical exertion including how heavy the AWID was breathing, colour in their face and amount of perspiration on the forehead as a result of the activity. Observable signs like this are likely to help proxy-respondents to estimate the intensity of the physical activity an AWID is participating in.

Proxy-respondent reports indicated that each proxy-respondent group was more accurate at answering questions in the IPAQ-ID that related to the environment they were able to regularly observe the AWID. This is supported by previous literature which suggests that different proxy-respondent groups, such as parents and staff, are more familiar with aspects of the AWID lives they are most involved in (Umb-Carlsson & Sonnander, 2006). A criticism of Umb-
Carlsson’s and Sonnander (2006) study however, is that staff proxy-respondent’s provided support from various areas of the AWID life, including housing, daily activities and counselling. This was not the case in this study, with proxy-respondents being divided and compared by two distinct environments, home and day agency. Nonetheless, similar results are seen in this study, with reports by day agency proxy-respondents for day agency total and vigorous-intensity activity, however not for moderate-intensity activity.

The lack of ability of proxy-respondents to report on the intensity levels of activities engaged in by AWID at day agency is supported by previous research on the use of proxy-respondents in measuring a subjective measure, quality of life, among AWID. Unlike reporting the number of days or length of time a person is engaged in physical activity, the classification of activity intensity is more of a subjective nature. It is likely that responses of the proxy-respondents were exacerbated by the minimal amount of regular, moderate-intensity to vigorous-intensity physical activity AWID engage in. When an AWID is typically involved in sedentary activities, any form of physical activity they engage in may be perceived as at least moderate-intensity simply because the AWID is involved in physical activity. The AWID may not participate in physical activity for long as they may quickly lose motivation, receive little encouragement and/or tire quickly as a result of being poorly conditioned due to not being regularly involved in physical activity. This cessation of involvement in physical activity may in turn give caregivers the impression that the activity has been physically demanding and of at least moderate-intensity for the AWID.

6.6.3 Home Domain

All proxy-respondent groups could adequately report total activity for the home domain. Day agency proxy-respondent reports on total home activity were not as accurate as the home and combination proxy-respondent groups, however differences were negligible. Nonetheless, validity correlation coefficients indicated a lack of ability for proxy-respondents to report on the intensity level of home-based physical activity. Of the proxy-respondent groups, home proxy-respondents were more accurate at reporting on home vigorous activity, however, day agency proxy-respondents were more accurate in reporting on home moderate activity. Results found that for both the day agency and home physical activity, the proxy-respondent group that that domain relates to were more accurate at reporting vigorous activity, but not moderate activity.
One possible explanation for the difference in the ability of proxy-respondent groups to report on moderate and vigorous activity is the AWID own perception of activity intensity and their willingness to share specific information with the proxy-respondent. It may be difficult for a proxy-respondent to respond to questions on the environment the proxy-respondent does not commonly see the AWID in because the proxy-respondents knowledge in this area is restricted to general information that is communicated to them from staff through a communication diary and/or the information the AWID volunteers. The amount of detail AWID provide proxy-respondents with is likely to be variable and would depend on factors including the relationship of the proxy-respondent to the AWID, how long the AWID has known the proxy-respondent, when information exchange occurs and the regularity of contact the proxy-respondent has with the AWID, the AWID cognitive and verbal skills, the interest shown and questions proxy-respondents ask the AWID. Given this it is possible that when proxy-respondents were questioned on the area that does not relate to their environment, they made assumptions on the length and intensity levels of activities the AWID engaged in, rather than indicating that they did not know.

6.6.4 Total Activity Domain

A good level of agreement for the total physical activity domain was found between the IPAQ-ID and accelerometer derived data (criterion validity) for each proxy-respondent group. This indicates that the IPAQ-ID is a valid instrument for use with proxy-respondents to report on the total physical activity behaviours of AWID. This finding is of great significance as public health surveys, including the Victorian Population Health survey, commonly assess sufficient or total physical activity. The consistency in routine of the AWID and proxy-respondent’s knowledge of the AWID, their behaviours and reactions in different situations may have played an important role in the findings. All proxy-respondents in this study were familiar with the AWID, having known the AWID for a minimum of 6-months, and were familiar with their daily routine.

A comparison of the proxy-respondent groups found that home proxy-respondents were more accurate at reporting AWID total weekly physical activity. The combined and day agency proxy-respondent groups did not yield consistently better results. Findings from this study are different from those reported by Stancliffe (1999), who reports strong correlations and lower variability in the scores reported by two proxy-respondents, and Santos-Eggimann and colleagues (1999) who conclude that responses from a team of caregivers may be more
representative than the scores from a single caregiver. A major difference between the present study and these studies is the nature of the variables under investigation, namely physical activity and quality of life. Quality of life includes areas related to dressing, feeding, continence, handling finances, mode of transport and food preparation. These areas are subjective in nature, an area where proxy-respondents have been shown to lack accuracy and reliability (Jokovic, Locker, & Guyatt, 2004). This study focused on asking proxy-respondents about the number of days, length of time and intensity of physical activity engaged in by AWID. Unlike quality of life attributes, the number of days and length of time engaged in physical activity are observable variables which are readily quantifiable. Although intensity of physical activity is more subjective, it is possible to determine this through behaviours which are readily observed, such as breathing faster and deeper, skin colour or perspiration forming on the forehead.

Although combined and day agency proxy-respondents provided good information on the total activity of AWID, results of this study indicate that the best option for researchers to obtain information on AWID total weekly physical activity is through proxy-respondents from the home environment of the AWID. A difference was found when administering the IPAQ-ID to day agency and home proxy-respondents with the time of day they were available to complete the IPAQ-ID. The investigator was limited to contacting the day agency proxy-respondents during work hours. These individuals typically scheduled the phone appointment during a scheduled non-AWID contact period of the day. Only two day agency proxy-respondents were willing to be contacted out of work hours. This raises issues for researchers to be able to successfully complete the IPAQ-ID within a reasonable time period to the reference week. The main issue encountered in this study was that day agency proxy-respondents were often not available at the predetermined time to complete the IPAQ-ID. This was reported to be because either the proxy-respondent had forgotten and involved themselves in other activities, or had been called out to assist with an off-site program or other duties. Additionally, it was found that in comparison to home-based proxy-respondents, day agency proxy-respondents were more likely to be distracted by happenings within their environment when completing the IPAQ-ID.

In contrast, proxy-respondents from the home environment were more flexible in the times they could complete the IPAQ-ID. This resulted in the IPAQ-ID being completed during quieter times, commonly late evening or during the day when the AWID was at day agency. Consequently, the conversation was of a more relaxed nature and proxy-respondents talked
more freely about the AWID, their daily routine and physical activity behaviours. It was not uncommon for home proxy-respondents to give researchers detailed information about the AWID week. This allowed proxy-respondents and researchers alike to clarify any query or responses, thus possibly contributing to the greater accuracy of home-based proxy-respondent reports on total activity of AWID.

6.6.5 Strength and Limitations of the IPAQ-ID

There is a pressing research and public health need for valid and reliable physical activity measurement procedures to be developed for proxy-respondents to report on or in conjunction with AWID (Temple, Frey, & Stanish, 2006). This study was successful in developing a proxy-respondent questionnaire, the IPAQ-ID, with acceptable psychometric measurement properties. A benefit of the IPAQ-ID is that it has been designed specifically for use with AWID. Until now measurement limitations have reduced confidence in results of studies investigating physical activity among this population (Temple, Frey, & Stanish, 2006).

Unlike many physical activity questionnaires, the IPAQ-ID seeks responses about physical activity behaviours across a wide range of domains including day agency, transport, housework, leisure and recreational physical activity and does not focus on just one area of physical activity. This study was limited in its ability to analyse all domains of the IPAQ-ID. The investigator was limited to exploring specific areas of the IPAQ-ID, including walking and leisure time physical activity, however these domains were collapsed into three broad areas; day agency physical activity, home physical activity and total physical activity. It was not possible to investigate how or where AWID engaged in all health-related physical activity. This was not the focus of the research as there is first the need for a psychometrically sound instrument to be able to measure the physical activity behaviours of AWID.

The IPAQ-ID requires proxy-respondents to report an average time per day the AWID is involved in moderate-intensity and vigorous-intensity activities. Results indicate varied abilities for proxy-respondents to estimate the intensity of the physical activity. In responding to each question proxy-respondents tended to discuss the AWID routine and involvement in activities. Home proxy-respondents did this in more depth than day agency proxy-respondents. It is not clear why a difference in reporting on the intensity level of activity existed between the home and day agency proxy-respondents. It is speculated that access to the AWID timetable may have assisted proxy-respondents. The researcher does not believe this to be a plausible
explanation however, as both the home and day agency proxy-respondents had access to the AWID timetable. AWID carry a communication diary that day agency and home staff use to communicate necessary information and messages to each other. A copy of the AWID timetable is included in their communication diary. An additional issue that arose is that proxy-respondents appeared conscious of emphasising that AWID are involved in a great variety of programs that provide benefits to the AWID rather than responding to the question for that particular domain and involvement of activities in the intensity level asked about. This is perhaps due to their desire to provide answers they deem socially acceptable within the disability service industry.

