Perceived barriers, facilitators and patterns of physical activity of older old adults living in assisted retirement accommodation

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Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

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Acknowledgments

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ABSTRACT

There is little data on the physical activity and perceived barriers and facilitators of physical activity of the older old living in assisted care. Physical activity is known to play a key role in healthy ageing and people aged 85 years and older are the largest growing proportion of the population. This study aims to: Identify perceived barriers and facilitators to participating in physical activity for the older old living in assisted care accommodation compared to independent living; assess the relationship of place of residence (assisted care versus independent living) to self-reported and objectively measured physical activity levels and functional indicators (strength and balance); and to assess the value of self-reported physical activity measures in this population, specifically the convergent validity between self-reported and objectively measured physical activity and association with functional indicators.

A cross sectional study was undertaken using qualitative and quantitative methods. Focus groups, physical activity and functional indicator measures were conducted with a convenience sample (n=40) of non-demented residents currently living in assisted care (mean age=89.2 years) and independent living (mean age =78.9 years) in a southern metropolitan Sydney retirement village. Barrier and facilitator themes were derived from thematic analysis of focus groups’ transcripts. Physical activity measures included average steps per day, moderate to vigorous physical activity (MVPA), light intensity physical activity (LIPA) and sitting behaviour measured by Sense Wear accelerometry and self-reported physical activity measured by the International Physical Activity Questionnaire (short-form; IPAQ).

Health concerns, fear of injury and motivation were overarching themes of barriers to participation; however, the frequency of these themes differed by place of residence. People living independently more often identified fear of injury and lack of motivation as barriers to physical activity. People living in assisted care more often identified health concerns as barriers to participating in physical activity. The social and physical environments were found to be key facilitators of physical activity. Social support as a facilitator was important for both genders. Staff involvement was identified as a key facilitator of physical activity for people living in assisted care. Whereas people living independently identified other residents or companions as important in facilitating physical activity. Aspects of the physical environment that were reported to increase participation in physical activity for independent living participants were short walking distances to facilities such as the gym, shops and parks. For the assisted living group, aspects of the physical environment that were reported to increase participation in physical activity accessibility of paths and the strategic placement of seats (seating situated with short distances between them). Both groups identified pleasant scenery as an important facilitator of physical activity. This pilot investigation
suggests that to keep older old adults physically active, social support and staff involvement are important facilitators for physical activity participation. Attention should be directed to making the physical environment safe and conducive to physical activity participation. This may involve having level paths for walking and strategically placed seating to allow for rest periods. In the older old it appears that increased hours of sitting are related to functional limitations. Therefore, attention should be directed to encouraging older old adults to sit for fewer hours during the day and participate in some form of physical activity.

Significant differences in age-adjusted balance and strength capacity were noted between people living in assisted care and independent living accommodation. People living independently had greater leg strength and better balance than people living in assisted care. By contrast, the only differences in age-adjusted physical activity patterns were greater average steps per day for the independent living group. The agreement between MVPA, steps per day and functional indicators (strength and balance) was low. No associations were found between steps per day or MVPA and measures of functional indicators. Sitting behaviour was inversely associated with functional indicators. That is, more hours spent sitting was correlated with decreased measures of strength and balance. Comparison between IPAQ (self-report) and SenseWear (objective) measures indicated a clear pattern of error in overestimating moderate to vigorous physical activity (MVPA) with the IPAQ. The assisted living group overestimated physical activity levels on the IPAQ to a greater degree than the independently living group. There was, however, greater agreement between the IPAQ and SenseWear when measuring sitting behaviour. The participants were able to recall more accurately the amount of time they spent sitting compared to the objective sitting measures.

In this study, self-reported data of physical activity should be taken with great caution in the older old population, especially in assisted care, as they overestimated physical activity levels using the IPAQ a greater degree than those living independently. This study found poor convergent validity between self-reported physical activity measures (IPAQ) and objectively measured (SenseWear) physical activity levels. Functional indicators appear unrelated to measures of physical activity such as MVPA and steps per day highlighting the inability of these aerobic dimensions to influence strength and balance. Strength and balance have been found to be key factors in healthy ageing and preventing falls, hence, it is important to include in questionnaires for older adults, specific questions on strength and balance activities in this population.
CHAPTER 1: Background

Ageing and physical activity in a societal context

Older adults are becoming a larger proportion of the Australian population. It is estimated that the proportion of people aged over 65 years in 2061 will be approximately 22% of the Australian population (compared with 14% in 2012). Adults over 85 years are the fastest growing group (Australian Bureau of Statistics (ABS), 2013). These figures reflect global trends in ageing. This shift in demographic dominance is unique in history and will provide unique challenges (Adams-Fryatt, 2010; Mihalko, Wickley, & Sharpe, 2006). Older adults have a higher proportion of chronic disease or long term health conditions and disability compared with younger demographic groups. Functional limitations resulting from chronic diseases may reduce the ability to perform activities of daily living. Low levels of fitness are also risk factors for functional limitations (Adams-Fryatt, 2010; Hardy & Grogan, 2009).

The aged population can be divided into two distinct groups, “younger older” and “older old”. Younger old are older adults aged between 60 and 79 years and the older old are older adults aged over 80 years. These two groups have distinct differences, the older old group are often referred to as “frail elderly” and is often characterised as presenting with significant chronic conditions, cognitive impairment, malnutrition, functional limitations, disability and poor social condition (Vogel, 2009).

Ageing is also associated with an increase in chronic conditions including degenerative musculoskeletal conditions (Wrosch, Schulz, Miller, Lupien, & Dunne, 2007). The combination of decreases in physical function, reduced ability to perform activities of daily living independently and increases in chronic conditions will lead to greater rates of hospitalisations or extended hospital stays, which will burden the health care system. Age related health problems may also result in a greater societal burden (Beswick et al., 2008; Chou, Hwang, & Wu, 2012; Guralnik & Kritchevsky, 2010; King & King, 2010). Physical inactivity has been identified as one of the major risk factors responsible for the overall burden of disease in Australia (Mathers, Vos, Stevenson, & Begg, 2000). This will be particularly important in the older population because physical activity levels are one of the modifiable factors of ageing.

Healthy or active ageing is a multidimensional concept: It is not just the absence of clinical disease but the ability to function with no significant activity limitation. In addition, healthy ageing incorporates maintenance of cognitive and social function (Hamer, Lavoie, & Bacon, 2013; Sabia et al., 2012; Sun et al., 2010). The World Health Organisation (WHO) defines active ageing as “optimising the opportunities for health, participation and security in order to enhance quality of life as people age.” The ageing process appears to be adaptable to change in animal studies, however the extent to which the ageing process in
adaptable in humans is yet to be explored. The ageing process is multifactorial and an understanding of ageing and key determinants of active or healthy ageing is necessary (Franco et al., 2009). Physical activity has been identified as a key health behaviour that may distinguish between older individuals who age successfully and those who do not (Adams-Fryatt, 2010; Hamer et al., 2013; King & King, 2010). The potential benefits of engaging in a lifestyle that incorporates regular physical activity is to enhance healthy ageing and slow the ageing process by promoting improved physical function, independence and quality of life (Stessman, Hammerman-Rozenberg, Cohen, Ein-Mor, & Jacobs, 2009). These changes have been shown to be of benefit even when physical activity is started at a later stage in life (Stessman et al., 2009). The epidemiological evidence indicates that current or recent physical activity levels are a stronger predictors of positive health outcomes (Schnohr, Scharling, & Jensen, 2003). Regular physical activity can reduce the burden of disease or years of “health loss” therefore, not only benefiting the individual but providing benefits at a societal level as well (Begg, Vos, Barker, Stanley, & Lopez, 2008).

The next sections will summarise the effect of ageing on body systems and the evidence for the benefits of physical activity on ageing processes and disease prevention at the primary, secondary and tertiary levels.

The effect of ageing on body systems

The physiological parameters that decrease with ageing are cardiovascular and pulmonary function, exercise or work capacity, musculoskeletal and neuromuscular function (Chou et al., 2012; Singh, 2002).

Cardiovascular function is dependent on resting heart rate, maximal cardiac output, endothelial reactivity, maximal skeletal blood flow, capillary density, arterial distensibility, vascular insulin sensitivity and plasma volume (Singh, 2002). All these factors except resting heart rate decrease with age or disuse (Singh, 2002).

Factors which contribute to exercise or work capacity are maximal aerobic capacity, heart rate and blood pressure response to submaximal exercise, tissue elasticity, muscle strength, power and endurance, motor coordination, oxidative and glycotic enzyme capacity, mitochondrial volume density, gait speed, step length, cadence and gait stability (Singh, 2002). These factors are observed to decrease with ageing, except for heart rate and blood pressure response to exercise which increases with age. In addition, vital capacity and maximal flow rates affect pulmonary function and are observed to decrease with age (Singh, 2002). Vo2 maximum has been documented to decline with ageing. Vo2 maximum is the greatest amount of oxygen a person can use while performing dynamic exercise involving a large part of total muscle mass. Vo2 max represents the amount of oxygen transported and used in cellular metabolism (Fletcher, Froelicher, Hartley, Haskell, & Pollock, 1990).

A major body composition change that occurs with ageing is overall adipose tissue mass increase. There is also greater deposition of adipose tissue around the trunk and viscera. There is an increase in degenerative musculoskeletal conditions
such as osteoporosis, arthritis and sarcopenia (Wrosch et al., 2007). Skeletal muscle mass decreases with preferential atrophy of type 2 (fast twitch) fibres. In addition, there is increased intramuscular fat and connective tissue resulting in decreased muscle quality. Associated with these changes are losses of bone mass with decreased bone density and increased bone fragility (Singh, 2002). The changes in bone mass with decreased bone density and increased bone fragility increase the risk of fracture following a fall (Kanis, 2002). In addition, neuromuscular function associated with reaction time and strength reduces with age and also increases the risk of falling (Lord, Sherrington, Menz, & Close, 2007).

Definitions of physical activity, exercise, physical fitness and functional ability

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure beyond resting expenditure (Caspersen, Powell, & Christenson, 1985; Haskell et al., 2007). There can be considerable variation in the intensity and duration (Howley, 2001). Balance training is of particular relevance to the older old population however it does not comply with this definition (Singh, 2002). Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective. Physical fitness comprises a set of attributes that people have or achieve which enables them to perform physical work or affects their health status. It includes cardiorespiratory fitness, muscle strength and endurance, body composition, flexibility and balance (Caspersen et al., 1985; Haskell et al., 2007; Powell et al., 2011; Singh, 2002). Functional ability is the capacity to perform practical tasks, activities and behaviours that fulfil an individual’s role in society, maintain independence and enhance quality of life (Powell et al., 2011).

Prevalence of health conditions in the older old

Increasing age is related to poorer reported health status, higher rates of disability and long term health conditions (ABS, 2006). The National Health Survey of 2004-05 reported on long term health conditions of Australian people aged 75 years and older. The most prevalent long term health conditions are conditions of the circulatory system, lower respiratory system, musculoskeletal system and connective tissue. Health conditions of the circulatory system are hypertensive disease, ischaemic heart disease and cerebrovascular disease. In people aged over 75 years, the prevalence of circulatory diseases is 65.4% for males and 61.6% for females. The prevalence of chronic lower respiratory disease in males is 16.7% and 14.1% in females (ABS, 2006b). Diseases of the circulatory system and malignant neoplasms (particularly lung, prostate, and colorectal cancers) are the leading causes of death for older persons aged 65 years. The respective rates per 100,000 increased with age from 451 and 691 for 65-74 year olds to 6,823 and 1,930 for those aged 85 years or more (ABS, 2006c).
Health conditions of the musculoskeletal system and connective tissue are osteoporosis, osteoarthritis, Rheumatoid arthritis and diabetes mellitus (ABS, 2016). The prevalence in people aged over 75 years for health conditions of the musculoskeletal system and connective tissue are 61.7% for males and 70.2% for females. (ABS, 2006b). Accidental falls are a significant issue with ageing. There is a much higher rate of death from accidental falls in people aged over 80 years compared to younger age groups in the population. (ABS, 2006c).

**The evidence for the benefits of physical activity in older age on long term health conditions**

Regular physical activity has been shown to decrease the risk of many adverse health conditions encountered in the aged population (American College of Sports et al., 2009; Chou et al., 2012; King & King, 2010; Lee et al., 2012; Owen, Bauman, & Brown, 2009; Powell, Paluch, & Blair, 2011; T Vogel et al., 2009). There is strong evidence that physical activity in adults can lower the rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, metabolic syndrome, type 2 diabetes, breast cancer and colon cancer. As regular physical activity decreases the risk of many common diseases, it can be used as a primary or an adjunct to treatment of chronic diseases (American College of Sports et al., 2009; Garber et al., 2011; Hamer et al., 2013; Lee et al., 2012; Vogel et al., 2009). Regular physical activity can also reduce the risk of further progression of pre-existing conditions (Church, LaMonte, Barlow, & Blair, 2005; Lee et al., 2010; McAuley et al., 2009; Myers et al., 2002; Sui, LaMonte, & Blair, 2007a).