The insight and knowledge of the investigator in the disability industry was found to be most beneficial in administering the IPAQ-ID and is deemed to be advisable during similar studies. The importance and need for local research assistants with knowledge of the population under investigation was also highlighted in the indigenous Australian IPAQ study (Marshall & Miller, n.d.). Both studies highlight the need to use researchers that are familiar with and who can relate to the population, content and context under investigation.

The information volunteered by the proxy-respondents to the investigator throughout the questionnaire was used by the investigator to make a decision as to whether further questioning of the proxy-respondent was necessary to gather information. When deemed necessary by the investigator, the proxy-respondent was reminded of the domain that was being asked about (day agency or leisure physical activity) and the definition of either moderate-intensity or vigorous-intensity physical activity. Proxy-respondents were then again asked if they believed this physical activity was of that intensity. A similar process, but in more depth, was used in the IPAQ probe study (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). It was found that proxy-respondents needed constant reminding of the specific time frame of 10 minutes or more that the questions related to. The investigator also found that proxy-respondents felt they needed to mention the same activity for more than one section. To overcome this, the investigator would place great emphasis on the wording “…that you have not mentioned already…” within each question.

Notwithstanding that the IPAQ-ID was found to have acceptable measurement properties in accordance with other physical activity surveys (Sallis & Saelens, 2000) there is limited evidence available on the ability of proxy respondents to provide accurate or reliable information. As discussed in Chapter 2, section 2.7.3 the literature concludes that proxy
respondents provide greater levels of agreement when reporting on observable, in comparison to non-observable measures. This study attempted to overcome foreseen limitations through the testing protocol outlined in the methodology of this chapter. Although questions in the IPAQ-ID were as objective as possible some subjectivity on the part of the proxy respondent was required when answering questions relating to the intensity level of the activity the AWID was engaged in.

6.6.6 Further Research

This study is the first known attempt at developing a surveillance tool specifically aimed at measuring the physical activity of AWID. Initial findings indicate that this proxy-respondent questionnaire has sound measurement properties and the IPAQ-ID could be used in public health surveillance. To add to the body of knowledge about the IPAQ-ID further studies are required to refine the instrument and improve the reliability and validity of the IPAQ-ID. This study was limited in geographical area and sample size. A larger sample size in future studies with AWID living in both CRU’s and at home with family, and attending a variety of day agencies, would allow for detailed comparisons to be made between different proxy-respondent groups and the influence of proxy-respondent characteristics on the psychometric properties of the IPAQ-ID. Additionally, further investigation is required into the extent of how the number of “don’t know” responses can influence psychometric properties of the IPAQ-ID.

Statistical procedures in this study followed those used by Craig and colleagues (2003) in the 12-country reliability and validity study of the IPAQ. This approach was done so as to enable comparisons to be made between the IPAQ and IPAQ-ID. However, it has been suggested that the statistical procedures used by Craig and colleagues (2003) are inefficient and data from the IPAQ reliability and validity study should be reanalysed using the kappa co-efficient (Hallal & Victora, 2004). It is therefore recommended that further studies investigate the effect of different statistical procedures on the reliability and validity of the IPAQ-ID. This would also allow investigators to explore other issues with the IPAQ-ID, including the level of over-or under-reporting by proxy-respondent groups, an issue that has recently been identified by Rzewnicki and colleagues (2003) when using the IPAQ among adults without a disability.

Further research also needs to consider emerging evidence that suggests the energy expenditure levels of AWID differ to their peers without a disability. Energy expenditure estimates are
commonly used to interpret information obtained from physical activity questionnaires. Therefore, if current energy expenditure levels based on the general population are used, this could result in inaccuracies in the interpretation of information derived from questionnaires.

Finally, investigations are required into a short version of the IPAQ-ID, as opposed to the long version telephone delivered approach used in this study, and the development of a proxy-respondent instrument to obtain data on the physical activity levels of children and adolescents with an intellectual disability. To date no valid and reliable instruments are available to assist researchers who face many methodological challenges when working with not only children and adolescents, but children and adolescents with an intellectual disability.
CHAPTER 7

CONCLUSIONS

Limited information is available about the physical activity behaviours of adults with an intellectual disability (AWID). Previous efforts to measure the physical activity of AWID has varied considerably with respect to the type of measurement approach used and with a strong reliance on measurement tools that have not been shown to be either valid or reliable. Much of the previous research has been based on small samples and depended on information provided by proxy-respondents whose ability to report accurately remains undetermined.

The primary objective of this thesis was to develop a valid and reliable proxy-respondent instrument to measure the physical activity of AWID. As part of the validation process underlying physical activity questionnaires, this thesis also aimed to investigate and compare the energy expended during common activities of daily living (ADL) by AWID and adults without an intellectual disability (AWOID). This final chapter will provide a general discussion of the findings from the research studies described in previous chapters, limitations and recommendations for the future.

7.1 Overview of Key Findings

Physical activity questionnaires are commonly used to assess the physical activity behaviours of populations, and increasingly AWID. The information provided from algorithms used in the calculation of energy expenditure in these physical activity questionnaires have used estimates based on AWOID to analyse, interpret and report the results. However, few studies have explored possible differences in levels of energy expended among AWID and AWOID. Chapter three describes an investigation of the energy expenditure by AWID and AWOID while undertaking seven common ADL. Evidence gathered through this study found that as the energy demand of the ADL increased there was an increase in the difference between energy expended by AWID and AWOID. Findings of this study and the studies described in Chapters four and five indicate differences in the energy expended by AWID and AWOID for the seven common ADL. Results indicate that for AWID walking at a pace of 3.0 km/hr or above is of moderate-intensity. If walking at this speed or greater was engaged in for a sufficient amount of time, a contribution to the health of AWID would occur.
Chapter four describes the investigation of a Caltrac® accelerometer. The Caltrac® accelerometer has been used as a criterion measure in previous Australian studies assessing the physical activity behaviours of AWID. Findings reported in this thesis suggest that the Caltrac® accelerometer underestimates energy expenditure of AWID for seven common ADL and is not valid for use with this population. The findings described in this chapter therefore question the validity of the Caltrac® accelerometer, casting doubt on the data reported in previous Australian studies (Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003). Chapter five reported, that despite significant differences and underestimation of the energy expended by AWID, metabolic equivalent values derived from the Caltrac® accelerometer for ADL that required less effort fall within the correct light-intensity physical activity classification. It was found that as the intensity of the physical activities increased, the validity of the Caltrac® accelerometer decreased.

The use of various physical activity questionnaires to report on the physical activity behaviour of AWID, that have not been shown to be valid or reliable when used with AWID, make it difficult to determine the prevalence of physical activity among the population. Chapter six describes the development of a universal questionnaire for assessing the physical activity behaviours of AWID, the IPAQ-ID. The proxy-respondent telephone delivered questionnaire described in this chapter was found to have good measurement properties with reliability and validity testing indicating that the IPAQ-ID is suitable for use as a common surveillance tool by researchers to collect comparable data on health-enhancing physical activity behaviours of AWID.

7.2 Limitations

The relative small sample sizes recruited to participate in the studies described in chapters three, four, five and six are a limitation of the studies in this thesis. Despite numerous and extensive efforts to recruit matched AWOID for the studies in chapters three, four and five the final sample of AWOID, were limited. This phenomenon has been reported by others and continues to act as a challenge to researchers.

There are limitations associated with the use of the Caltrac® accelerometer at only one site of the body. Researchers have reported an inability for accelerometers to detect an increased energy cost of upper body movement (Hendelman, Miller, Baggett, Debold, & Freedson, 2000). Two of the seven ADL in the studies described in chapters four and five, that investigated the
accuracy of the Caltrac\textsuperscript{®} accelerometer involved limited upper body movement. As AWID have been reported to engage in predominately sedentary activities, future studies investigating use of the Caltrac\textsuperscript{®} accelerometer with AWID should investigate differences in the placement of the accelerometer.

The development of the IPAQ-ID is described in Chapter six. This study was limited in the ability to examine all domains of the IPAQ-ID as it was not possible to determine how or where the AWID engaged in health enhancing physical activity. The need to probe proxy-respondents on some of their responses to ensure they considered the amount of time and intensity of the activity they were referring to is a further limitation. It has previously been reported that probing participants on their responses to physical activity questionnaires resulted in more accurate responses (Rzewnicki, Auweele, & De Bourdeaudhuij, 2003). Now that a psychometrically sound instrument has been developed to measure the physical activity behaviours of AWID, future studies will be able to explore such additional information.

7.3 Implications for Future Research

Chapters three, four and five highlighted some of the differences in energy expenditure values between AWID and AWOID for common ADL. The results suggest that either the existing equations that underpin the energy expenditure calculations of the Caltrac\textsuperscript{®} accelerometer or the instrument itself require refinement if the device is to be used with AWID. It is possible that differences in walking gait may have influenced the level of energy expended by AWID. Further investigation is required into the effect of walking gait and other characteristics that could account for the difference in energy expenditure between AWID and AWOID.

The study described in Chapter six is the first known attempt at developing a surveillance tool, the IPAQ-ID, which is specifically aimed at measuring the physical activity of AWID. It is recommended that future studies further investigate the reliability and validity of the IPAQ-ID. The analysis described in Chapter six was consistent with the methods used by Craig and colleagues (2003) in the validation and reliability study of the IPAQ among adults without a disability, the instrument the IPAQ-ID evolved from. The appropriateness of this analysis has recently been questioned (Hallal & Victora, 2004). It is therefore recommended that future studies investigate the effect of different statistical procedures on the reliability and validity of the IPAQ-ID. This will allow investigators to explore other issues including the level of over-or under-reporting by various proxy-respondent groups. Additionally, research is required into the
development of a proxy-respondent instrument to obtain data on the physical activity levels of children and adolescents with an intellectual disability.

7.4 Conclusions

This thesis makes a unique contribution to the body of knowledge relating to the measurement of physical activity of AWID. The research reported in Chapters three, four and five of this thesis can be used to help validate physical activity measurement tools and appropriately target health promotion towards AWID. It is anticipated that these results can be used in order to cross validate the energy expenditure values used in epidemiological surveys with the reported energy values reported in the Compendium of Physical Activities.

The development of a valid and reliable questionnaire, discussed in Chapter 6, will allow researchers to accurately and confidently estimate the participation of AWID in physical activity. Gaining accurate knowledge on physical activity behaviours of AWID will allow researchers to provide evidence that can be used to inform government and non-government agencies about the participation of AWID in physical activity. Such information will assist in influencing the decisions of policy makers and resource allocation related to health promotion of AWID through physical activity. The data obtained from the IPAQ-ID will enhance intervention efforts and provide valuable information required to evaluate health-related campaigns targeted toward AWID.
REFERENCE LIST


Appendix 1: Plain language statement for next of kin/ legal guardian of adult with an intellectual disability
Plain Language Statement.

(To be sent to each potential participants next of kin)

Dear………………………

My name is Kerrie Simmons. I am undertaking my postgraduate studies at RMIT University, under the supervision of Associate Professor Jeff Walkley and Dr Viviene Temple. This letter is to inform you that we would like ………………………………….. to consider becoming involved in a project which aims to determine the amount of energy adults with an intellectual disability use during common activities of daily life. Please carefully read the following information about the project, complete the appropriate response slip and return it to us in the enclosed reply paid envelope.

Project title: Energy expended during daily activities by adults with an intellectual disability.

Background:

Physical activity has an important influence on health. However, there is little direct evidence about the physical activity behaviour of adults with an intellectual disability. Without any knowledge of the physical activity behaviour of adults with an intellectual disability, it is difficult to determine whether any public health campaigns need to be directed toward this group. Research suggests that current information used to calculate the energy expended through physical activity among the general population is inappropriate for use with adults with an intellectual disability. Therefore, to gain reliable and valid information on the physical activity behaviour of adults with an intellectual disability, it is first necessary to collect information about energy expenditure that relates to adults with an intellectual disability.

The purpose of this project is to determine the amount of energy adults with an intellectual disability use during common activities of daily life (sitting, standing, walking and jogging).
The project will require participants to take part in the following activities:

1. **Visit to the doctor.** Participants will be required to visit their medical doctor and obtain a letter indicating they are able to participate in this project. A doctor's letter is a necessary procedure to ensure each participant is able to safely and comfortably complete the activities included in the project. The visit to the doctor will be paid for by the project.

2. **Measurement of energy expenditure.** Participants will be asked to complete tasks while sitting and standing, walk slowly, walk quickly and jog on a motorised treadmill. During each of these activities the participant will wear a face-mask that fits comfortably over the nose and mouth. The face-mask is fitted to a tube that transports the air each participant breathes out to a machine for analysis. Each participant will wear a chest belt and wrist receiver in order to measure heart rate.

3. **Measurement of height and weight.** A wall mounted height ruler and bathroom-like scales will be used. So as to avoid embarrassment, a person with whom each participant is comfortable will measure weight in private.

We have identified some important issues associated with this project that we will do to ensure the safety and comfort of participants. How we intend to address these issues has been considered and approved by the RMIT Human Research Ethics Committee.

- **Vulnerability.** Adults with an intellectual disability are considered to be a vulnerable population. To ensure that participants understand the activities involved in this project and feel comfortable about undertaking them we will:

  a) talk with each participant to explain the activities they would do during the project;
  b) show participants a video that would allow them to see the activities they would do during the project, the equipment they would use and their visit to RMIT University at Bundoora;
  c) allow each participant to practice several times the activities involved in the project;
  d) both before and during the project, tell participants that they do not have to complete any part of the project if they do not wish to;
e) tell participants that their care giver, guardian and/or support person is welcome to accompany them when they undertake activities at RMIT University. Where someone is unable to accompany the participant, a contact phone number will be obtained from the participants care giver, guardian or support person.

- **Measurement of energy expenditure.** Participants will be required to obtain a letter from their doctor stating they are able to safely participate in the project. Each potential participant will be given a letter to take to his or her medical doctor. The cost of the doctor’s visit will be paid by the project. The activities each participant will do (sitting, standing, walking and jogging) are activities commonly engaged in by adults with an intellectual disability during their activities of daily living. When testing occurs a person with a current first aid qualification will be in attendance. A mobile phone and list of emergency service phone numbers will be available each time an energy expenditure test is conducted.

- **Sensitivity.** Participants height and weight will be measured. Some participants may be sensitive about their weight. Therefore, participant’s weight will be measured in private and, if appropriate, the measurement of weight will be conducted by a person with whom the participant is comfortable.

- **Electricity.** The chest belt and wrist receiver are powered by a small watch-like battery that is safe. Participants walk/jog on a motorised treadmill that is well maintained and safe.

- **Comfort.** The energy expenditure tests may cause some minor discomfort. During the test they may begin to feel tired, sweat or become puffed out. Additionally, wearing of the face-mask or chest belt may be mildly uncomfortable. Each participant will complete a number of familiarisation trials. This will help participants to become familiar and comfortable with the equipment and procedures. The process is designed to reduce any anxiety the participant may feel and build their confidence in using the equipment.

- **Dependency.** Participants will be regularly reminded that they do not have to undertake any task involved in the project that they do not wish to.

- **Confidentiality.** Participant information will be securely stored. Reports, in any form will not identify participants.

Participants have the right to withdraw from the project at any time or have any information collected during the project that has not been processed withdrawn. All information collected during the project will be treated as confidential. No participant will be identified in any publications or presentations that may arise from the work.
If you have any questions or concerns about any aspect of the project please do not hesitate to contact Associate Professor Jeff Walkley on 9925-7359 or Dr Viviene Temple on 9925-7677.

Yours sincerely,

Ms. Kerrie Simmons            Associate Professor Jeff Walkley            Dr. Viviene Temple

Please detach and return in the reply paid envelope.

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I …………………………………………. do not object to …………………………………………. of
(insert your name) (insert potential participants name)
……………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
being approached so that he/she
(insert potential participants address)
may consider whether they would like to be involved in the project entitled “Energy expended during daily activities by adults with an intellectual disability.”

Signature: ………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
Date: …………………………………………. ………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

I …………………………………………. object to …………………………………………. of
(insert your name) (insert potential participants name)
…………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
being approached so that he/she
(insert potential participants address)
may consider whether they would like to be involved in the project entitled “Energy expended during daily activities by adults with an intellectual disability.”

Signature: …………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
Date: …………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………
Appendix 2: Plain language statement for adult with an intellectual disability
Plain Language Statement.

(To be given to each potential participant with an intellectual disability)

Dear…………………………

My name is Kerrie Simmons and I am studying at RMIT University. This letter is to ask you to think about becoming involved in a project. It will look at what happens to your breathing when you do different things when you are sitting down, standing up, walking or jogging. The project will need you to visit RMIT University in Bundoora.

There are some important things you need to know before you decide if you want to be involved in the project.

The project will let us see what happens to your breathing when you do different things. Things that you do everyday like watching TV, standing, walking and jogging. This will help us to find out what happens to your breathing when you take part in physical activity. This will let us see how we can help you and other people like you to become healthy.

If you decide that you want to take part in the project, you would do a number of things.

1. **Visit your doctor.** You need to get a letter from your doctor to say if it is OK for you to take part in the project. The letter from your doctor is important because it will tell us if you are able to take part safely in this project. You don't have to pay for the visit to your doctor; we will pay for you.
2. **Video.** We have made a video for you to watch. It will show you the things you would do if you want to take part in the project.

3. **Measure height and weight.** You will have your height and weight measured. If you don’t want us to measure your height or weight, we can let you choose someone to measure your height and weight for us.

4. **Measurement of energy expenditure.** You will do a test where you walk on a machine called a treadmill. When you walk on the machine you get to breathe through a mask and wear a special belt. The belt goes around your chest. You may start to feel tired and get hot and sweaty. You also get to do some activities when you are sitting down, like watching T.V. When you do this you get to wear the mask and special belt again.

5. **Privacy.** When you do all these activities we write down what happens. Anything we write down about what you do will be kept secret.

If you don’t want to take part in the project that is alright. If you decide to take part and we ask you to do something that you don’t want to, tell us. You don’t have to do something you don’t want to.

Yours Sincerely,

Ms. Kerrie Simmons        Associate Professor Jeff Walkley        Dr. Viviene Temple
Appendix 3: Medical clearance
Dear Doctor,

Accompanying this letter is a request for you to complete a Pre-Exercise Medical Clearance Form. As this request is part of a research project being undertaken for a Ph.D Degree at RMIT University, payment for this service is able to be made from funds set aside for this project. As such, I would be grateful if you could invoice us for the service. RMIT has a policy of payment within 31 days of receipt of an invoice. Please address the invoice to:

Associate Professor Jeff Walkley

Division of Exercise Sciences

School of Medical Sciences

RMIT University

Bundoora 3083.