**Diseases of the Circulatory system**

Individuals (middle aged and older adults) who engage in regular physical activity have been shown to have a lower risk of diseases of the circulatory system. This includes reductions in disease mortality and morbidity (Blair et al., 1995; Lee et al., 2010; Sui, LaMonte, & Blair, 2007b; Sui, LaMonte, Laditka, et al., 2007)

Reduction of mortality due to physical activity has been demonstrated in many longitudinal studies. Data from The Cardiovascular Health Study, SENECA, HALE and FINE studies, Honolulu Heart Program, The Zutphen Elderly Study and the Framingham Heart Study have shown a decrease in mortality, along with decreases in circulatory system diseases with increased rates of physical activity in older adults (Vogel et al., 2009). The increased in life expectancy observed was linked to decreases in circulatory system diseases (Knoops et al., 2004). Other studies have shown similar results in the older old population (Benetos, Thomas, Bean, Pannier, & Guize, 2005; Bijnen et al., 1998; Chakravarty, Hubert, Lingala, & Fries,
Prevention of coronary heart disease with physical activity has been demonstrated in studies which reported a decrease in the relative risk of developing a coronary event in older men aged 71 to 93 years (Hakim et al., 1998). Other studies have shown a reduction of total and cardiovascular risk of mortality in older adults who participated in moderate physical activity. These results were maintained at four and five year follow up (Wannamethee, Shaper, & Walker, 2000).

Decreases in older people’s aerobic fitness (Vo2 max) are related to mortality, increased risk of coronary artery disease, poor health and functional status (Stathokostas, Jacob-Johnson, Petrella, & Paterson, 2004). Small sample size studies have demonstrated that older people can improve Vo2 max with high intensity endurance exercise programs (Evans et al., 2005; Malbut, Dinan, & Young, 2002). One study showed trends of increased total energy expenditure as a result of increased physical activity (Evans et al., 2005). Sattelmair et al (2011) were able to quantify the specific amounts of physical activity required to lower the risk of coronary heart disease. Individuals engaging in 150 minutes per week of moderate intensity leisure time physical activity had a 14% lower coronary heart disease risk compared to those who participated in no leisure time physical activity. Individuals participating in 300 minutes per week of moderate intensity in leisure time physical activity had a 20% lower risk. Interestingly, individuals who participated in higher levels of physical activities had modestly lower relative risks and even those who did not meet the minimum recommended levels of physical activity also had lower risk of coronary heart disease. These findings support the activity guidelines that some physical activity is better than none and additional benefits occur with more physical activity. It also supports the concept that it is never too late to gain benefits from regular physical activity (Sattelmair et al., 2011).

Cholesterol levels in the blood contribute significantly to the development of cardiovascular disease. Small studies have demonstrated that regular physical activity lowers Low Density Lipoprotein (LDL) cholesterol levels and increases High Density Lipoprotein (HDL) cholesterol levels (Halverstadt, Phares, Wilund, Goldberg, & Hagberg, 2007; Petrella, Lattanzio, Demeray, Varallo, & Blore, 2005). A small decrease in LDL cholesterol levels by physical activity has a relatively large impact on the absolute risk reduction due to the high incidence of cardiovascular events in older people (Vogel et al., 2009).

**Hypertension**

There is a strong association between inactivity and increased risk of developing high blood pressure in middle aged adults. Aerobic activity has the most evidence for reducing both systolic blood pressure and diastolic pressure (Whelton, Chin, Xin, & He, 2002). Studies in older populations have produced more inconsistent findings with some results showing decreases in both systolic and diastolic blood pressure (Braith, Pollock, Lowenthal, Graves, & Limacher, 1994; Jessup, Lowenthal, Pollock, & Turner, 1998; Whelton et al., 2002) and other studies only reductions in resting systolic blood pressure and non-
resting diastolic blood pressure (Vaitkevicius et al., 2002). Physical activity as secondary prevention for high blood pressure appears less successful in older populations than middle aged populations (Seals, Silverman, Reiling, & Davy, 1997).

**Stroke**

The risk of a stroke has been found by many studies to decrease with regular physical activity (Do Lee et al, 2003; Hu et al, 2000). Studies have reported that physical activity has a strong protective effect for ischaemic stroke that is dose and intensity related (Goldstein et al, 2006). Physical activity is also associated with decreases in mortality due to stroke (Bijnen et al., 1998; Sacco et al., 1998). Results from meta-analyses that did not exclusively include older people showed moderate physical activity provided a protective effect for both ischaemic and haemorrhagic stroke (Wendel-Vos et al., 2004). There is little evidence for the benefit of physical activity as secondary prevention after stroke (Meek, Pollock, Potter, & Langhorne, 2003).

**Diseases of the musculoskeletal system and connective tissue**

Musculoskeletal conditions are defined as conditions of the bones, muscles and their attachments and joints. Arthritis involves inflammation of the joints, causing pain, stiffness and disability. Other musculoskeletal conditions, such as osteoporosis, affect the muscles, bones and joints (AIHW, 2014). Diabetes type 2 is described as a disease of connective tissue (ABS, 2006).

**Osteoarthritis**

Osteoarthritis is a common musculoskeletal disorder in older adults which causes pain, disability and functional limitations. Muscle weakness has been identified as a risk factor for developing osteoarthritis and therefore resistance or muscle strengthening exercises may decrease the risk of developing osteoarthritis (Slemenda et al., 1998). In individuals who have osteoarthritis, physical activity incorporating resistance or muscle strengthening exercises can reduce pain and disability (Bischoff & Roos, 2003; Messier, 2009).

**Sarcopenia**

Sarcopenia is a syndrome associated with ageing and is characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, loss of independence, poor quality of life and death (Cruz-Jentoft et al, 2010). It is thought to be associated with mitochondrial loss. Broskey et al (2014) have demonstrated that ageing per se is not the cause of mitochondrial dysfunction. They concluded that a decrease in mitochondrial function observed in older adults was due to decreased physical activity (Broskey et al, 2014).
Osteoporosis

The role of physical activity in bone mineral density and risk of fractures is complex and there are conflicting results. It has been suggested that certain types of physical activities may increase the risk of falls (Vogel et al., 2009). The research on the effect of physical activity on osteoporosis indicates that long-term physical activity has positive benefits (Chien, Wu, Hsu, Yang, & Lai, 2000; Iwamoto, Takeda, & Ichimura, 2001). High intensity vigorous exercises appear to increase bone density (Vogel et al., 2009). It has been shown that exercise that increases muscle strength also increases bone mineral density and content and the strength of the bones which are stressed during the exercise (Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004; Mâimoun & Sultan, 2011; Suominen, 2006). In people with osteoporosis, exercises to increase muscle strength and therefore increase bone mass, may prevent, slow or even reverse loss of bone mass (Kohrt et al., 2004; Mâimoun & Sultan, 2011; Suominen, 2006). Despite these positive results there are still no clear guidelines on the type and intensity of physical activity needed to reduce risk of fractures (Vogel et al., 2009).

Diabetes

A recent systematic review to evaluate the relationship between physical activity and risk of type 2 diabetes has demonstrated that regular physical activity of moderate intensity such as brisk walking can substantially reduce the risk of type 2 diabetes (Jeon, Lokken, Hu, & Van Dam, 2007). Physical activity and exercise have been shown to prevent Type 2 diabetes in the general population especially in people at risk of developing diabetes (Laaksonen et al., 2005). Both resistance and endurance physical activity have been shown to be effective in reducing the risk of type 2 diabetes (Castaneda et al, 2002; Broule et al, 2003). The mechanism by which physical activity affects glycaemic control is by increasing glucose transporters, which results in greater sensitivity to insulin (Cox, Cortright, Dohm, & Houmard, 1999; DiPietro, Dziura, Yeckel, & Neufer, 2006; Evans et al., 2005; Laaksonen et al., 2005). Randomised controlled trials which studied lifestyle modification had better results for participants who increased their physical activity levels when compared with participants who were prescribed antidiabetic drugs for the prevention of type 2 diabetes (Diabetes Prevention Program Research Group, 2002). These findings have also been found in the older population, particularly in the younger old for whom even low levels of physical activity were sufficient to produce positive results in the prevention of type 2 diabetes (Hu et al., 1999). Studies which looked at older participants with glucose intolerance, often the precursor of type 2 diabetes, demonstrated that again even with low levels of physical activity, positive results were found. Physical activity such as gardening and bicycling resulted in a lower plasma glucose and lower glucose intolerance in men aged 69 to 89 years (Van Dam, Schuit, Feskens, Seidell, & Kromhout, 2002). Similar results have been found for older women (Folsom, Kushi, & Hong, 2000; Hsia et al., 2005; Van Dam et al., 2002).
Other health conditions

Cancer

The evidence for the association of physical activity levels and decrease in risk for some cancers (colon and breast cancer) is considerable (Friedenreich, 2001, 2011; Hardman, 2001; Monninkhof et al., 2007; Wolin, Yan, Colditz, & Lee, 2009). However, this is not exclusive to older people but is across the lifespan (Nilsen, Romundstad, Petersen, Gunnell, & Vatten, 2008; Slattery & Potter, 2002). The evidence is strong for a link between physical activity and risk reduction in breast cancer post-menopausal women (McTiernan et al, 2003) However, it is difficult to account for confounding factors (Friedenreich, Thune, Brinton, & Albanes, 1998). Although little evidence exists, there is the possibility that there may be a potential role for physical activity in the reduction in risk of other cancers such as lung and endometrial cancers (Friedenreich & Orenstein, 2002).

Obesity

Several studies have shown that physical activity in older adults can lead to decreases in body fat mass, body weight, total body fat, intra-abdominal fat and subcutaneous fat (American College of Sports et al., 2009; Irwin et al., 2003). Physical activity in conjunction with a moderate calorie controlled diet was shown to be superior to low caloric diet as body fat mass was reduced with less effect on sarcopenia (Christmas & Andersen, 2000). Decreases in body fat mass may also have positive effects on cardiovascular and musculoskeletal functions (Singh, 2002).

Evidence for the benefits of physical activity in older adults in relation to functional status

Regular physical activity has been shown to have a role in decreasing physiological changes associated with ageing in sedentary populations (Hamer et al., 2013; Vogel et al., 2009). There is a similarity between physiological changes that occur with disuse or a sedentary lifestyle and those associated with normal ageing (Singh, 2002). It is difficult to differentiate between disuse and ageing. However, the physiological changes associated with ageing or disuse can have an effect on many systems and functional capacities (Hamer et al., 2013; Vogel et al., 2009). These systems and functional capacities have the potential to change the health status of older adults (Singh, 2002). These physiological changes can lead to a decrease in physical function and the ability to perform activities of daily of living independently (Beswick et al., 2008). The consequences of reduced independence in activities of daily of living are not only physical but can affect psychological and social functions. This in turn can lead to poor quality of life (Chou et al., 2012). Frailty has been described as the inverse of healthy ageing (Franco et al., 2009). Frailty is a common clinical syndrome in older adults that carries an increased risk for
poor health (Xue, 2011). It includes sarcopenia, osteoporosis, poor motor function, impaired energy metabolism, extreme values of body mass index, poor nutritional status, blood pressure instability and vulnerability to infection (Bergman et al., 2007; Ensrud et al., 2007; Fried et al., 2001; Walston et al., 2006). Physical activity has been advocated as one way to reverse frailty in older people (Franco et al., 2009).

**Aerobic exercise**

Many studies have demonstrated that regular aerobic exercise in older adults can produce changes in the cardiovascular and musculoskeletal systems that may overcome the functional limitations that are associated with the ageing and disuse (Panton et al, 1995; Singh, 2002). The physiological parameters of heart rate, blood pressure, dyspnœa will be decreased, as part of the cardiorespiratory response to exercise, which will allow an individual to work at higher submaximal loads with associated less muscle fatigue (Seals et al, 1984; Rogers et al, 1990). Broskey et al (2014) demonstrated that an aerobic exercise program in older people (aged 60 to 80 years) can enhance mitochondrial content and function and may prevent ageing muscle comorbidities (Broskey et al., 2014).

**Progressive resistance training and endurance exercise**

Resistance or muscle strengthening exercises have been associated with a lower risk of developing functional limitations (Brill, Macera, Davis, Blair, & Gordon, 2000; Manini et al., 2006).

Findings of studies into physical activity programs in the older old have produced increases in strength (Andrews, 2001; Brach, Simonsick, Kritchevsky, Yaffe, & Newman, 2004; Hasten, Pak-Loduca, Obert, & Yarasheski, 2000; Nied & Franklin, 2002). The postulated mechanism of increases in strength is due to muscle fibre hypertrophy in fibres I and II and improved motor unit recruitment (Frontera, Hughes, Krivickas, & Roubenoff, 2001; Toth, Matthews, Tracy, & Previs, 2005).

Two randomised controlled trials have studied physical activity in older populations using progressive resistance training and endurance exercises (Fiatarone et al., 1994; Meuleman, Brechue, Kubilis, & Lowenthal, 2000). Fiatarone et al (1994) reported improvements in muscle strength, gait velocity and increase in thigh muscle cross sectional area after a 10-week period of progressive resistance training. Meuleman et al (2000) reported significant improvement in functional activity after an endurance and resistance program lasting four to eight weeks (Meuleman et al., 2000). Other research has shown improvements in pre frail elderly but not frail elderly (Faber, Bosscher, Chin A Paw, & van Wieringen, 2006; Gill et al., 2002). The effect of physical activity on disability of the older old or frail elderly is not clear (Carrière, Colvez, Favier, Jeandel, & Blain, 2005; Latham, Bennett, Stretton, & Anderson, 2004; B. W. Wang, Ramey, Schettler, Hubert, & Fries, 2002) despite some studies showing a positive association between physical activity and disability.
Neuromotor and balance training

Neuromotor and balance training has been shown to improve balance, agility, muscle strength and reduce the risk of falls in older people (Bird, Hill, Ball, Hetherington, & Williams, 2011; Jahnke, Larkey, Rogers, Etnier, & Lin, 2010; S Karinkanta et al., 2007; Li, Devault, & Van Oteghen, 2007; Nelson et al., 2007; Takeshima et al., 2007; Tüzün, Aktas, Akarirmak, Sipahi, & Tüzün, 2010). Tai Chi is the most studied neuromotor activity (Jahnke et al., 2010). The risk of falling and fear of falling has been shown to be reduced with activities that address balance and agility (Barnett, Smith, Lord, Williams, & Baumand, 2003; S Karinkanta et al., 2007; Liu-Ambrose, Khan, Eng, Lord, & McKay, 2004; Liu-Ambrose et al., 2004). Improving balance and agility is also associated with improved quality of life (S. Karinkanta et al., 2012). There is a possibility that agility and balance training may also reduce the number of falls however more evidence is still needed (Harmer & Li, 2008; Liu-Ambrose et al., 2008; Liu-Ambrose et al., 2004; Logghe et al., 2010; Nelson et al., 2007; Wu, 2002). Recommendations for programs designed to prevent falls should include exercise that provides a moderate or high challenge to balance, must be of a sufficient dose to have an effect, be ongoing, be targeted at the general community and those at increased risk of falls, and can be in a group or home based setting (Sherrington, Tiedemann, Fairhall, Close, & Lord, 2011; Sherrington et al., 2008).

Regular physical activity can be utilised in the treatment or prevention of disability (Hamer et al., 2013; Singh, 2002; Vogel et al., 2009). There is strong evidence that regular physical activity can result in a higher level of cardiorespiratory and muscular fitness, healthier body mass and composition, enhanced bone health, higher level of functional health and better cognitive function, and feelings of positive well being. (American College of Sports et al., 2009; Chou et al., 2012; King & King, 2010; Lee et al., 2012; Owen, Bauman, & Brown, 2009; Powell, Paluch, & Blair, 2011; T Vogel et al., 2009)

Physical activity is an important factor in maintenance of independent living in old age. This is achieved by maintaining strength, flexibility and balance and therefore limiting disability. Given the importance of maintaining independence in old age, it would appear that regular physical activity is more critical for the older old (American College of Sports et al., 2009; Australian Institute of Health and Welfare, 2011; Franco et al., 2009; Garber et al., 2011; World Health Organisation, 2010).

Physical activity recommendations for older populations

It is widely acknowledged that all older adults should engage in regular physical activity and avoid an inactive lifestyle (Nelson et al., 2007). Public health recommendations on physical activity for older adults have been issued from the Australian Government Department of Health (Sims et al, 2010). The recommendations are:
1. Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities.

2. Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility.

3. Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days.

4. Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity.

5. Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.

The recommendations are for older adults over 65 years and adults aged between 50 and 64 with chronic diseases or functional limitations. The Australian recommendations are very similar to recommendations of the American College of Sports Medicine and the American Heart Association.

The recommendations outline physical activity needed to improve and maintain health of older adults emphasise the need to include a combination of aerobic activity, muscle strengthening activity, flexibility and balance exercises (Nelson et al., 2007). Older adults’ aerobic fitness is taken into account in these recommendations. The aerobic activity should be of moderate intensity for 30 minutes’ duration on five days a week or vigorous intensity for 20 minutes’ duration for three days a week or combinations of moderate and vigorous intensities. The intensity can be calibrated by a 10-point scale where zero is sitting and ten is maximal effort. Moderate intensity is rated as 5 or 6 and vigorous is 7 or 8. Muscle strengthening activity should be of a moderate intensity with a weight that allows 10 to 15 repetitions. The program should be progressive, that is, the weight being lifted should be increased over time and large muscle groups should be used in the activity. Flexibility activities that maintain or increase flexibility should be performed on at least two days for at least ten minutes. Balance exercises are recommended for older adults at risk of falls. The importance of an activity plan for achieving the recommended activity levels is emphasised to achieve optimal preventive and therapeutic benefits. Older adults who are sedentary or have chronic conditions should gradually work towards the recommended activity levels by gradually increasing bouts of 10-minute activity throughout the day until they can participate in continuous activity for the recommended time (20 to 30 minutes). The time frames are minimum recommendations and older adults are encouraged to participate in physical activity for longer than minimum recommendations. Older adults are also encouraged to reduce sedentary behaviour and manage risk.

Tudor Locke et al (2011) attempted to translate public health recommendations for older Australian people in terms of steps per day. Normative data suggests that healthy older adults take between two thousand and nine thousand (2000–9000) steps per day and special populations (disabled or frail) take between one thousand and two hundred and eight thousand eight hundred (1200-8800) steps per day. They concluded that three thousand (3000) steps above activities performed in the course
of daily living was a target for meeting guidelines. It was also reported that the intensity should be at least of moderate intensity equalling one hundred and fifty (150) minutes per week. This could be achieved in short bouts which could equate to as little as ten minute intervals.

There has been shown to be a lack of diversity of leisure time physical activity in Australian older adults. Merom et al (2012) found that older adults participated in only one activity and only 2.6% of the participants in the study reported a combination of aerobic, balance and strength activities. It appears that while promoting increases in physical activity is important, it is just as vital to promote a combination of physical activity to meet the recommendations for healthy ageing. Despite the evidence of the benefits of an active lifestyle there is a low rate of participation with only 46% of the Australian adult population achieving the recommended minimum level of physical activity per week. Older Australians are less likely to participate in sufficient activity than younger people (Australian Institute of Health and Welfare, 2011). It has been estimated that approximately 77 % of adults over 75 years in Australia, are insufficiently active (Australian Institute of Health and Welfare, 2011).

A major challenge for the older population is to maintain quality of life by promoting healthy behaviours and minimising disability. Promoting active ageing will help to older people to maintain good health and enjoy enhanced quality of life. One way to maintain quality of life and promote healthy behaviours is to promote physical activity. Promoting physical activity, especially encouraging sedentary adults to increase physical activity levels is difficult (Resnick & D'Adamo, 2011). It is imperative not only to increase physical activity levels but increase diversity of activities, to enhance active and healthy ageing of this increasing population.

**Barriers and facilitators for physical activity participation in older populations**

**Social ecological model**

Health promotion has shifted to a setting based approach placing human health within an ecological framework (Harris & Grootjans, 2012). This framework recognises that health of individuals within a population or community is linked to the community ecosystem (Begon, Townsend, & Harper, 2006). The settings approach highlights that individual health behaviours are a product of the organisation or community. Therefore, the behaviour of individuals cannot be simply interpreted by studying individual behaviours but must also take into account the physical and social environments in which people are living (Bauman et al., 2012; Owen, Leslie, Salmon, & Fotheringham, 2000). The physical and social environment appears to have a greater influence on determining behaviours and not the individual (Harris & Grootjans, 2012).
The social ecological model for physical activity has been used quite extensively in the past ten years and in relation to older adults more recently. There is large body of research into the role of environment on active living and healthy behaviour of adults living in community settings. Promotion of physical activity must examine why older people are not engaging in physical activity (barriers to physical activity) and what makes it easier for people to choose to participate in physical activity (facilitators to physical activity) (McMurdo et al., 2012; Schutzer & Graves, 2004). Another layer of complexity in physical activity is the combination of different types of activity to address aerobic fitness, muscle strength, balance and flexibility issues (Macniven, 2013).

There appear to be three groups of factors that are associated with physical activity for all ages: individual factors, social environment and physical or built environmental factors. Individual factors are related to an individual’s knowledge, attitudes and values, skills and self-efficacy. Social factors are related to a broader peer group or community beliefs and values about importance of physical activity. Social environment includes social support, having someone to exercise or walk with and accepted social norms. Physical or built environment relates to the presence of recreational and transport facilities, neighbourhood design, safety, aesthetics, destinations to walk to and policies that influence land use and transportation systems (Gebel, Bauman, Owen, Foster, & Giles-Corti, 2009). It has become apparent that all three factors, (individual, social and physical environments) have a role in facilitating or providing challenges or barriers to participation on physical activity (Gebel et al., 2009).

Physical environment and physical activity

This research has come from the areas of public health, urban planning, parks and recreation, transportation and built environments in the community setting (Nathan, Wood, & Giles-Corti, 2013; Saelens & Papadopoulos, 2008). For people living independently in the community the link between environment and physical activity behaviour demonstrates that the higher the walkability, the higher the total physical activity. Walkability can be used to reflect overall physical activity levels. Walkability is a concept that reflects how “friendly” an environment is for pedestrians. Research that has studied walking for transportation has created walkability indices that consider mixed land use, residential density and street connectivity (Gebel Klaus, 2009). Mixed land use refers to the variety and proximity of destinations. Access to key destinations appears to be a critical factor for choosing to walk for transportation. The density of a neighbourhood is indirectly linked to walking as higher residential densities are able to support the presence of shops and services. Street connectivity refers to the directness of travel routes between destinations, especially homes and facilities such as shops, and workplaces. Neighbourhood with grid like patterns were found to have greater connectivity than those with a lay out that was curvilinear. Walking for transport is supported when there is greater street connectivity, less obstacles and no major roads to cross (Gebel et al., 2009).
These findings focus on neighbourhood walkability dependent on street connectivity, residential density and mixed land use. People with greater access to recreational and fitness facilities were more likely to use them (Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Carnegie et al., 2002; Giles-Corti & Donovan, 2002). Also important was enjoyable scenery or neighbourhood aesthetics (Brownson et al., 2001; King et al., 2000; Lee & Moudon, 2004). The presence of shops and their proximity increased walking (Handy, Cao, & Mokhtarian, 2006). Different elements in the physical environment have been shown to influence physical activity and walking dependent on the reason for walking for example neighbourhood aesthetics and access to large public open spaces and convenience of facilities have been shown to positively affect physical activity and walking behaviour for recreational purposes (Gebel et al., 2009).

Most of the research of the effect of the environment on physical activity levels has been on the general population which generally excludes older adults or only includes the “younger old” (60-75 years). In a recent systematic review there were inconsistent results with regard to the relationship between the physical environment and physical activity in older adults (Van Cauwenberg et al., 2011). Unlike studies on adolescents or adults, most of the studied environmental characteristics (such as, walkability, land use, access to public transport and recreational facilities) were found to be not significantly related to physical activity. The authors suggested that methodological issues could be responsible for this finding (Van Cauwenberg et al., 2011). Cross sectional studies have not established a strong link between physical environment and physical activity levels in the older population (Merom, 2013). Studies have not looked at other aspects of the environment which may be of greater importance to older adults and is not taken into account when assessing walkability of an environment. Physical status of older adults and their perceptions of the environment have not been included in studies of the environment on physical activity levels. It has been shown that older adults are particularly susceptible to the characteristics of their local environments (Clarke & Nieuwenhuijsen, 2009). In communities where the environmental factors were challenging the research demonstrated that older people are at risk of functional decline (An, Lee, & Kim, 2013; Clarke & Nieuwenhuijsen, 2009). Conversely more favourable environments demonstrated older people being more physically active and independent in activities of daily living (Clarke & George, 2005).