Yours Sincerely,

Jeff Walkley, Ph.D

Associate Professor
Dear Doctor,

……………………………………… has expressed an interest in becoming involved in a study that aims to determine the energy expended during common activities of daily living among adults with an intellectual disability.

The project is being undertaken for the research component of a Ph. D Degree. The degree is being undertaken at RMIT University under the supervision of Associate Professor Jeff Walkley and Dr Viviene Temple. In the interests of promoting the comfort and safety of participants involved in the program, I am writing to you to seek your considered opinion on whether there exists any medical reasons that would prevent ………………… from participating. The activities involved in the program include:

**Measures:** Energy expenditure will be estimated through indirect calorimetry. While (1) sitting quietly; (2) sitting watching television; (3) sitting while completing a simulated assembly task (packing blocks into a box); (4) standing while completing a simulated assembly task; (5) walking slowly (30 meters per minute); (6) walking quickly (60 meters per minute) and (7) jogging (100 meters per minute participants will wear a face-mask that fits securely over their nose and which is attached via thin tubing to a calibrated MedGraphics Metabolic Measurement Cart (MedGraphics Cardiorespiratory Diagnostics Systems, St. Paul, MN, USA). The walking and jogging activities involve participants using a motorised treadmill. Expired air will be analysed for carbon dioxide (CO\textsubscript{2}), oxygen (O\textsubscript{2}) and volume expired. During all trials, participant's heart rate (HR) will be measured and stored every 5 seconds using a Polar Sports Tester (Polar Electro OY, Kempele, Finalnd). The Polar Sports Tester consists of an electrode belt that is worn around the chest, a transmitter, and a wrist mounted receiver, which records the HR at predetermined intervals (5 s). Participant height and weight will be measured using calibrated digital scales and a wall mounted stadiometer.

**Procedures:** Before testing, participants will undergo a familiarisation process in order to promote participant comfort and compliance with procedures. A video will be shown to
participants depicting a person visiting RMIT University (Bundoora Campus) and undertaking the energy expenditure procedures. Additionally, each participant will engage in a number of familiarisation trials at RMIT University (Bundoora Campus) using the treadmill, wearing a face-mask and a Polar Sports Tester. Familiarisation trials will continue until each participant is confident and can comfortably complete the procedures. Participants will undertake each activity for 7 minutes and during the last 2 minutes expired air will be collected for analysis. The treadmill activities will be stopped if a participant reaches any of (1) volitional fatigue, (2) a respiratory exchange ratio greater than 1.1 (RER > 1.1), (3) a heart rate within 10% of the predicted maximum heart rate, or (4) is unable to maintain the walking/jogging cadence to remain in the centre of the treadmill. A person with a current first aid qualification will be in attendance during the test. A mobile phone and list of emergency service phone numbers will be available each time a test is conducted.

I would be grateful if you could complete the section below and ask ………………………… to return this letter to me. Please contact Associate Professor Jeff Walkley on 9925-7359 or Dr Viviene Temple on 9925-7677 should further information be required.

Having considered the activities involved in the study investigating the energy expenditure of people with an intellectual disability explained herein, and in light of __________________________________ medical condition, I hereby authorise __________________________________ participation.

Doctor’s Signature:………………………………………… Telephone: ………………………………

Please print name: …………………………………………

Date:   …………………………………………..

Yours sincerely,

Ms. Kerrie Simmons                  Associate Professor Jeff Walkley            Dr. Viviene Temple
Appendix 4: Consent form
Consent Form

Division of Exercise Sciences

School of Medical Sciences

Name of participant:

Project Title: Energy expended during daily activities by adults with an intellectual disability.

Name(s) of investigator(s):

Miss Kerrie Simmons                     Phone: 9925 7670
Associate Professor Jeff Walkley       Phone: 9925 7677
Dr. Viviene Temple                    Phone: 9925 7309

1. I have received a statement explaining the tests/procedures involved in this project.

2. I consent to participate in the above project, the particulars of which - including details of tests or procedures - have been explained to me.

3. I authorise the investigator or his or her assistant to use with me the tests or procedures referred to in 1 above.
4. I acknowledge that:

(a) The possible effects of the tests or procedures have been explained to me to my satisfaction.

(b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.

(c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.

(d) The confidentiality of the information I provide will be safeguarded. However should information of a confidential nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.

(e) The security of the research data is assured 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 to <specify as appropriate>. Any information which will identify me will not be used.

Participant’s Consent

Signature: ……………………………………. Date: ……………………. 

(Participant)

Signature: …………………………………….. Date: ……………………..

(Witness to signature)
OR: Where participant has a legal guardian:

I consent to the participation of ………………………………………………………….in the above project.

Signature:……………………………… Signature: ………………………………. Date:
…………………….

(Signatures of parents or guardians)

Signature: ………………………………….. Date: …………………….

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.
Appendix 5: Sample of recruitment materials for adults without an intellectual disability
Advertisement placed in the Community Health & Welfare Volunteer Register in the Herald Sun, Victorian daily newspaper.

**RMIT**

Volunteers required for project at RMIT (Bundoora Campus) investigating the amount of energy adults’ use during normal daily activities (sitting, standing, walking). Predominantly (but not only) males in mid 20’s required. Females 18 – 50yrs also required. Volunteers need to have exercised **NO MORE THAN** 2 times per week in the last 6 months. Volunteers will receive **2 FREE MOVIE TICKETS**. Inquiries: Kerrie on 0408 501 484; email: kerries@vegas.com.au
HELP NEEDED
FROM ADULTS WITH AN INTELLECTUAL DISABILITY

Find out how much energy you expend when

- Sitting
- Standing
- Walking

How?
Come and visit us here at RMIT, Bundoora.
Have fun watching TV, making candles and walking.
Enjoy a great breakfast with us.

AND FOR YOUR HELP YOU WILL GET 2 FREE MOVIE TICKETS

FOR FURTHER INFORMATION CONTACT
Kerrie on 0408 501 484 or kerries@vegas.com.au
Appendix 6: Plain language statement for adults without an intellectual disability
Dear……………………………..

My name is Kerrie Simmons. I am undertaking my postgraduate studies at RMIT University, under the supervision of Associate Professor Jeff Walkley and Dr Viviene Temple. This letter is to invite you to participate in a project which aims to determine the amount of energy adults with an intellectual disability use during common activities of daily life in comparison to people without an intellectual disability.

**Project title:** Energy expended during daily activities by adults with an intellectual disability.

**Background:**

Physical activity has an important influence on health. However, there is little direct evidence available regarding the physical activity behaviour of people with an intellectual disability. Without any knowledge of the physical activity behaviour of people with an intellectual disability, it is difficult to determine whether any public health campaigns need to be directed toward this group. Research suggests that current information used to calculate the energy expended through physical activity among the general population is inappropriate for use with people with an intellectual disability. Therefore, to gain reliable and valid information about energy expenditure that relates to people with an intellectual disability. This same information also needs to be collected from a comparison group, people without an intellectual disability.
The purpose of this project is to determine the amount of energy adults with an intellectual disability use during common activities of daily life (sitting, standing, walking and jogging).

**The project will require you to take part in the following activities:**

1. **Complete a physical activity readiness questionnaire.** This questionnaire is to be completed prior to your participation in the study. If the questionnaire reveals you have a risk factor that may effect participation in physical activity you will be asked to gain a medical clearance prior to inclusion in the study. If you fall within this category you will be required to visit your medical doctor and obtain a letter indicating they are able to participate in this project. This visit will be paid for by the project. This letter is a necessary safety procedure to ensure you are able to safely complete the activities included in the project.

2. **Measurement of energy expenditure.** You will be asked to complete a series of activities. These involve walking slowly, walking quickly and jogging on a motorised treadmill. We also require you to complete tasks while sitting and standing. During each of these activities you will wear a mask that fits comfortably over your nose and mouth. The mask is fitted to a tube, which transports the air each participant breathes out to a machine for analysis. Each participant will wear a chest belt and wrist receiver in order to measure heart rate.

3. **Measurement of height and weight.** A wall mounted height ruler and bathroom-like scales will be used. So as to avoid any embarrassment we will measure your weight in private.

We have identified some important issues associated with this project that must be addressed to ensure the safety and comfort of participants. How we intend to address these issues has been considered and approved by the RMIT Human Research Ethics Committee.

- **Familiarisation process.** In order to promote your comfort we ask that you undergo a familiarisation process. This will involve seeing what you will be required to do and the equipment that will be used during the project. You would be given the opportunity to practice the activities involved in the project.

- **Measurement of energy expenditure.** We require you to complete a physical activity readiness questionnaire. From this we will establish if it is necessary for you to obtain a medical clearance from your doctor before participating. This clearance will state that
you are able to safely participate in the project. If a medical clearance is necessary you will be given a letter to take to your medical doctor (See attached). The activities you will be asked to do (sitting, standing, walking and jogging) are activities you would engage in daily. Please note that when testing occurs a person with a current first aid qualification will be in attendance.