**Social environment and physical activity**

Social support and connectedness appear to be important factors in older adults physical activity levels (Sugiyama & Ward Thompson, 2007). The extensive research that exists on physical activity levels and barriers for participation in older populations is derived primarily from surveying populations that are living independently in the community. A range of personal, social, and environmental factors influence physical activity in all ages (Trost, Owen, Bauman, Sallis, & Brown, 2002), however, older adults appear to have additional age-related factors which impact on their ability to participate in
physical activity. These factors include health status, the potential for injury, fear of falling and loss of social support (Baert, Gorus, Mets, Geerts, & Bautmans, 2011; Buman, Daphna Yasova, & Giacobbi Jr, 2010; Costello, Kafchinski, Vrael, & Sullivan, 2011; Macniven R, 2013; McMurdo et al., 2012; Moran et al., 2014; Schutzer & Graves, 2004).

Measurement of physical activity in old age

Measurement challenges
Little is known of the physical activity patterns of the older old living in assisted care. In addition, little is known how measurement of older adults living in assisted care will differ from measurement of older adults living independently in the community. Tools to measure physical activity in the older old population in assisted living must reflect their needs and be tested for reliability and validity in this population. There are issues with accuracy and feasibility of both self-report and objective measurement instruments (Evenson et al., 2011; Merom et al., 2013). These instruments have been validated in the general population but may be less accurate in the elderly population due to measurement error. These measurement tools have rarely been used in the environmental context of assisted living accommodation facilities.

As the current literature has shown that maintaining or increasing physical activity is vital for healthy ageing, it is also vital to measure physical activity to determine if adequate levels for health benefits are being met. Measurement of physical activity is complex in nature (Forsén et al., 2010) and needs to accurately reflect the actual physical activity levels being achieved to be valid and reliable. The broader definition of physical activity encompassing “any bodily movement” increases the challenge of measurement. There are unique features of older adults physical activity behaviour that may affect the measurement of physical activity (Murphy, 2009). The aged population is a heterogeneous group, not only does it cover a wide range of ages, but physical function of this group varies markedly from athletic to frail and immobile. Physical activity, function or capacity cannot be predicted or determined by age alone (Active, 2011). The heterogeneity of this population is one consideration that adds complexity to measurement of physical activity in this population. Older adults, especially the older old, spend a higher percentage of the day performing low intensity activities and a lower percentage of the day performing high intensity activities (Taraldsen et al., 2012). The low intensity activities are ubiquitous as they are usually spread throughout the day. This may be due in part to older adults having a higher prevalence of chronic conditions affecting physical activity levels (Bauman et al., 2012).

Measurement concepts
Important concepts associated with the measurement of physical activity are accumulation, duration, frequency and intensity. Intensity can be divided into absolute and relative intensity. Accumulation is the collection of short episodes of physical
activity during a limited period of time to achieve a larger amount. This concept is useful in considering the duration of activity (Powell et al., 2011). Duration is the length of time an activity is performed. It is usually measured in minutes (Powell et al., 2011). Frequency is the number of times an activity is performed within a specified time period. This can be expressed as episodes, bouts or sessions per week (Powell et al., 2011). Absolute intensity is the rate of energy expenditure measurement of aerobic activity. It is expressed in metabolic equivalent (METs). The metabolic equivalent (MET) is a unit of sitting, resting oxygen uptake (3.5 ml O2 per kilogram of body weight per minute [ml. kg⁻¹ min⁻¹]). It does not allow for the physiological capacity of the individual. Relative intensity measures the difficulty or ease with which an individual perceives an activity to be: very light, light, moderate, hard, very hard or maximal. It can also describe the ease or difficulty in relation to an individual’s maximal capacity. It can be described as a percentage of maximal aerobic capacity (VO2 max) or percentage of maximal heart rate (Powell et al., 2011).

Physical activity has been traditionally measured by questionnaires and interviews. More recently the use of accelerometry has allowed for objective measurement of physical activity.

**Self-reported physical activity**

Self-reported questionnaires have been widely used in the literature to estimate physical activity in research and practice including in older adults (Ainsworth et al., 2012; Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012; Merom et al., 2013). Among the most commonly used questionnaires with older populations, whether for research or practice, are: The International Physical Activity Questionnaire (IPAQ), Active Australia Questionnaire (AAQ), Community Healthy Activities Model Program for Seniors (CHAMPS), Yale Physical Activity Survey (YPAS) and Physical Activity Scale for the Elderly (PASE). Generally, these questionnaires assess frequency and duration of walking and moderate and vigorous leisure time physical activity. In addition, IPAQ and PASE assess light intensity physical activity.

Self-reported questionnaires are widely used because they are low cost and convenient to use. They offer rich information as they are able to measure multiple dimensions of physical activity (Helmerhorst et al., 2012). Information that can be measured by self-report questionnaires are: Type and frequency of physical activity, domains or settings (domestic, work or leisure related) of physical activity, estimates of time spent in activity at various intensities. They can also differentiate between walking for leisure and active community transport. Incidental energy expenditure and time spent in sedentary settings can also be captured (Bauman & Merom, 2002; Helmerhorst et al., 2012). However, there are still many limitations with questionnaires. Self-report questionnaires are prone to measurement error and bias due to misreporting. There is also a tendency for respondents to questionnaires in a manner that they perceive will be viewed favourably (Helmerhorst et al., 2012). Some of the questionnaires are too long to be practical and often don’t take into account the cognitive burden for older adults in recalling information and confusion about intensity of activity. The ubiquitous nature of light activity being spread
throughout the day may make it more difficult to recall than vigorous or formal exercise (Dipietro, Caspersen, Ostfeld, & Nadel, 1993; Forsén, L., 2010; Heesch, et al, 2010; Merom et al., 2013). In a systematic review by Forsen et al (2010), the IPAQ-C received a positive rating on reliability.

**Objective measurement of physical activity**

Accelerometry is an objective way of measuring directly physical activity parameters. Accelerometers are particularly useful for recording light activity that can be missed in questionnaires. Accelerometers are motion sensors that can be attached to a person to detect acceleration and measure galvanic skin responses. The motion sensor detects acceleration in different planes as the person moves. It converts the data into “counts” which are measured in epochs which are specific time intervals. Accelerometry in older adults is a relatively new field of research that is being used more often with older adults. The challenges of objective measurement in older adults is defining typical activity patterns in older adults and consensus on cut points. Therefore, the best way to extract and analyse data is still being explored. Activity counts and activity pattern recognition are the typical outcomes, but more recently activity pattern is being described as well. Consensus regarding the relative importance of different outcomes and the information they provide still has not been reached. There is a lack of normative data of physical activity levels in older adults. There is also no standard activity monitoring protocols for measuring physical activity in older adults. Raw accelerometry signals are used to derive variables based on activity counts, for example energy expenditure is derived from the amplitude of the acceleration signals. Activity counts also give information about intensity. Activity recognition gives information about recognised postures or activities such as walking or transitions between postures or activities. In addition to activity counts and activity recognition, there are reports on activity pattern. Mean length of activity events is an example of how this variable is reported in the literature (Taraldsen, Chastin, Riphagen, Vereijken, & Helbostad, 2012). Physical activity energy expenditure and postures represent different aspects of physical activity with regards to intensity. Older adults involved in sport had lower total physical activity compared to those not involved in sport (Buchheit et al., 2004). However, older adults participating in sport had higher physical activity energy expenditure. Similarly, Hansen (2011) reported that older men spent less time being active but had greater intensities of activities compared with older women. Older women had greater total physical activity levels (Taraldsen et al., 2012).

There are unique features of older adults that may affect the measurement of physical activity by accelerometry (Murphy, 2009). Older adults, especially the older old spend a higher percentage of day performing low intensity activities and a lower percentage of the day performing high intensity activities (Westerterp, 2008). There are age related declines in basal metabolic rate and decreases in fat free mass that may contribute to errors in energy expenditure calculations that were developed for younger adult samples (Murphy, 2009). Older adults have a higher prevalence of chronic conditions that can
affect physical activity levels and memory and recall may affect compliance in wearing monitors over a number of days (Murphy, 2009).

Another limitation of accelerometry as a measurement tool in the older population is the lack of consensus on cut points to determine physical activity intensity (Evenson, Buchner, & Morland, 2011; Merom et al., 2013). In younger populations a cut point of 6 METs is used to denote vigorous activity. However due to declining maximal cardiorespiratory fitness levels, it is more difficult for older people to achieve this level. This is due to the relative intensity of effort increasing with declining maximal cardiorespiratory fitness for the same activity. Light activities defined as less than 3 METS in younger populations may be seen as moderate effort for older populations (Evenson et al., 2011). Rather than determining each person's true resting oxygen uptake, a MET is taken as this average (Fletcher et al., 1990). The older population have been found to spend most of their total physical activity in low intensity activity (Westerterp, 2008). Older adults also have altered gait patterns compared to younger populations affecting the metabolic cost of walking (Brach, Studenski, Perera, VanSwearingen, & Newman, 2007; Storti et al., 2008). These factors will affect the determination of cut points used for accelerometry to determine moderate vigorous physical activity (Davis & Fox, 2007). A cut point set too high will underestimate the physical activity especially of moderate vigorous physical activity (Evenson et al., 2011).

At present the most appropriate variables derived from accelerometry have not been determined in older persons. The different physical activity results may have differed due to different algorithms in that come with the different accelerometers. There is no standard algorithm and many of the software packages have embedded algorithms which are not available to the consumer. Older people and more importantly, the older old who tend to be frail with more chronic conditions, tend to perform most of their total physical activity in activities of daily living which have low intensities (Westerterp, 2008).

Outcome measures that capture this would appear to be the most appropriate (Taraldsen et al., 2012). Traditionally, outcomes have been derived from activity counts and activity recognition. There is an emerging trend to describe activity patterns as well. Different outcome measures will give different information about physical activity, health and function for older people (Taraldsen et al., 2012). There is also confusion about optimum number of days to record physical activity using objective instruments. The majority of the studies in the systematic review by Taraldsen et al (2012) collected data for one week. It can be concluded that optimum number of days for recording physical activity will depend on the instrument used. The other variable to take into account is also the effect of day of the week on physical activity behaviour; however, this may not be a factor with the older old. Overall, there is a lack of normative data and standardised protocols for objective measuring physical activity of older populations (Taraldsen et al., 2012).
Self-reported versus objectively measured physical activity

Colbert et al (2011) compared the validity of three objective instruments and three self-report questionnaires with doubly labelled water which the accepted gold standard in measurement of total energy expenditure. The three objective instruments were: pedometer, actigraph, accelerometer & Sense Wear armband and three questionnaires were: Yale Physical activity survey (YPAS), Community health activity model program for seniors (CHAMPS) and Modified Physical Activity Scale for the Elderly (modePASE). The objective instruments provided a more appropriate ranking of physical activity energy expenditure than the self-reported instruments. The CHAMPS was found to be significantly correlated with physical activity energy expenditure but the absolute estimates of physical activity energy expenditure were found to be inaccurate (Colbert, Matthews, Havighurst, Kim, & Schoeller, 2011).

Problem

Planning for long term care is imperative in response to the expected increases in the older population (Mihalko & Wickley, 2003). As the Australian population ages, it is expected that a larger number of older adults will be moving into aged care facilities. Aged care facilities were developed to meet the long term care needs of the increasing older population. Aged care facilities are special-purpose facilities which provide accommodation and other types of support, including assistance with day-to-day living and intensive forms of care to frail and aged residents (Australian Institute of Health and Welfare, 2012). Admissions to aged care facilities have increased by 25% between 2001-02 and 2011-12 and this is expected to increase as a result of population ageing (Australian Institute of Health and Welfare, 2012).

There are limited data on the physical activity levels of older adults in aged care facilities in Australia as population surveillance usually excludes them from the sampling procedures. Older people in the community setting have documented lower levels of physical activity and higher levels of sedentary behaviours than other age groups (Evenson et al., 2011; Gardner, de Bruijn, & Lally, 2011). Older people living in assisted living facilities have reported decreased health, disability and cognitive function compared to older people living in the community (Chen, 2010). It seems therefore likely that older people living in assisted living care facilities may be at greater risk of decreased levels of physical activity.

Older age and mobility problems are often the reason cited for people moving from independent living into assisted accommodation. These reasons are also cited as barriers to physical activity participation. Alternatively, the transition from the community into retirement villages may facilitate participation in physical activity as recreational and exercise facilities are promoted as reasons to move into these facilities and appeared to increase level of participation due to ease of access (Miller & Buys, 2007). However, the levels of activity of assisted living residents may not be equivalent to those in independent living. In addition, provision of recreational exercise facilities is not as well documented in assisted living accommodation as in independent living in retirement accommodation.
Given the pivotal role of staying active in old age, it is important to explore the association between physical activity and perceived barriers and facilitators of physical activity in assisted living accommodation.

Little research, however, exists on the role of the environment and its effect on healthy behaviour of older adults living in assisted care in aged care facilities. In addition, little is known about the barriers and facilitators of physical activity of older people living in assisted care.

**Study aim**

The overall study aim was to explore the perceived barriers and facilitators of physical activity behaviour in older old adults in assisted living accommodation and to link the findings to physical activity levels and functional indicators using qualitative and quantitative methods. Specifically, the objectives are:

1) To identify perceived barriers and facilitators to participating in physical activity for the older old living in assisted care accommodation compared to independent living

2) To explore the relationship of place of residence (assisted living and independent living) to self-report and objectively measured physical activity levels and functional indicators.

3) To assess the value of self-reported physical activity measures in this population, specifically the convergent validity between self-reported and objectively measured physical activity and association with functional indicators.
CHAPTER 2: Methods

Study design

A cross sectional study was undertaken with older old adults who live in assisted accommodation as the main focus. Residents in independent living in the same village were chosen as the comparison group to enable control for place of residence or setting. Independently living residents are also assumed to be representative of community-dwelling older adults at the same age, with caveat of more representing females than males. In general, retirement villages have greater female to male ratio than in the community as women are more likely to move to secured accommodation, particularly if they live alone. Women are also more to live in secured accommodation because they live longer and have more health conditions (Australian Bureau of Statistics (ABS), 2012-2013).

Participants and recruitment:

A convenience sample of 40 participants were recruited from a retirement village in metropolitan southern Sydney of 270 residents. This retirement village has three levels of care; independent living, assisted living and nursing home (high care). Residents from independent living and assisted living were invited to be part of the study. Participants were required to be English speaking, able to walk independently with or without a walking aid and able to provide consent. Participants were excluded if they had dementia that prevented them from following instructions or giving informed consent. The study was approved by the Human Research Ethics Committee of The University of Sydney (HERC Number: 14416) (see Appendix 1) and approval from the Board of Directors of the retirement village (see Appendix 2). Written informed consent was obtained from all participants (see Appendix 3).

All people residing in the independent and assisted living accommodation in the retirement village were invited to participate in the study through an advertisement in their mailbox. A notice was also posted on a closed circuit TV channel, which was used by the retirement village to display notices to all residents’ televisions in their apartments. The advertisement asked for volunteers to participate in a study on active and sedentary lifestyles and sharing their experience in physical activity participation (see Appendix 4). Interested participants were invited to contact the researchers. Recruitment was staggered and stopped until the target sample size of forty people was reached; twenty of whom were living independently in self-care units and twenty requiring assistance, living in the hostel (assisted living). This sample size was calculated to form two focus groups from each level of care of 8-10 participants in each group.

The study consisted of two phases. In Phase 1, physical measures and face to face interviews were conducted. These interviews and physical measures took place in a private room in a common meeting area in the retirement village. The
interviews recorded length of time at current residence and significant co-morbidities participants perceived as limiting walking and participation in physical activity. Isometric quadriceps strength for each leg was measured by a cable tensiometer and balance was assessed with the Near Tandem Stand test (Lord et al., 2007). To assess objective physical activity, participants wore a SenseWear armband for 7 days during waking hours (see Appendix 5). This was applied following the physical measures (see Appendix 6). In Phase 2, one month after Phase 1, four focus groups were held (2 with assisted living and 2 with independently living participants). Focus groups were held in meeting rooms in a common area in the retirement village. Participants selected one of two options that was convenient for them (see Appendix 7 for focus group lead questions). Of the 40 participants who had baseline data collected, 30 of these individuals participated in the focus groups, with numbers in focus groups ranging from 6-12 participants.

Qualitative methods

The duration of each focus group was between one to two hours. Specific themes identified from the literature acted as guides for key topics discussed. Key topics leading discussion were barriers and facilitators to physical activity, current physical activity and specific activities that participants considered would increase participation in physical activity (Baert et al., 2011; Buman et al., 2010; Costello et al., 2011; McMurdo et al., 2012; Moran et al., 2014; Schutzer & Graves, 2004). The focus group discussions were audio recorded and transcribed verbatim into a written format. The transcripts were de-identified for participant confidentiality.

Qualitative Analysis

Thematic analysis was the qualitative research analytic approach used in this study (Braun & Clarke, 2006; MacMillan et al., 2014). A constructionist thematic analysis approach was used to organise and explain the perceived barriers and facilitators to participating in physical activity of older people living in different levels of care in a retirement village (Braun & Clarke, 2006; MacMillan et al., 2014). Coding was initially done by a single researcher and transcripts were subsequently coded by an independent coder to ensure rigour (Barbour, 2001). Themes were identified as patterns in the data. Tables were developed to collate major themes and subthemes. Excerpts were included in tables to illustrate the meaning and indicate frequency of themes.
Quantitative methods

Physical measures

Physical measures were recorded for all participants. Participants were measured for height and weight and body mass index (BMI) was calculated from these measures. Other physical measures included leg strength and a static balance measure. Strength and balance measures were chosen to reflect functional status (Perera, 2006). Lower limb strength was measured by measuring isometric quadriceps strength for each leg by a cable tensiometer. Participants were positioned in a standard chair with arm rests, sitting with their knees flexed ninety degrees. Their feet were elevated from the floor and their arms crossed on their chest so as to prevent them using their arms. A seat belt was tightened across the thighs to prevent the participant from lifting their leg, thus isolating the quadriceps muscle action. The cable tensiometer was attached to the ankle via a cuff, positioned just above the malleoli. The distance was measured from the lateral knee joint line to the centre of the cuff. Participants were asked to push against the cuff as though they were attempting to straighten the knee. Three trials were taken; however, if the measure kept increasing, this process was repeated until the last trial was a lesser value compared to the previous trial.

Balance was assessed with the Near Tandem Stand test (Lord et al., 2007) which requires a participant to stand in a near-tandem position with their bare feet separated laterally by 2.5 cm and the heel of the front foot 2.5 cm anterior to the great toe of the back foot. Participants choose which foot to place in the forward position for the test. The position is held for thirty seconds with eyes open and thirty seconds with eyes closed. The time that a participant held this position before a step was taken or the eyes were opened in the eyes closed condition was recorded as the score. The participants were allowed two attempts. A research assistant stood next to the participant in the event the participant reached out to steady themselves.

Measurement of physical activity

The most common physical activity parameters that can be measured are energy expenditure, intensity, frequency and duration. These parameters can be measured by direct methods (measuring the behaviour) with accelerometry, considered as objective and more accurate, or by self-reported questionnaires, which are subjective but contain details complementary to objective methods such as the type of activity (walking, weight training, or swimming), which cannot be accessed by activity monitors, as well as the environment and social context (Bauman & Merom, 2002). Furthermore, accelerometers are particularly useful in measuring light activity which is usually not asked in physical activity questionnaires but is the major source of physical activity for older old adults (Horgas et al, 1998; Merom et al, 2013). However, as accelerometry is a relatively new measurement of physical activity in older adults, there is a lack of normative data and no consensus on cut
points. Cut points developed for younger populations may not correctly estimate an older person’s physical activity, especially when measuring moderate to vigorous activity (Evenson et al, 2012). There is also no consensus regarding the optimum number of days to record physical activity using objective instruments. The majority of the studies in the systematic review by Taraldsen et al (2012) about accelerometer-based body worn sensors on older people instruments collected data for one week.

To collect a comprehensive picture of the physical activity of the older adults in this study both methods of measuring physical activity in older adults, self-report questionnaire and SenseWear accelerometry, were used. Data were also collected for seven consecutive days.

**Self-report physical activity measurement**

Self-reported physical activity was measured using the International Physical Activity Questionnaire short form (IPAQ SF). Although the IPAQ was not specifically designed for the older population, it has been used quite extensively in this population. The IPAQ-C has been shown to be reliable (Forsen, et al, 2010). It has not been validated against objective measures of physical activity. Therefore, it is important to examine the relationship between IPAQ (self-report) and SenseWear (objective) measurement instruments in this study population (Forsén et al., 2010). The IPAQ protocol was followed. Seven questions were asked in order, using the wording provided so as not to affect the psychometric properties of the instrument (Committee, 2005). Participants were asked to consider the previous seven days. They were asked about how many days in the week they participated in vigorous and moderate activity. Examples of vigorous and moderate activities were provided. Participants were also asked to estimate how many hours or minutes they spent in vigorous and moderate physical activity. Participants were also asked to recall the number of days where they walked for at least ten minutes and the duration or time in hours or minutes that they walked on these days. Lastly, participants were asked to recall the total time spent in sitting over the last seven days. (See Appendix 5 for entire questionnaire).

Separate scores were recorded for walking, moderate intensity and vigorous intensity activity. A total score to describe the overall level of activity was derived from summation of the duration in minutes and frequency in days of walking, moderate intensity and vigorous intensity activity. The volume of activity was computed by weighting each type of activity by its energy requirements defined by METS to result in a score in MET-minutes. The data collected with the IPAQ were recorded as a continuous measure as median MET-minutes. Median intensity values were used following the IPAQ scoring protocol, 3.3 METs for walking, 4 METs for moderate-intensity and 8 METs for vigorous –intensity. Participants’ reported days of activity and duration of each activity were multiplied by the corresponding METs value. A combined total physical activity MET-minute for the week (MVPA) was derived from the sum of walking and moderate and vigorous MET minute for the
week (Craig et al., 2003). Total weekly MET-minutes were divided by 7 to get an average daily estimate to compare with Sense wear averaged daily estimates. For example, 4 days of walking x 30 mins per day x 3.3 METS = 396 MET.min/week = 56.6 MET.min/day.

Following the physical measures, participants were fitted with a Sense Wear armband (Body Media Inc. Pittsburgh, PA) and instructed on its use. The SenseWear armband is a portable multisensory device that measures energy expenditure (Liden et al, 2002). The SenseWear armband was chosen because of the capability of this device to measure changes in skin temperature during activity. The embedded algorithms allow for differentiation of a rise in skin temperature associated with activity even in a seated position. Seated or chair based activity, which may account for a large percentage of an older person’s physical activity, was recorded at the level of energy expenditure. As the device is attached to the upper arm it may better capture upper body movement associated with household duties that do not involve vertical movement or locomotion. Accelerometers that attach to the lower limb may not capture this information.

The armband monitor was attached above the elbow on the posterior aspect of the upper arm (over the triceps muscle) as instructed by the Body Media Incorporation. Participants were instructed to wear the arm band for seven days during waking hours. They were specifically instructed to put the device on after waking and remove only during the day for a shower. They were also instructed to remove the device on retiring to bed. Written instructions with these verbal instructions were given to the participant. Photographs of the correct position of the device on the arm were also included in the instructions given to the participant. Participants were also given a contact number to call if there were any problems with the device or if any problems arose in its application (see Appendix 5). The participants were instructed to record in a diary if they did not wear the monitor during these seven days. The data were downloaded from the physical activity monitors onto Sense Wear media files. The files contained a summary of hours of armband data, energy expenditure, steps per day, average METs and sedentary behaviour and light, moderate and vigorous physical activity duration. Light physical activity was recorded by the SenseWear by a cut point of 1.5-2.9 METs. The minutes per day were recorded. Moderate to vigorous physical activity was defined by the cut points of 3.0 METs and above.

Quantitative analysis

Differences in participants’ demographic, health and physical activity profile by type of residency were examined using the chi-square test for categorical variable and t-test or Wilcoxon tests for continuous variables with parametric and non-parametric distributions, respectively. Due to large differences in mean age and physical functioning between participants from each residential type, further examination was conducted to detect whether differences in physical activity and inactivity indicators between resident types remained after adjusting for age and physical limitations.
The associations between physical activity levels as measured by IPAQ and SenseWear were analysed using the SAS software system. The CORR procedure was used to calculate correlations between the following IPAQ and Sense Wear physical activity measures. Variables measured were moderate to vigorous physical activity and time in sitting. A spearman correlation coefficient was used as the physical activity data were not normally distributed. The Bland-Altman plot was produced in order to visualise any pattern in departure from the average activity level as measured by the objective and self-reported measures. We adopted Bland’s definition of “empirical” support for the presence of a relationship based on p-values (Bland, 1995). A p-value greater than 0.1 equates to little or no evidence; p-value between 0.05 and 1 equates to weak evidence; p-value less than 0.01 equates to strong evidence and p-value less than 0.001 is equated with very strong evidence. Due to small sample size, weak evidence is reported as probable evidence if sample power were to increase.
CHAPTER 3: Results

From the sample of 40 participants, 30 of these individuals participated in the focus groups, with numbers in focus groups ranging from 6-12. Overall, 67.5% of participants were females. Participants residing in assisted living were significantly older (89.2 ± 6.8 years) than those living in the independent living (78.9 ± 5 years). Gender, Body mass index (BMI) and number of chronic diseases were not significantly different between the groups. Participants in independent living had lived significantly longer at their place of residency (8.3 ± 5.7 years) compared with the participants in assisted living (1.7 ±1.4 years). Table 1 describes the characteristics, health profile and physical status of the participants.