- **Sensitivity.** Your height and weight will be measured in private.

- **Electricity.** The chest belt and wrist receiver are powered by a small watch like battery that is safe.

- **Comfort.** The energy expenditure tests may cause some minor discomfort. Additionally, wearing of the mask or chest belt may be mildly uncomfortable. To assist you in becoming familiar and comfortable with the equipment and procedures you will be asked to undergo a familiarisation process. This will assist in reducing any anxiety you may feel and will enable you to build your confidence in using the equipment.

- **Confidentiality.** Participant information will be securely stored. Reports, in any form, based on participant data will not identify participants.

Participants have the right to withdraw from the project at any time or have any information collected during the project that has not been processed withdrawn. All information collected during the project will be treated as confidential. No participant will be identified in any publications or presentations that may arise from the work.

If at any time you wish to discuss any aspect of this project please do not hesitate to contact Associate Professor Jeff Walkley on 9925-7359 or Dr Viviene Temple on 9925-7677.

Yours sincerely,

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Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.
Appendix 7: Physical Activity Readiness Questionnaire
Physical Activity Readiness Questionnaire*

Please read each question carefully. Answer each question YES or NO

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. &quot;Has your doctor ever said that you have a heart condition AND that you should only do physical activity recommended by a doctor?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. &quot;Do you feel pain in your chest when you do physical activity?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. &quot;In the past month, have you had chest pain when you were not doing physical activity?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. &quot;Do you lose your balance because of dizziness or do you ever lose consciousness?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. &quot;Do you have a bone or joint problem that could be made worse by a change in your physical activity?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. &quot;Is your doctor currently prescribing drugs for your blood pressure or heart condition?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. &quot;Do you know of ANY OTHER REASON why you should not do physical activity?&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Return this questionnaire to a project investigator. If you have answered YES to one or more of the questions, your project investigator will ask you to consult your medical practitioner BEFORE participating in the energy expenditure research project.

Signature: ___________________________ Date: _______________  

(Participant)

Signature: ___________________________ Date: _______________  

(Project Investigator)

Appendix 8: Participant plain language statement
Plain Language Statement
Version 1 Dated December 1, 2001

Full Project Title: Development of a proxy response instrument to measure the physical activity behaviour of Adults with an Intellectual Disability.

Principal Researcher: Ms. Kerrie Simmons

Associate Researcher(s): Associate Professor Jeff Walkley
Dr. Viviene Temple

This Plain Language Statement and all relevant documentation is _____ pages long. Please make sure you have all the pages.

1. Your Consent

You are invited to take part in this research project.

I am undertaking my postgraduate studies at RMIT University, under the supervision of Associate Professor Jeff Walkley and Dr Viviene Temple. This research project is part of the requirements for my postgraduate studies.

This Plain Language Statement contains detailed information about the research project. 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 Plain Language Statement carefully. Feel free to ask questions about any information in the Statement. You may also wish to discuss the project with a relative or friend or your local health worker.

Once you understand what the project is about and if you agree to take part, you will be asked to sign a Consent Form. By signing the Consent Form you indicate that you understand the information about the project and that you give your consent to participate in the research project.

You will be given a copy of both the Consent Form and this Plain Language Statement to keep as a record.

2. Description of the Project

The purpose of this project is to develop a proxy response telephone survey to measure the physical activity behaviours of adults with an intellectual disability.

A total of 44 people with an intellectual disability and 88 proxy respondents will participate in this project.

This project will help us learn more about the physical activity behaviour of adults with an intellectual disability and how to evaluate the effect of programs that promote participation in physical activity.

You have been invited to participate in this research project because your physical activity behaviour, along with that of others who participate in the project, will help us learn more about the physical activity behaviour of adults with an intellectual disability.

Participation in this project will require the adult with an intellectual disability to wear an accelerometer for a 7-day period (from waking to sleep) while partaking in their normal daily activities. Accelerometers are small, battery operated, lightweight self-contained monitors, which measure movement. They are worn at waist level in a pouch, which is much like a bum-bag. You can see a picture of this here.

Two other people (one from the individuals community residential unit and one from their day placement) who know the individual well will also be asked to take part in the project. They will be asked if they are
willing to act as a proxy respondent on behalf of the person with an intellectual disability. Proxy respondents must have known the adult with an intellectual disability for at least 3-6 months. Furthermore, they must have regular contact with the individual. If the adult with an intellectual disability decides to partake in the project we will, in consultation with the participant and their carer establish who may be a suitable proxy respondent. We will then approach them by means of an information letter.

Proxy respondents will be required to complete a 30-minute telephone interview based questionnaire. The questionnaire requires proxy respondents to respond to questions as best they can on the physical activity behaviours of the adult with an intellectual disability.

3. Possible Benefits

As an individual participating in this project you will not receive any immediate benefit. It is the population of adults with an intellectual disability, as a whole that will gain benefits from this project.

Clear evidence tells us that regular participation in moderate-intensity physical activity promotes health. Public health campaigns aimed at promoting participation in moderate-intensity physical activity require evaluation so that its effectiveness can be determined and the appropriate steps taken to improve services and facilities. Effectiveness of such campaigns for adults with an intellectual disability is currently unable to be determined because no measurement tool exists. This project will develop a cost effective measurement tool so that this may occur.

4. Possible Risks

Possible risks, side effects and discomforts resulting from the project and action to be taken to minimise these include

- Vulnerability

Adults with an intellectual disability (AWID) are a vulnerable population. Participants will be provided with a briefing session during which the project, procedures and tasks will be explained. Participants and their care givers will be informed that participants are free to withdraw from the project at any time, and to have any unprocessed data withdrawn, without
penalty or loss of privilege. Home visits will also occur so that the AWID may become comfortable with the investigator/s and talk to us about the project. During this visit they will also be shown and have an opportunity to put the accelerometers they will be asked to wear on. As the project revolves around the daily activities of the AWID, it is anticipated that the individual will not be placed in any vulnerable situation.

- Dependency

Participants will be reminded regularly that they do not have to undertake any task involved in the project they do not wish to.

5. Confidentiality and Disclosure of Information

Any information obtained in connection with this project and that can identify you will remain confidential. It will only be disclosed with your permission, except as required by law. If you give us your permission by signing the Consent Form, we plan to use the results of this project to inform others, including researchers, administrators, direct care workers and University students, through publications and presentations.

In any presentation or publication, information will be provided in such a way that you cannot be identified. All data will be aggregated and reported as group data or, where appropriate, as a case number.

6. New Information Arising During the Project

During the research project, new information about the risks and benefits of the project may become known to the researchers. If this occurs, you will be told about this new information. This new information may mean that you can no longer participate in this research. If this occurs, the person(s) supervising the research will stop your participation. In all cases, you will be offered all available care to suit your needs and medical condition.

7. Results of Project

A report of the project outcomes will be made available to participants. This report will consist of meaningful group data and will not identify any individual
8. Further Information or Any Problems

If you require further information or if you have any problems concerning this project (for example, any side effects), you can contact the principal researcher or Associate Professor Jeff Walkley. The researchers responsible for this project are Ms. Kerrie Simmons (9925-7670), Associate Professor Jeff Walkley (9925-7359) and Dr. Viviene Temple (9925-7677).

9. Other Issues

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact

Name: Dr Harry Majewski
Position: Professor & Head of School
Telephone: (03) 9925 7075

You will need to tell Professor Majewski the name of one of the researchers given in section 8 above.

10. Participation is Voluntary

Participation in any research project is voluntary. If you do not wish to take part you are not obliged to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage.

Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your routine treatment, your relationship with those treating you or your relationship with the Department of Human Services or RMIT.

Before you make your decision, a member of the research team will be available so that you can ask any questions you have about the research project. You can ask for any information you want. Sign the Consent Form only after you have had a chance to ask your questions and have received satisfactory answers.
If you decide to withdraw from this project, please notify a member of the research team before you withdraw. This notice will allow that person or the research supervisor to inform you if there are any health risks or special requirements linked to withdrawing.

It would be appreciated if you could complete the expression of interest form and return it in the enclosed self-addressed, postage paid envelope. By completing this form we will know who does and does not wish to participate in the project. If you would like to participate in the project (indicated by the response on the expression of interest form) we will then contact you to discuss the next step of the project.

11. Ethical Guidelines

This project will be carried out according to the National Statement on Ethical Conduct in Research Involving Humans (June 1999) 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 Department of Human Services and RMIT Human Research Ethics Committees.

Thanking you for your time,

Yours Sincerely

Kerrie Simmons.
EXPRESSION OF INTEREST FORM

PLEASE COMPLETE AND RETURN IN THE ENCLOSED ENVELOPE

Having considered the above information I ………………………………………………… am
(insert your full name)

happy / unhappy for …………………………………………………… to participate
(please circle appropriate response) (insert potential participant’s name)

in the project entitled “Development of a proxy response instrument to measure the physical activity
behaviour of Adults with an Intellectual Disability.”

If you do not wish to take part in the project you do not need to provide contact details
but please return this form with the above section completed.

If you are happy to take part in this project please continue by completing the following
contact details and return it in the enclosed envelope.