Focus groups

Several themes emerged from the focus groups. Themes were identified as barriers, facilitators, and suggestions that would increase participation in physical activity. These themes are discussed and quotes are presented in Tables 2 and 3.

Barriers

Several common themes emerged as barriers that were common to both groups. Although both groups had barriers in common, the importance of barriers differed between the groups. Barriers common to both groups were health, fear of risk of injury, lack of companion and motivation. Barriers that differed between the groups were lack of time, which was a theme that emerged only in the independent living focus groups. Barriers that were limited to the assisted living group were old age and perceived difficulty of physical activity.

Facilitators

Three major themes emerged as facilitators of physical activity: the physical environment, the social environment and personal factors. The sub themes of physical environment were scenery, convenience of facilities, accessibility of paths, and strategic placement of seats. Participants described the presence of seating, especially in the outdoor areas as important as they felt confident to walk if they knew that they could sit and rest at regular intervals. The term “strategic placement of seats” is used to denote seating with short distance between them. Scenery was important to both groups. The sub themes that emerged as important to independent living were short walking distances to gym, shops and parks, and sub themes of personal factors emerged as self-motivation, discipline and commitment. Sub themes that emerged as important to the assisted living group were accessibility of paths and the strategic placement of seats. The sub themes of social environment that emerged for both groups were the importance of social aspect of physical activity, the friendliness of people, social support, including a companion, and assistance of others.
The social aspect of physical activity was seen as important by both groups. The independent living group identified having a companion, organised activities and self-motivation as important in facilitating physical activity. Organised walking groups and dancing were the specific activities identified by the participants as most likely to increase participation in physical activity in the independent living group. Assisted living participants identified assistance of staff and encouragement of other participants as an important facilitator of physical activity.

The 7 participants who did not attend to focus groups were not different to those attending the focus group except for a lower number of steps per day than those who did participate.
Table 1-Participant characteristics, health profile and physical activity status by residency type

<table>
<thead>
<tr>
<th>Variables</th>
<th>Assisted Living N=20</th>
<th>Independent Living N=20</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Males: Females</td>
<td>6:14</td>
<td>7:13</td>
<td>ns</td>
</tr>
<tr>
<td>Age (years) mean ±SD</td>
<td>89.2 ± 6.8</td>
<td>78.9 ± 5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²) mean ± SD</td>
<td>26.6 ±5.6</td>
<td>25.1 ± 4.4</td>
<td>ns</td>
</tr>
<tr>
<td>Overweight &amp; obese n (%)</td>
<td>11 (55)</td>
<td>9 (45)</td>
<td>ns</td>
</tr>
<tr>
<td>No. of chronic diseases * mean ± SD</td>
<td>2.9 (1.5)</td>
<td>2.6 (1.9)</td>
<td>ns</td>
</tr>
<tr>
<td>Self-report limitation in walking, n (%)</td>
<td>2 (10)</td>
<td>2 (10)</td>
<td>ns</td>
</tr>
<tr>
<td>Self-report limitation in physical Activity n (%)</td>
<td>1 (5)</td>
<td>3 (15)</td>
<td>ns</td>
</tr>
<tr>
<td>Participated in focus groups n (%)</td>
<td>13 (65)</td>
<td>17 (85)</td>
<td>0.038</td>
</tr>
<tr>
<td>Walking minutes/week (median, Q25; Q75)</td>
<td>165 (82;210)</td>
<td>120 (55;217)</td>
<td>ns d</td>
</tr>
<tr>
<td>MVPA b minutes/week (median, Q25; Q75)</td>
<td>315(202; 397)</td>
<td>217 (110; 675)</td>
<td>ns d</td>
</tr>
<tr>
<td>Meeting guidelines by self-report n, (%)</td>
<td>15 (75)</td>
<td>12 (60)</td>
<td>ns d</td>
</tr>
<tr>
<td>Average steps per day mean ± SD</td>
<td>1620 ± 1854</td>
<td>5802 ± 2733</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Average MVPA b minutes/day mean ± SD</td>
<td>43 ± 42</td>
<td>74 ± 70</td>
<td>0.093 d</td>
</tr>
<tr>
<td>Average LIPA c minutes/day mean ± SD</td>
<td>76 ± 64</td>
<td>129 ± 62</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>Average sitting hours per day</td>
<td>10.5 ± 1.3</td>
<td>10.0 ± 2.1</td>
<td>ns</td>
</tr>
<tr>
<td>Right leg strength (Nm) mean ± SD</td>
<td>48.8 (22.5)</td>
<td>73.7 (30.9)</td>
<td>0.01 d</td>
</tr>
<tr>
<td>Near tandem stand eyes open mean ± SD</td>
<td>15.8 (6.8)</td>
<td>24.8 (6.3)</td>
<td>&lt;0.001 d</td>
</tr>
<tr>
<td>Near tandem stand eyes close mean ± SD</td>
<td>9.1 (7.3)</td>
<td>17.5 (8.6)</td>
<td>0.003 d</td>
</tr>
</tbody>
</table>

a Any chronic conditions included: cancer, heart disease, stroke, high blood pressure, diabetes, COPD, asthma, Osteoarthritis, Osteoporosis, Parkinson’s Disease, depression, anxiety diagnosed by doctor.

b MVPA = Moderate to vigorous-intensity physical activity that is (≥3 METs)

c LIPA = light-intensity physical activity (1.6-3METs)

d Non-parametric test Wilcoxon
Nm= Newton metres
Overweight or obese= BMI definitions
<table>
<thead>
<tr>
<th>Sub themes</th>
<th>Independent living</th>
<th>Excerpt Number</th>
<th>Assisted living</th>
<th>Excerpt Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>“I have Osteoarthritis and I find that restricts me sometimes and also because of my knee replacement I have trouble getting down to my feet and things like that. I think it’s when you are stiff and you can’t do things.”</td>
<td>002 Female, 75 years</td>
<td>“It’s just [my] diabetes so bad at the moment …so it’s not very healthy it doesn’t induce me to do any exercises”.</td>
<td>016 Female, 88 years</td>
</tr>
<tr>
<td>Fear of injury</td>
<td>“I used to walk every morning here until I had that fall 13 years ago and I have never walked early in the morning again because it frightened me and I really had a bad fall”</td>
<td>009 Female, 83 years</td>
<td>“Well I used to play bowls for, 40 years but I can’t play indoor bowls here now because I can’t balance, I’d fall over”</td>
<td>036 Female, 91 years</td>
</tr>
<tr>
<td>Motivation</td>
<td>“For me a lot of it is just lazy, I’m a bit lazy and I think I should go for a walk, I really should go for a walk, I couldn’t be bothered.”</td>
<td>021 Male, 73 years</td>
<td>“It’s really whether I am in the mood or not. There are quite a few nice activities that normally I might be prepared to go to but ah you can ask anybody. Given half the chance, I will go and lie down.”</td>
<td>034 Male, 75 years</td>
</tr>
<tr>
<td>Lack of companion</td>
<td>“I think it would be a good idea if you could have a companion, not to go by yourself because often I will walk into the shops, you see people in twos, and that way you sort of can’t renge, you’ve got to go and I suppose it a bit more pleasant too”.</td>
<td>001 Female, 84 years</td>
<td>“It’s nice too if you get a mate.”</td>
<td>045 Female, 89 years</td>
</tr>
<tr>
<td>Lack of time</td>
<td>“I find that I seem to be so busy that sometimes I just don’t have time I don’t know why that is but I’m involved in more things or whether things take longer to do I don’t know but I find sometimes I don’t have the time.</td>
<td>008 Female, 69 years</td>
<td>Not discussed</td>
<td></td>
</tr>
<tr>
<td>Perceived difficulty</td>
<td>Not discussed</td>
<td>028 Female, 90 years</td>
<td>“It’s just getting an effort.”</td>
<td></td>
</tr>
<tr>
<td>Old age</td>
<td>Not discussed</td>
<td>033 Male, 98 years</td>
<td>“I think when you are younger you are involved in sport, some type of physical activity and because when you are younger you are free of a lot of things you get as you get older, disabements and that sort of thing, complaints.”</td>
<td></td>
</tr>
<tr>
<td>Sub themes</td>
<td>Independent living</td>
<td>Excerpt Number</td>
<td>Assisted living</td>
<td>Excerpt Number</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>----------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Physical environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenery</td>
<td>“The trees they make the place just lovely, beautiful. ”</td>
<td>1.7a</td>
<td>“And again the gardens are beautifully kept.”</td>
<td>1.7b</td>
</tr>
<tr>
<td></td>
<td>002 Female, 80 years</td>
<td></td>
<td>034 Male, 75 years</td>
<td></td>
</tr>
<tr>
<td>Convenience of walking distance</td>
<td>“The station would take me roughly 10 minutes at the most but if I want to go for a walk I will walk down there.”</td>
<td>1.8</td>
<td>Not discussed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>014 Female, 77 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility of paths</td>
<td>Not discussed</td>
<td></td>
<td>“We do a fair bit of walking around here; we haven’t had any trouble [with the paths].”</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>026 Female, 94 years</td>
<td></td>
<td>026 Female, 94 years</td>
<td></td>
</tr>
<tr>
<td>Placement of seats</td>
<td>Not discussed</td>
<td></td>
<td>“And I go for a walk if I get tired sit on a garden bench or my walker”</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>045 Female, 89 years</td>
<td></td>
<td>045 Female, 89 years</td>
<td></td>
</tr>
<tr>
<td>Social environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friendliness of people</td>
<td>“I find people that you meet on a walk are very friendly.”</td>
<td>1.11a</td>
<td>“Everybody is so friendly and nice. You need never be lonely. You can just walk outside and somebody always stops and talks to you”.</td>
<td>1.11b</td>
</tr>
<tr>
<td></td>
<td>004 Male, 85 years</td>
<td></td>
<td>052 Female, 91 years</td>
<td></td>
</tr>
<tr>
<td>Social support</td>
<td>“Particularly if you are a widow or widower you’re surrounded by people that understand your situation that means a lot you can relate to people”.</td>
<td>1.12a</td>
<td>“I notice lot of people are interested in shuffle board,… but they sit around and watch each other and barrack each other along”.</td>
<td>1.12b</td>
</tr>
<tr>
<td></td>
<td>013 Male, 85 years</td>
<td></td>
<td>034 Male, 75 years</td>
<td></td>
</tr>
<tr>
<td>Personal factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>“Do what we needed to do, but you know, get people enthused about doing things. We have to do things to keep people active.”</td>
<td>1.13</td>
<td>Not discussed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>002 Female, 80 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commitment</td>
<td>“You have to have people make a commitment to attend.”</td>
<td>1.14</td>
<td>Not discussed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>002 Female, 80 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discipline</td>
<td>“Yeh well I’ve made up my mind I was going to go the gym for an hour every morning.”</td>
<td>1.15</td>
<td>Not discussed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>021 Male, 73 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objective physical activity measures

Physical activity objective measures were collected from all participants but only 14 (70%) of assisted living participants and 18 (90%) of independent living participants were able to be analysed. Objective data was not able to be analysed due to the SenseWear devices not recording for sufficient periods. The reason for lack of recording was usually due to the participant wearing the sensor incorrectly. This difference in coverage of objective assessment is not significant. The participants in independent living had a significantly greater number of average steps per day, 5802 (SD ± 2733) steps per day compared with the assisted living participants who had 1620 (SD ±1854) steps per day p<0.001. Moderate to vigorous intensity physical activity, defined as ≥3 METS, was approaching significance between the groups with assisted living participants achieving an average of 43 (SD ±42) minutes per day and independent living participants achieving an average of 74 minutes (SD ±70) per day (p=0.093) non parametric test Wilcoxon. The independent living participants on average spent 129 minutes (SD ± 62) per day in light intensity physical activity defined as 1.6-3.0 METS. This was significantly more than the assisted living group who on average spent 76 (SD ±64) minutes per day in light intensity physical activity. The average hours of sitting between the groups did not differ significantly.

However, after adjusting for the effect of age and limitations in physical activity steps per day remained significantly higher for the independent living group, 4796 adjusted mean steps per day compared with 2941 adjusted mean steps per day (p=0.08). Although there were no differences between assisted and independent living participants in the proportion of reported limitations to physical activity or walking, functional indicators, balance (near-tandem eyes open) and leg strength were significantly lower for assisted living compared to independent living. There was no significant difference for the near-tandem with eyes closed, which is harder to complete irrespective of age. (See table 4).
Table 4-Adjusted* means of physical activity, sitting and functional parameters according to type of accommodation derived from General Linear Regression model

<table>
<thead>
<tr>
<th></th>
<th>Assisted</th>
<th>Independent</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps per day</td>
<td>2841 (865; 4927)</td>
<td>4796 (3221; 6453)</td>
<td>0.089</td>
</tr>
<tr>
<td>MVPA mins/d</td>
<td>100 (49; 150)</td>
<td>103 (63; 143)</td>
<td>0.901</td>
</tr>
<tr>
<td>LIPA mins/d</td>
<td>117 (61; 175)</td>
<td>132 (87; 177)</td>
<td>0.650</td>
</tr>
<tr>
<td>Sitting hrs/d</td>
<td>9.1 (7.5; 10.6)</td>
<td>9.2 (7.9; 10.4)</td>
<td>0.910</td>
</tr>
<tr>
<td>Right Leg Strength</td>
<td>0.61 (0.33; 0.89)</td>
<td>0.95 (0.72; 1.17)</td>
<td>0.039</td>
</tr>
<tr>
<td>Near tandem eyes open</td>
<td>13.7 (8.6;18.8)</td>
<td>22.8 (18.7; 27.0)</td>
<td>0.003</td>
</tr>
<tr>
<td>Near tandem eyes closed</td>
<td>9.6 (4.5; 14.7)</td>
<td>11.6 (7.4; 15.8)</td>
<td>0.495</td>
</tr>
</tbody>
</table>

* = adjusted for age and limitations in physical activity

Self-reported physical activity

All participants completed a self-report questionnaire on physical activity levels via the IPAQ. There were no significant differences between the groups on walking minutes per week, MVPA and percentage of participants meeting the physical activity guidelines by self-report. However, there was a tendency for participants’ in assisted living to report higher medians on all these parameters. For example, participants in assisted living reported a median of 315 minutes per week doing moderate to vigorous physical activity, interquartile range (202; 397) compared with 217 median minutes reported by independent living participants with an interquartile range of (110; 675).

Comparison between objective and self-report measures of physical activity

Moderate to vigorous physical activity (MVPA)

Figure 1 is a Blant-Altman plot for IPAQ MVPA expressed in minutes per day and SenseWear MVPA minutes per day. The mean differences between the two instruments is 151 minutes a day and the limit of agreement ranged from 609 minutes a day to 307 minutes a day, suggesting huge variations between participants. The figure shows an error pattern; at the lower end of the physical activity spectrum, the error tends to be more consistent and usually under-estimates self-report compared to SenseWear. However, as physical activity level approaches the higher end of the spectrum of MVPA, the error tends to increase almost linearly with IPAQ overestimating the SenseWear reading. Since some of this pattern can be due to the skewed distribution of physical activity data we have carried a log 10 transformation of the MVPA readings of both instruments when data are normally distributed (See Figure 2). Figure 2 continues to show a pattern of errors below and above the mean difference line. The majority of the readings at the lower range of physical activity are under-estimating
IPAQ compared to SenseWear, however, there is more heterogeneity between participants. The majority of the dots at the upper end of the physical activity levels are over estimations of IPAQ compared to SenseWear.

Figure 1 - Bland–Altman plot comparing moderate to vigorous intensity physical activity: IPAQ MVPA with SenseWear MVPA
Figure 2 - Bland–Altman plot comparing Log 10 moderate to vigorous intensity physical activity IPAQ MVPA with SenseWear MVPA

Sitting behaviour

The Blant–Altman plot (Figure 3) compares self-reported sitting, measured by IPAQ, with minutes per day spent in sitting, measured by SenseWear. The figure indicates that self-reported sitting was an under-estimation of the SenseWear data by a mean difference of 269 minutes a day. However, the error was spread in a random manner with no specific pattern across the different levels of the average sitting time; that is both high and low levels of sitting had mean differences above and some below the mean difference. There was one outlier that reported greater time spent sitting by self-report than the SenseWear and was outside of the whole group limits of agreement -3 to -535. This consistent and random pattern of error may explain the better correlation between the two instruments for sitting.
Comparison of age-adjusted functional indicators and physical activity measures

The associations between steps per day (dichotomised as below 6,000 steps/day, considered as low ambulation) and functional indicators (strength and balance) adjusted for age were low. Analysis of covariance for strength and steps per day (Figure 4) showed minimal differences in average leg strength for low and high steps per day with participants of both groups. A similar pattern was recorded for balance and steps per day (figure 5). Analysis of covariance showed minimal differences (1 second) in the ability to maintain eyes closed near tandem stand for 30 seconds for low steps per day (<6000) and high steps per day.

The association between MVPA and balance was also low (Figure 6). Analysis of covariance showed minimal differences between balance and low MVPA (below median of 42 minutes) and high MVPA (above median of 42 minutes).

Sitting behaviour was inversely associated with functional indicators. That is, the more hours spent in sitting correlated with decreased strength and balance.
The association between physical activity (objectively measured) and functional indicators were tested on 31 participants with at least 2 valid days of SenseWear data. All the correlation coefficients between steps and functional indicators as continuous variables (strength or balance) adjusting for age were very low (Spearman rho< 0.1). This was the same when comparing MVPA (minutes) and functional indicators, for example the Spearman rho partial correlation between MVPA and time in tandem stand was 0.05. Similarly, the correlation with steps per day and eyes closed tandem stand was 0.09. This is also very poor. The high steps group stood about 1 second more than the low steps group (age adjusted beta was 0.99 p =0.739). This was for only 31 participants with at least 2 valid days which equates to basically no difference between the groups. For strength, the beta coefficient was -0.10 (p=0.531) comparing the high steps group with the low steps group. The same pattern was noted for those low and high MVPA: That is, no difference between the groups. The beta coefficient for strength for the high MVPA group versus low MVPA group was 0.022. For balance, the results were in an unexpected direction: The high MVPA group stood for 2 seconds less than low MVPA group (beta -2.85000538, p=0.212).

![Analysis of Covariance for strength](image)

Figure 4- Analysis of covariance for strength and low steps per day. (<6000 steps per day)
Figure 5 - Analysis of covariance for balance and low steps per day (<6000 steps per day)

Figure 6 - Analysis of covariance for balance and low MVPA (below median of 42 minutes)
CHAPTER 4: Discussion

To our knowledge, this research is only the third study that examined barriers and facilitators to physical activity participation among older old adults who do not reside in the community (Ingrid & Marsella, 2007; Weeks et al., 2008) and the first study to use both quantitative and qualitative methods with this population. Participants in assisted living and independent living accommodation identified similar barriers and facilitators to participation in physical activity, however, the relative importance of these barriers and facilitators differed substantially between the two levels of accommodation reflected by the different frequency with which they were mentioned. Health concerns, fear of injury and lack of motivation were overarching barriers to participation. Environmental factors, whether physical or social, emerged as the facilitators for participation in both groups. Social factors (encouragement of others and staff involvement) emerged as important facilitators in assisted care accommodation. Intrapersonal issues (e.g., laziness, lack of motivation) were more pronounced in independent care accommodation. Lastly, there were minimal differences in objectively measured physical activity patterns between older old adults living in assisted and independent living accommodation when adjusting for the age differences, with the exception of ambulatory activity (i.e., average steps per day). Against expectations, a higher level of physical activity was reported by assisted living residents on self-reported questionnaire.

As expected, health status was the main barrier for physical activity; yet, health was also mentioned in the independent living group as a facilitator in that it provided an incentive to be physically active to prevent further functional decline. The assisted living participants viewed health as a bigger issue than did participants living independently, which may be explained by the lower functional status of this group, with differences in balance and leg strength remaining significant after accounting for the age differences and self-reported limitations. Alternatively, it is possible that the greater emphasis on health was due to participants in assisted living having moved into care due to ill health, which made the health issue more prominent in their recent experience.

The independent living group perceived risk of injury and fear of falling as major barriers for physical activity. This may be because the independent living residents could possibly engage in physical activity that is potentially riskier or in a wider environmental context. (i.e., walking to shops or train station, walking in crowds). In this respect they are no different to community-dwelling older adults. The injury most mentioned was due to falling. Findings from a systematic review of community dwelling older adults identified fear of different origins as barriers to physical activity; fear from going outside at dark, fear from injury, or fear from exercising outside (Baert et al, 2011). These fears have also been reported to increase with age (Baert et al., 2011). By contrast, the participants in assisted living did not perceive falling as much a risk, possibly due to the supervision or assistance of staff, or due to limiting their physical activity to safer environments confined to the
boundaries of the retirement village. This is supported by the objectively measured physical activity pattern of this group whose ambulatory activity was significantly lower compared to those living in independent living accommodation.

A wide range of intrapersonal barriers for physical activity in old age were also listed in the systematic review by Baert et al, 2011. This study’s findings confirm the diversity of personal factors identified in the systematic review. The barriers to participating in physical activity such as, not being motivated, lazy, lack of discipline or commitment featured more commonly in the independent living group. This may be due to these participants acknowledging that they can do more but they lack the personal attributes that will enable them to act upon this. Lacking energy to exercise and caregiving duties ranked among the top four most frequently reported barriers among older women from all ethnic groups in a study in United States of America (USA) (King et al., 2000).

The most prominent interpersonal facilitators were related to the social environment. With people living independently, friends or other residents acting as companions in physical activity was seen as an important facilitator for physical activity. Whereas people living in assisted living accommodation reported that assistance from staff would facilitate physical activity. The importance of social support to be physically active has been noted by other studies from the USA, but mostly for women (King, 2001). In this study the issue of social support was also mentioned by men (both independent and assisted living), which may suggest that as people age the gender differences may be reduced.

Although the role of the physical environment in influencing physical activity levels has been extensively researched in the past 10 years, findings from studies with older adults that utilised objective measures of environments’ walkability are inconsistent (Van Cauwenberg et al., 2011). On the other hand, qualitative studies with older adults consistently indicate that adequate pedestrian infrastructure, safety (from traffic and crime), close-by shopping, services including public transport, neighborhood attractiveness/aesthetics, and environmental conditions (that is, weather and air quality) are important facilitators of older adults’ physical activity (Moran et al., 2014). These aspects were also mentioned as key attributes to influence active ageing in focus groups in the USA (Michael, Green, & Farquhar, 2006). In this study, despite living in the same geographical area, there were differences in importance of aspects of the environment. For independent living participants’ short walking distances to facilities such as the gym, shops and parks were the most important aspects, whereas for the assisted living group, accessibility of paths and the strategic placement of seats (seating situated with short distances between them) were more important. This may reflect a lower level of cardiovascular fitness of these older old adults.

Scenery emerged as a facilitator of physical activity and was important to both groups. Consistent with findings of previous studies in older adults, the themes of pleasing neighbourhood aesthetics surroundings and green spaces for walking as facilitators to physical activity emerged in all focus groups (Brownson et al., 2000; King et al., 2000; Lees, Clarkr, Nigg, & Newman, 2005; Takano, Nakamura, & Watanabe, 2002). Although objective measures were not used to assess the quality of
the environment in this specific retirement village, the impression of the author is that the retirement village is set in a pleasant bush land setting. There is a small number of benches placed throughout the grounds of the village. Some of the paths were disrupted by tree roots and covered in tree twigs. Residents were required to walk on some roads used by cars; however, the speed limit for cars was designated at ten kilometres per hour. Walking was the most common activity that both groups participated in on a regular basis. Whether these participants are less active than would be expected for their age and place of residence is difficult to assess, as there are very few studies that have measured activity levels in assisted living settings. The median average steps for assisted living in our study was 898 steps per day which appears very low when compared to previous studies. Step defined physical activity levels ranged from 6000-8000 in healthy older adults living the community in Australia (Tudor-Locke et al., 2011). The population in this present study differs from the previous reported study in age range, (50 years and over compared with 75 years and over), and in place of residence (community compared with assisted living). However, in an Australian study, 12% of community-dwelling older adults aged 80 years had 8000 steps/day or above (Ewald, Duke, Thakkinstian, Attia, & Smith, 2009). In this respect, this sample presents a very low level of ambulatory activity, even for their age, compared to the community. For older adults who live with chronic conditions and disability the population studies indicate a range of 1,000-4000 steps/day (Tudor-Locke et al., 2011). Again using this as a comparison group, in general the activity level of participants in this study is lower. This may highlight the possibility that in this particular retirement village, improving the physical environment and increasing social support would result in greater ambulation.