CONTACT DETAILS (PLEASE PRINT)

Participants full name …………………………………………………
Participants address …………………………………………………
………………………………………………
Contact person …………………………………………………
     Phone …………………………………………………
Relationship to participant …………………………………………………
Address to send correspondence to …………………………………………………
………………………………………………
Appendix 9: Participant and proxy respondent consent forms
CONSENT FORM

Consent Form
Version 1 Dated December 1, 2001

Full Project Title: Development of a proxy response instrument to measure the physical activity behaviour of Adults with an Intellectual Disability.

I have read, or have had read to me in my first language, and I understand the Plain Language Statement version1 dated December 1, 2001.

I freely agree to participate in this project according to the conditions in the Plain Language Statement.

I have a copy of the Plain Language Statement and the Consent Form to keep.

The researcher has agreed not to reveal my identity and personal details if information about this project is published or presented in any public form.

Participant’s Name (printed) ……………………………………………………………………

Signature and Date

Witness to Signature (printed) …………………………………………………………………

Signature and Date

Researcher’s Name (printed) …………………………………………………………………

Signature and Date

Note: All parties signing the Consent Form must date their own signature.
THIRD PARTY CONSENT FORM
(To be used for participants who cannot consent for themselves.)

Consent Form
Version 1 Dated December 1, 2001

Full Project Title: Development of a proxy response instrument to measure the physical activity behaviour of Adults with an Intellectual Disability.

I have read, or have had read to me in my first language, and I understand the Plain Language Statement Version 1 Dated December 1, 2001

I give my permission for ………………………………………………… to participate in this project according to the conditions in the Plain Language Statement.

I have a copy of the Plain Language Statement and the Consent Form to keep.

The researcher has agreed not to reveal the participant’s identity and personal details if information about this project is published or presented in any public form.

Participant’s Name (printed) ……………………………………………………

Name of Person giving Consent (printed) ……………………………………………………

Category (strike out that which is not applicable):

- Next of Kin
- Agent under the Medical Treatment Act 1986
- Guardian under the Guardianship and Administration Act.

Signature and Date

Researcher’s Name (printed) ……………………………………………………

Signature and Date

Note: All parties signing the Consent Form must date their own signature.
Appendix 10: Proxy respondent plain language statement
Plain Language Statement
Version 1 Dated December 1, 2001

Full Project Title: Development of a proxy response instrument to measure the physical activity behaviour of Adults with an Intellectual Disability.

Principal Researcher: Ms. Kerrie Simmons

Associate Researcher(s): Associate Professor Jeff Walkley
Dr. Viviene Temple

This Plain Language Statement and all relevant documentation is _____ pages long. Please make sure you have all the pages.

1. Your Consent

This letter is to inform you that …………………………………… has decided to participate in a project that aims to develop a simple, low cost telephone survey of physical activity behaviour. For …………………………… to partake in the project they must have two people (one from their home and one from their day placement) who know them well and are willing to act as a proxy respondent on their behalf.

We invite you to take part in this research project by acting as a proxy respondent for ……………………………
I am undertaking my postgraduate studies at RMIT University, under the supervision of Associate Professor Jeff Walkley and Dr Viviene Temple. This research project is part of the requirements for my postgraduate studies.

This Plain Language Statement contains detailed information about the research project. 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 Plain Language Statement carefully. Feel free to ask questions about any information in the Statement. You may also wish to discuss the project with a relative or friend.

Once you understand what the project is about and if you agree to take part, you will be asked to sign a Consent Form. By signing the Consent Form you indicate that you understand the information about the project and that you give your consent to participate in the research project.

You will be given a copy of both the Consent Form and this Plain Language Statement to keep as a record.

2. Description of the Project

The purpose of this project is to develop a proxy response telephone survey to measure the physical activity behaviours of adults with an intellectual disability.

A total of 44 people with an intellectual disability and 88 proxy respondents will participate in this project.

This project will help us learn more about the physical activity behaviour of adults with an intellectual disability and how to evaluate the effect of programs that promote participation in physical activity.

You have been invited to participate in this research project because after discussion with the participant and family/carers it is believed that you would be the most appropriate person that
works with ………………………… to be able to respond to the questionnaire you will be asked to complete.

Proxy respondents must have known the adult with an intellectual disability for at least 3-6 months. Furthermore, they must have regular contact with the individual. As a proxy respondent you will be required to complete a 30-minute telephone interview based questionnaire. The questionnaire requires you to respond to questions as best you can on the physical activity behaviours of the adult with an intellectual disability that you are acting as proxy for.

Participation in this project will require the adult with an intellectual disability to wear an accelerometer for a 7-day period (from waking to sleep) while partaking in their normal daily activities. Accelerometers are small, battery operated, lightweight self-contained monitors, which measure movement. They are worn at waist level in a pouch, which is much like a bum-bag.

3. Possible Benefits

Proxy respondents will not receive any individual benefits as a result of their participation in the project.

It is the population of adults with an intellectual disability, as a whole that will gain benefits from this project.

Clear evidence tells us that regular participation in moderate-intensity physical activity promotes health. Public health campaigns aimed at promoting participation in moderate-intensity physical activity require evaluation so that its effectiveness can be determined and the appropriate steps taken to improve services and facilities. Effectiveness of such campaigns for adults with an intellectual disability is currently unable to be determined because no measurement tool exists. This project will develop a cost effective measurement tool so that this may occur.
4. Possible Risks

Proxy respondents should experience no risks, side effects or discomforts as a result of participating in the project.

All participants have the right to withdraw from the project at any time or have any information collected during the project that has not been processed withdrawn. All information collected during the project will be treated as confidential. No participant will be identified in any publications or presentations that may arise from the work.

5. Confidentiality and Disclosure of Information

Any information obtained in connection with this project and that can identify you will remain confidential. It will only be disclosed with your permission, except as required by law. If you give us your permission by signing the Consent Form, we plan to use the results of this project to inform others, including researchers, administrators, direct care workers and University students, through publications and presentations.

In any presentation or publication, information will be provided in such a way that you cannot be identified. All data will be aggregated and reported as group data or, where appropriate, as a case number.

6. New Information Arising During the Project

During the research project, new information about the risks and benefits of the project may become known to the researchers. If this occurs, you will be told about this new information. This new information may mean that you can no longer participate in this research. If this occurs, the person(s) supervising the research will stop your participation. In all cases, you will be offered all available care to suit your needs and medical condition.

7. Results of Project

A report of the project outcomes will be made available to participants. This report will consist of meaningful group data and will not identify any individual.
8. Further Information or Any Problems

If you require further information or if you have any problems concerning this project (for example, any side effects), you can contact the principal researcher or Associate Professor Jeff Walkley. The researchers responsible for this project are Ms. Kerrie Simmons (9925-7670), Associate Professor Jeff Walkley (9925-7359) and Dr. Viviene Temple (9925-7677).

9. Other Issues

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact

Name: Dr Harry Majewski

Position: Professor & Head of School

Telephone: (03) 9925 7075

You will need to tell Professor Majewski the name of one of the researchers given in section 8 above.

10. Participation is Voluntary

Participation in any research project is voluntary. If you do not wish to take part you are not obliged to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage.

Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your routine treatment, your relationship with those treating you or your relationship with the Department of Human Services or RMIT.

Before you make your decision, a member of the research team will be available so that you can ask any questions you have about the research project. You can ask for any information you want. Sign the Consent Form only after you have had a chance to ask your questions and have received satisfactory answers.
If you decide to withdraw from this project, please notify a member of the research team before you withdraw. This notice will allow that person or the research supervisor to inform you if there are any health risks or special requirements linked to withdrawing.

It would be appreciated if you could complete the expression of interest form and return it in the enclosed self-addressed, postage paid envelope. By completing this form we will know who does and does not wish to participate in the project. If you would like to participate in the project (indicated by the response on the expression of interest form) we will then contact you to discuss the next step of the project.

11. Ethical Guidelines

This project will be carried out according to the National Statement on Ethical Conduct in Research Involving Humans (June 1999) 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 Department of Human Services and RMIT Human Research Ethics Committees.

Thanking you for your time,

Yours Sincerely

Kerrie Simmons.
Having considered the above information I .............................................. am
(insert your full name)
happy / unhappy to act as a proxy respondent for .................................
(please circle appropriate response) (insert individual’s name)
in the project entitled “Development of a proxy response instrument to measure the physical activity
behaviour of Adults with an Intellectual Disability.”

If you do not wish to take part in the project you do not need to provide contact details
but please return this form with the above section completed.

If you are happy to be a proxy respondent and complete the telephone survey please
continue by completing the following contact details and return it in the enclosed
envelope.

CONTACT DETAILS (PLEASE PRINT)
Proxy respondents full name ...........................................................
Proxy respondents workplace address ...............................................
Phone ..........................................................................................
Name of person you are acting as proxy for ....................................
Relationship to this person ..........................................................
How long have you known this person ............................................
Appendix 11: The International Physical Activity Questionnaire – Intellectual Disability
IPAQ-ID QUESTIONNAIRE COVER SHEET

Date completed: __________________________ Original / Test-Retest

Proxy for: _________________________________

Proxy Details

Name: _________________________________ Home / CRU / Day Placement

Number years known <insert name> ______ years ______ months

In the past week that this questionnaire related to how many hours were you with <insert name>?

Does this include any sleepovers? YES / NO

If yes, how many? ________________

Is this past week typical of most weeks? YES / NO

If no, what is typical ________________

____________________________________________________________________________

____________________________________________________________________________

WEIGHT ________________
We are interested in the physical activities that adults with an intellectual disability do as part of their everyday lives. Your answers will help us to understand how active adults with an intellectual disability are.

I am going to ask you about the time <insert name> spent doing everyday activities in the last 7 days. I will ask you questions about day placement, transport, housework and recreation. I will ask you about the activities that were vigorous or that required moderate physical effort for <insert name> to do. Please answer each question to the best of your knowledge. If you think you are unable to answer a question please indicate this by responding that you don’t know.

PART 1: DAY PLACEMENT PHYSICAL ACTIVITY

The first questions are about the everyday physical activities <insert name> did at his/her day placement. This includes day program activities and supported employment, learning programs or any other paid or unpaid work that <insert name> did AWAY FROM the home.

1a Does <insert name> currently attend a day placement?
Yes  [go to Question 1b]    If yes:  Part time ( ____ days per week)    or    Full time

No  [skip to Question 2a]

Refused    Don’t know

[Interviewer clarification: This does not include work or chores <insert name> might assist with around the home. This will be asked in a later section]

1b  First, think about all the vigorous activities which take hard physical effort that <insert name> did at his/her day placement. This does NOT include travelling to and from day placement.

Vigorous activities make you breathe MUCH HARDER than normal. These may include things like heavy lifting, digging, shovelling soil, or climbing up several stairs. Think about only those VIGOROUS physical activities that <insert name> did for at least 10 minutes at a time.

During the last 7 days, on how many days did <insert name> do vigorous physical activities at his/her day placement?

_________ days per week  [If answers zero, skip to Question 1d]

Refused  [Skip to Question 1d]    Don’t know  [Skip to Question 1d]

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer: day placement includes day program activities and supported employment, learning programs or any other sought of work, paid or unpaid that <insert name> did outside the home.]

lc  How much time in total does <insert name> usually spend on ONE of those days doing vigorous physical activities when at day placement?

______ hours _______ minutes
[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of activities at day placement ask:

“What is the total amount of time <insert name> spent over the last 7 days doing vigorous physical activities when at day placement?” _______ hours _______ minutes per week

1d Now think about activities which take moderate physical effort that <insert name> did at his/her day placement. Moderate physical activities make you breathe a LITTLE HARDER than normal and may include activities like carrying light loads, sweeping paths etc. Do NOT include walking. Again, think about only those MODERATE physical activities that <insert name> did for at least 10 minutes at a time.

During the last 7 days, on how many days did <insert name> do moderate physical activities when at day placement?

_______days per week [If answers zero, skip to Question 1f]

Refused [Skip to Question 1f] Don’t know [Skip to Question 1f]

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer: day placement includes day program activities and supported employment, learning programs or any other sought of work, paid or unpaid that <insert name> did outside the home.]

le How much time in total did <insert name> usually spend on ONE of those days doing moderate physical activities when at day placement?

___________hours ___________minutes
[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, or includes time spent doing a variety of activities at day placement ask:

What is the total amount of time <insert name> spent over the last 7 days doing moderate physical activities when at day placement? _____ hours _____ minutes per week]

If now think about the time <insert name> spends walking for at least 10 minutes at a time at his/her day placement. Please do NOT count any walking <insert name> did to travel to or from day placement.

During the last 7 days, on how many days did <insert name> walk when at day placement?

___________ days per week  [If answers zero, skip to Question 2a]

Refused       [Skip to Question 2a]    Don’t know    [Skip to Question 2a]

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]

[Interviewer: Include all activities <insert name> engages in when at day placement.]

lg How much time in total did <insert name> usually spend on ONE of those days walking when at day placement?

______________ hours ______________minutes

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer
because the pattern of time spent varies widely from day to day, or includes time doing a variety of activities at day placement, ask:

What is the total amount of time <insert name> spent walking over the last 7 days when at day placement? _________ hours ________ minutes per week

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

2a Now, think about how <insert name> travelled from place to place, including to places like his/her day placement, the shops, movies and so on.

During the last 7 days, on how many days did <insert name> travel in a motor vehicle like a train, bus, car or tram?

____________ days per week [If answers zero, skip to Question 2c]

Refused [Skip to Question 2c] Don't know [Skip to Question 2c]

2b How much time in total did <insert name> usually spend on ONE of those days travelling in a car, bus, train, tram or other kind of motor vehicle?

_______________ hours ____________ minutes

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days travelling in a motor vehicle? _________ hours _____________ minutes per week]

2c Does <insert name> ever ride a bike?

Yes

No [skip to Question 2e]
I want you to only think about the bike riding <insert name> did to travel to and from day placement, to run errands, or to go from place to place. Only include bike riding that <insert name> did for at least 10 minutes at a time.

During the last 7 days, on how many days did <insert name> ride a bike to go from place to place?

_________days per week [If answers 0, skip to Question 2e]

Refused [Skip to Question 2e] Don't know [Skip to Question 2e]

[Interviewer clarification: Think about only the bike riding that <insert name> did for at least 10 minutes at a time.]

2d How much time in total did <insert name> usually spend on ONE of those days riding a bike from place to place?

________________ hours ________________ minutes

[Interviewer clarification: Think about only the bicycling that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent bicycling over the last 7 days to travel from place to place? _______ hours ________ minutes per week]

2e Now think only about the walking <insert name> did to travel to and from day placement, to run errands or to go from place to place. Only include walking that <insert name> did for at least 10 minutes at a time
During the last 7 days, on how many days did <insert name> walk to go from place to place?

___________ days per week [If answers zero, skip to question 3a]

Refused [Skip to question 3a] Don't know [Skip to question 3a]

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]

2f How much time in total did <insert name> usually spend on ONE of those days walking from place to place?

___________ hours ___________ minutes

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days walking from place to place? ______ hours _______ minutes per week]

PART 3: HOUSEWORK / HOUSEMAINTENANCE / AND CARING FOR OTHERS

3a Now think about the physical activities <insert name> has done in the last 7 days in and around the home, like helping or assisting with housework, gardening, general maintenance work, and caring for others.

First, think about vigorous activities which take hard physical effort that <insert name> did in the garden or yard. Vigorous activities make one breathe MUCH HARDER than normal and may include heavy lifting, chopping wood, or digging. Again, think about only those vigorous physical activities that <insert name> did for at least 10 minutes at a time.
During the last 7 days, on how many days did <insert name> do vigorous physical activities in the garden or yard?

_______ days per week  [If answers zero, skip to question 3c]

Refused  [Skip to question 3c]  Don't know  [Skip to question 3c]

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

3b  How much time in total did <insert name> usually spend ONE of those days doing vigorous physical activities in the garden or yard?

_______ hours _________ minutes

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days doing vigorous physical activities in the garden or yard? _______ hours ______ minutes per week]

3c  Now think about activities which take moderate physical effort that <insert name> did in the garden or yard. Moderate activities make one breathe SOMewhat HARDER than normal and may include carrying light loads, mowing the lawns, weeding, raking, or sweeping. Again, include only those moderate physical activities that <insert name> did for at least 10 minutes at a time.

During the last 7 days, on how many days did <insert name> do moderate activities in the garden or yard?

_________days per week  [If answers zero, skip to question 3e]

Refused  [Skip to question 3e]  Don't know  [Skip to question 3e]
3d How much time in total did <insert name> usually spend on ONE of those days doing moderate physical activities in the garden or yard?

__________ hours ___________ minutes

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days doing moderate physical activities in the garden or yard? ________ hours ________ minutes per week]

3e Now think about activities which take MODERATE physical effort that <insert name> did inside the home. Examples include carrying light loads, washing windows, scrubbing floors, vacuuming, and sweeping. Include only those moderate physical activities that <insert name> did for at least 10 minutes at a time.

[Interviewer clarification: Moderate activities make one breathe somewhat harder than normal]

During the last 7 days, on how many days did <insert name> do moderate activities inside the home?

______________ days per week

[If answers zero, skip to question 4a]

Refused [Skip to question 4a] Don't know [Skip to question 4a]

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]
[Interviewer clarification: During the last 7 days, on how many days did <insert name> do activities that take moderate effort inside the home]

3f How much time in total did <insert name> usually spend on ONE of those days doing moderate physical activities inside the home?

__________ hours __________ minutes

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days doing moderate physical activities inside the home? ________ hours ________ minutes per week]

PART4: RECREATION SPORT EXERCISE AND LEISURE TIME PHYSICAL ACTIVITY

4a Now, think about all the physical activities that <insert name> did in the last 7 days solely for recreation, sport, exercise or leisure. Please do NOT include any activities you have already mentioned.

NOT counting any walking already mentioned, during the last 7 days, on how many days did <insert name> walk for at least 10 minutes at a time in his/her recreation, sport, exercise or leisure time?

______________ days per week [If answers zero, skip to question 4c]

Refused [Skip to question 4c] Don’t know [Skip to question 4c]

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]
4b How much time in total did <insert name> usually spend on ONE of those days walking in his/her recreation, sport, exercise or leisure time?

_________ hours ___________ minutes

[Interviewer clarification: Think about only the walking that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days walking in his/her recreation, sport, exercise or leisure time? _______ hours _______ minutes per week]

4c Now think about other physical activities <insert name> did in his/her leisure time for at least 10 minutes at a time.

First, think about vigorous activities which take HARD PHYSICAL EFFORT that <insert name> did in his/her leisure time. Examples include aerobics, playing a game of basketball, singles tennis or soccer, running, fast bicycling, or fast swimming.

During the last 7 days, on how many days did <insert name> do vigorous physical activities in his/her recreation, sport, exercise or leisure time?

_________ days per week [If answers zero, skip to question 4e]

Refused [Skip to question 4e] Don't know [Skip to question 4e]

[Interviewer clarification: Vigorous activities make one breathe much harder than normal]

[Interviewer clarification: Think about only those vigorous physical activities that <insert name> did for at least 10 minutes at a time.]

4d How much time in total did <insert name> usually spend on ONE of those days doing
vigorous physical activities in his/her recreation, sport, exercise or leisure time?

_________ hours __________ minutes

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent in the last 7 days doing vigorous physical activities in his/her leisure time? _______ hours ________ minutes per week

4e  Now think about activities which take moderate physical effort that <insert name> did in his/her leisure time. Examples include bicycling at a regular pace, swimming at a regular pace, and doubles tennis. Again, include only those moderate activities that <insert name> did for at least 10 minutes at a time.

During the last 7 days, on how many days did <insert name> do moderate physical activities in his/her leisure time?

___________days per week

[If answers zero, skip to question 5a]

Refused [Skip to question 5a]  Don't know [Skip to question 5a]

[Interviewer clarification: Moderate activities make one breathe somewhat harder than normal]

[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

4f  How much time in total did <insert name> usually spend on ONE of those days doing moderate physical activities in his/her leisure time?

___________ hours __________ minutes
[Interviewer clarification: Think about only those physical activities that <insert name> did for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask:

What is the total amount of time <insert name> spent over the last 7 days doing moderate physical activities in his/her leisure time?______hours _______ minutes per week]

PART5: TIME SPENT SITTING

5a The last set of questions are about the time that <insert name> spent sitting during the last 7 days.

Include time spent sitting at day placement, at home, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. DO NOT include any time spent sitting in a motor vehicle that you have already told me about.

How much time in total did <insert name> usually spend sitting on a WEEKDAY?

______________hours _________ minutes

[Interviewer clarification: Include time spent lying down (awake) as well as sitting]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent sitting varies widely from day to day, ask: How much time in total did <insert name> spend sitting on Wednesday? _____ hrs ____min]

5b During the last 7 days, how much time in total did <insert name> usually spend sitting on the WEEKEND?

__________hours _________ minutes
[Interviewer clarification: Include time spent lying down (awake) as well as sitting]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent sitting varies widely from day to day, ask:

How much time in total did <insert name> spend sitting on Saturday?

_________ hours ___________ minutes]

Thank you for taking the time to complete this telephone questionnaire. To test the reliability of this instrument we are looking for a number of proxy respondents who will be willing to complete this questionnaire, answering questions related to this same week in another 3 – 5 days. Are you willing to assist with this?

Yes / No

If yes: Suitable day & date ____________________________ Suitable time: _________

Ph: ____________________
Appendix 12: MTI Actigraph information sheet
WEARING OF MOTION SENSOR (ACTIGRAPH)

WEARING THE POUCH

- The pouch is to sit **SECURELY** on the **HIP**.
- The pouch is attached to an adjustable strap that goes around the waist. The strap is to be on **firmly** as the pouch is **NOT** to sag or move around freely.
- The piece of tape on the pouch should be facing up.
- Wear the motion sensor from **waking to sleep** every day. You do **NOT** wear it in bed.
- ONLY take the pouch off when participating in water based activities where it would get wet. I.e. swimming, or showering.
  
  **REMEMBER TO PLACE THE POUCH **FIRMLY BACK ON THE HIP** ONCE THIS ACTIVITY HAS FINISHED.**
- There are **no** problems with wearing the device during **any other** activities. I.e. aerobics, netball, basketball, football, reading, household chores and activities.
- If possible, wear the pouch under clothing during sporting activities.
- **If the pouch is taken off:** please make a note of the length of time it was off for and what activity the person was engaged in during this time.
  
  This information is to be passed back to the researcher.

**IF YOU HAVE ANY QUERIES, QUESTIONS OR CONCERNS**
**PLEASE CONTACT:**
Kerrie Simmons: 0408 501 484  Or  Jeff Walkley: 0407 345 525
Appendix 13: MET equation calculations
### Day Agency Domain

Walking MET-minutes/week at work = $3.3 \times$ walking minutes $\times$ walking days at day agency

Moderate MET-minutes/week at work = $4.0 \times$ moderate-intensity activity minutes $\times$ moderate-intensity days at day agency

Vigorous MET-minutes/week at work = $8.0 \times$ vigorous-intensity activity minutes $\times$ vigorous-intensity days at day agency

Total Work MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores at day agency

### Transportation Domain

Walking MET-minutes/week for transport = $3.3 \times$ walking minutes $\times$ walking days for transportation

Cycle MET-minutes/week for transport = $6.0 \times$ cycling minutes $\times$ cycle days for transportation

Total Transport MET-minutes/week = sum of Walking + Cycling MET-minutes/week scores for transportation

### Housework and Garden Domain

Vigorous MET-minutes/week garden chores = $5.5 \times$ vigorous-intensity activity minutes $\times$ vigorous-intensity days doing garden work

(Note: the MET value of 5.5 indicates that vigorous garden work should be considered a moderate-intensity activity for scoring and computing total moderate intensity activities)

Moderate MET-minutes/week garden chores = $4.0 \times$ moderate-intensity activity minutes $\times$ moderate intensity days doing yard work
Moderate MET-minutes/week housework chores = 3.0 * moderate-intensity activity minutes * moderate intensity days doing housework
Total Housework and Garden MET-minutes/week = sum of Vigorous garden + Moderate garden + Moderate housework MET-minutes/week scores

**Leisure Domain**
Leisure walking MET-minutes/week leisure = 3.3 * walking minutes * walking days in leisure

Moderate MET-minutes/week leisure = 4.0 * moderate-intensity activity minutes * moderate-intensity days in leisure

Vigorous MET-minutes/week leisure = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days in leisure

Total Leisure-Time MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores in leisure.

**Total Scores for all Walking, Moderate and Vigorous Physical Activities**

Total Walking MET-minutes/week = Walking MET-minutes/week (at Day agency + for Transport + in Leisure)

Total Moderate MET-minutes/week total = Moderate MET-minutes/week (at Day agency + Garden chores + housework chores + in Leisure time) + Cycling Met-minutes/week for Transport + Vigorous Garden chores MET-minutes/week

Total Vigorous MET-minutes/week = Vigorous MET-minutes/week (at Day agency + in Leisure)

**Note:** Cycling MET value and Vigorous garden work MET value fall within the coding range of moderate-intensity activities.

**Total Physical Activity Scores**

Total physical activity MET-minutes/week = sum of Total Day Agency + Total Transport + Total Housework and Garden + Total Leisure-Time MET-minutes/week scores.
Appendix 14: Reported reasons for atypical week
## Reasons reported by home proxy respondents as why it was not a typical week

<table>
<thead>
<tr>
<th>Ppt ID</th>
<th>Reason</th>
<th>Affect on activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Normally does ballroom dancing on Tuesday nights, didn't this week.</td>
<td>Less active</td>
</tr>
<tr>
<td>35</td>
<td>Usually plays netball on Thursday mornings, didn't this week</td>
<td>Less active</td>
</tr>
<tr>
<td>41</td>
<td>Went to watch a football match on Saturday so did more walking. Usually plays indoor cricket on Tuesdays, didn't this week. Walked instead though.</td>
<td>More active</td>
</tr>
<tr>
<td>43</td>
<td>Did not attend water aerobics on Wednesday. Went to a come and try netball on Friday evening.</td>
<td>No affect</td>
</tr>
<tr>
<td>59</td>
<td>Was more motivated to do things compared to usual. Started water aerobics this week</td>
<td>More active</td>
</tr>
<tr>
<td>61</td>
<td>Didn't play badminton, games or swim as normal due to school holidays</td>
<td>Less active</td>
</tr>
<tr>
<td>64</td>
<td>Did not attend swimming or netball this week however has been doing more walking lately.</td>
<td>No affect</td>
</tr>
<tr>
<td>65</td>
<td>Would normally go swimming but didn't this week.</td>
<td>Less active</td>
</tr>
<tr>
<td>74</td>
<td>Has been in a play the last 3 weeks so has not been at home at night due to rehearsal etc</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
## Reasons reported by day agency respondents as why it was not a typical week

<table>
<thead>
<tr>
<th>Ppt ID</th>
<th>Reason</th>
<th>Affect on activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>Played basketball on Friday due to change in program, wouldn't normally do this</td>
<td>More active</td>
</tr>
<tr>
<td>61</td>
<td>Didn't play badminton, games or swim as normal due to school holidays</td>
<td>Less active</td>
</tr>
<tr>
<td>63</td>
<td>Played cricket which wouldn't normally do.</td>
<td>More active</td>
</tr>
<tr>
<td>64</td>
<td>Slack week. Did not attend a lot of the normal programs due to school holidays interrupting programs</td>
<td>Less active</td>
</tr>
</tbody>
</table>