Participants from both assisted living and independent living accommodation over-estimated physical activity levels using the IPAQ. This is consistent with findings of other studies (McMurdo et al., 2012). In an Australian study of 41 community-dwelling seniors aged 65-89 years, IPAQ was found to pose substantial cognitive burden, which resulted in numerous recall errors (Heesch et al., 2010). The assisted living group in the current study had the lowest objectively measured physical activity levels and the highest physical activity levels by self-report, which corroborates the findings from cognitive interviewing; mistakes can be in recall of activities for an average week, recalling only activities that lasted >10 minutes and double counting the activity several times (Heesch et al., 2010). Additionally, these participants may walk slower and have sat for longer (at seating provided at regular intervals) resulting in them miscalculating the exact duration they were walking/being active. A major finding in this study was that participants over-estimated physical activity using the IPAQ compared to objective measures by the SenseWear. The poor agreement between the two measures may be attributed to the heterogeneity of the sample in terms of physical function, mobility and possibly fitness levels rather than large reporting errors. Yet given the consistent low validity of self-report questionnaires (Heesch et al., 2010), it is more likely that participants over-estimated their activity measured by IPAQ. However, there are other considerations to take into account when comparing variables that measure physical activity in older adults. When MET cut points are included in the calculation, such as, average MET.min
per day with SenseWear and average MVPA MET.min per day minutes with IPAQ, the measurement error is compounded and the correlation becomes worse. This is because absolute cut points for older adults can underestimate the intensity of the physical activity being performed. This error can be magnified when averages are calculated from inaccurate estimates of physical activity intensities (Evenson et al., 2011). Due to the tendency for over reporting physical activity levels in self-report measures of physical activity, they should be considered cautiously, especially in the older old living in assisted care.

There was however, greater agreement between the IPAQ and SenseWear when measuring sitting behaviour. The participants were able to recall more accurately the amount of time they spent sitting, compared to sitting as measured by SenseWear. There may be less cognitive burden remembering sedentary behaviour than active behaviour. Sitting behaviour is also a less confusing concept than trying to distinguish between light, moderate and vigorous physical activity. Participants were also able to anchor the sitting behaviour to other behaviours such as eating, watching television or reading a book.

Functional indicators appear unrelated to measures of physical activity such as MVPA and steps per day. The lack of association between functional indicators and physical activity measures highlights the inability of these aerobic dimensions to influence strength and balance. This also suggests that ambulation is not a good discriminator of lower extremity strength and balance in this population. Lower limb strength and balance is known to be improved by progressive resistance exercises (Liu & Latham, 2009) and neuromotor training (balance exercises) (Howe, Rochester, Neil, Skelton, & Ballinger, 2011). Hence it is important to include in self-reported questionnaires for this population, specific questions on strength and balance activities.

Sitting behaviour was inversely associated with functional indicators. That is, the more hours spent in sitting, the lower the scores on the strength and balance indicators. The small sample size prevented further analysis to remove the effect of age and the skewness of the data in this population to allow for a more rigorous analysis of the data.

**Limitations of the study**

There are several limitations of this study related to methodology. One limitation was the small convenience sample size. Also, participants were from one geographical location. The small sample size did not allow for a rigorous analysis of the data to determine correlation between the measures collected. Participants were from one retirement village and likely to have similar education, attitudes and beliefs and represent only this geographical location. Participants that volunteered are more likely to be interested in remaining active and are more likely to have higher levels of physical activity. This can result in selection bias. It has been demonstrated that people with higher activity levels are more likely to be recruited for studies on physical activity (Crombie et al., 2004). Thus, due to small sample size and convenience sample representing one geographical location, the generalisability of results is limited. The collection of functional indicator measures would have been enhanced if a measure of gait was included. Lower limb strength and balance, functional indicator measures which were
collected, directly affect gait and functional ability. They are also major factors in falls. However, these important measures would have been complemented by a gait measure. Gait is also a relevant measure as a large proportion of older old adults’ physical activity behaviour is walking or ambulatory activity. Additional major limitations related to the choice of the questionnaire. There are not many physical activity questionnaires that are developed specifically for older adults (Forsén et al., 2010). The IPAQ has been developed for surveillance purposes and not specifically for older adults. Nevertheless, it appears that it has been widely used even in samples that are specifically older population (Forsén et al., 2010). Further, its cognitive error with this group was also evaluated. Heesch et al (2010) found older adults had difficulty with understanding the intent of the questions, recalling the information required and in making calculations (Heesch et al., 2010). Hence this option to gauge its performance in the older old and against objective measure was chosen which hasn’t been done before. In doing so, the types of exercise in which participants engaged were unable to be linked. The ability to separate walking for errands from walking for exercise and recreation was also missed. Type of exercise is usually assessed in long questionnaires such as CHAMPS, IPEQ and PASE. Having a questionnaire that asks about the types of exercise in which residents participate, separating walking for exercise and recreation and specifically quantifying daily household chores and caring activities is superior for understanding some of the issues that arose in the focus groups. In this respect the study is very limited to the generic classification by intensity on account of type of and context of physical activity.

Furthermore, the timing of collecting the IPAQ was not ideal for testing agreement as it was collected in the week prior to the accelerometry measurements. It would have been better to collect the IPAQ data for the week corresponding to the week that that accelerometry was worn. It may however be the case that older old adults living in assisted care do not change their routines from week to week and a typical week’s physical activity remains fairly constant due to the nature of care provided in assisted living accommodation. This may also apply to the group who live in independent accommodation whereby some weekly routines exist. The new Incidental and Planned Exercise Questionnaire (IPEQ) showed better reliability coefficients for the usual week than the past week (Delbaere, Hauer, & Lord, 2010). The validation of the usual week also showed fair coefficients (0.35) and was administered after the questionnaire was asked (Merom et al., 2013). Hence, timing of administration of measurement may be less of a concern in this study. Lastly, this is a cross-sectional design, which prevents the drawing of definite conclusions regarding possible cause effect relationships between physical activity status and performance.
CONCLUSION

It appears that to keep older old adults active in assisted care accommodation, social support and staff involvement are important facilitators for physical activity participation. To increase physical activity participation in the older old in assisted accommodation in this retirement village, adopting strategies identified by the participants would seem to be the most successful approach. Encouraging activities which promote social interaction and involve staff (or volunteers) would appear to be the most successful strategy to increasing physical activity participation. Attention should also be directed to making the physical environment safe and conducive to physical activity participation. This may involve having level paths for walking and strategically placed seating to allow for rest periods. In the older old, increased hours of sitting are related to functional limitations but this needs further research on greater representative sample. Yet, if this is correct, attention should be directed to encouraging older old adults to sit for fewer hours during the day and participate in some form of physical activity. These suggestions may create the necessary conditions for the older old to remain active through transition from independent living to assisted accommodation.

Objectively measured physical activity levels demonstrated that participants living independently had significantly higher steps per day. This result was found after adjusting for the effect of age as the people living in the assisted living accommodation were significantly older than those people living independently. Although there were no differences between assisted and independent living participants in the proportion of reported limitations to physical activity or walking, functional indicators, balance and leg strength, were significantly lower for assisted living compared to independent living. All participants completed a self-report questionnaire on physical activity levels via the IPAQ. There were no significant differences between the groups on walking minutes per week, MVPA and percentage of participants meeting the physical activity guidelines by self-report. Participants from both assisted living and independent living accommodation over-estimated physical activity levels using the IPAQ. However, there was a tendency for participants in assisted living to report higher medians on all these parameters compared with participants living independently.

Self-report data of physical activity should be taken with great caution in older old populations, especially in assisted living accommodation. Participants from both assisted living and independent living accommodation over-estimated physical activity levels using the IPAQ. However, the older old in assisted living over estimated their physical activity level to a greater extent than those living independently. There is poor convergent validity between self-reported physical activity measures (IPAQ) and objectively measured (SenseWear) physical activity levels in this study. Functional indicators appear unrelated to most commonly used measures of physical activity intensity such as MVPA or steps per day, highlighting the
inability of these aerobic dimensions to influence strength and balance. The IPAQ is not the most appropriate measurement tool for measuring physical activity in the older old population. Hence, it would be beneficial to use surveillance questionnaires that include specific questions on strength and balance activities in this population.


Australian Bureau of Statistics (ABS)(2006b), *Population by Age and Sex, Australia, June 2005*,(Cat. no. 3235.0.55.001), Canberra.


Giles-Corti, B., & Donovan, R. J. (2002). Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Preventive Medicine, 35*(6), 601-611.


Dear Professor Kilbreath,

Thank you for your correspondence dated 23 February 2012 addressing comments made to you by the Human Research Ethics Committee (HREC) on the 13th of December, 2011.

I am pleased to inform you that with the matters now addressed your protocol entitled “Physical Activity of residents living in retirement villages” has been approved.

Details of the approval are as follows:

**Protocol No.:** 14416

**Approval Date:** 22 February 2012

**First Annual Report Due:** 28 February 2013

**Authorised Personnel:**
- Professor Sharon Kilbreath
- Professor Glen Davis
- Mrs Frances Moran

**Documents Approved:**

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<th>Document</th>
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<tr>
<td>Participant Information Statement</td>
<td>1</td>
<td>18/11/2011</td>
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<td>Consent form</td>
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<td>24/11/2011</td>
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<td>Questionnaire</td>
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HREC approval is valid for four (4) years from the approval date stated in this letter and is granted pending the following conditions being met:

**Condition/s of Approval**

- Continuing compliance with the National Statement on Ethical Conduct in Research Involving humans. Provision of an annual report on this research to the Human Research Ethics Committee from the approval date and at the completion of the study. Failure to submit reports will result in withdrawal of ethics approval for the project.

- All serious and unexpected adverse events should be reported to the HREC within 72 hours.

- All unforeseen events that might affect continued ethical acceptability of the project should be reported to the HREC as soon as possible.

- Any changes to the protocol including changes to research personnel must be approved by the HREC by submitting a Modification Form before the research project can proceed.

**Chief Investigator / Supervisor’s responsibilities:**

1. You must retain copies of all signed Consent Forms (if applicable) and provide these to the HREC on request.

2. It is your responsibility to provide a copy of this letter to any internal/external granting agencies if requested.

Please do not hesitate to contact Research Integrity (Human Ethics) should you require further information or clarification.

Yours sincerely

Ms Karen Greer
Human Ethics Administrator
On behalf of the HREC

cc: Frances Moran
frances.moran@sydney.edu.au

This HREC is constituted and operates in accordance with the National Health and Medical Research Council’s (NHMRC) National Statement on Ethical Conduct in Human Research (2007), NHMRC and Universities Australia Australian Code for the Responsible Conduct of Research (2007) and the CPMP/ICH Note for Guidance on Good Clinical Practice.
Mrs Fran Moran

Physiotherapist 24 November 2011

John Paul Village
15 The Avenue
Heathcote
NSW 2233

Dear Fran,

I refer to your submission to the Advisory Committee of John Paul Village requesting permission to undertake research in the Village involving residents. The Committee has given permission to undertake the research as outlined in your proposal as it relates to the health benefits of physical exercise. The only condition is that you obtain written consent from any residents who agree to participate in the project. The Committee is very interested in the outcomes of the study and would appreciate seeing a copy of your findings. The members of the Committee wish you all the best in undertaking the research.

Yours sincerely

[Signature]

Gerry Renouf  CEO

A PROJECT OF THE CATHOLIC CHURCH - PARISH OF ST. JOHN BOSCO, ENGADINE
Physical Activity in Retirement Villages

PARTICIPANT INFORMATION STATEMENT

(1) What is the study about?

You are invited to participate in a study of sedentary behaviour and physical activity of people living in retirement villages. The study aims to identify risk factors for sedentary behaviour by asking older adults what they perceive as barriers to physical activity.

(2) Who is carrying out the study?

The study is being conducted by Professors Sharon Kilbreath and Glen Davis and Ms Fran Moran from the Faculty of Health Sciences at the University of Sydney. It will form the basis for the degree of Master of Applied Science - Research at The University of Sydney for Fran Moran.

(3) What does the study involve?

The study comprises two parts: 1) baseline assessments; and 2) focus group, both which will be conducted at John Paul Village.

Prior to the focus group, we would like you to undertake some baseline assessments. These include:
• Measurement of your height, weight, leg muscle strength, and balance;
• Completion of questionnaires in which you will answer questions about your general health, physical activity in the last 7 days and history of falls; and
• In addition, we ask that you wear a physical activity monitor for 7 days. Ms Moran will show you how to wear it. We ask that you keep it on for all activities except those involving water (eg. showering or swimming). These monitors record information about your physical activity, including steps taken. Ms Moran will return one week later to collect the devices.

Following the baseline assessment, we will invite you to attend a focus group at John Paul village of approximately 2 hour duration in which we will see your input on how to encourage older persons to living in retirement village to be physically active.

(4) How much time will the study take?

The focus groups will take approximately 2 hours. The questionnaires will take approximately 15 minutes to fill out and the baseline measure session will take approximately 30 minutes.

(5) Can I withdraw from the study?

Being in this study is completely voluntary - you are not under any obligation to consent and - if you do consent - you can withdraw at any time without affecting your relationship with The University of Sydney or John Paul Village.

If you take part in a focus group and wish to withdraw, as this is a group discussion it will not be possible to exclude individual data once the session has commenced.

(6) Will anyone else know the results?

All aspects of the study, including results, will be strictly confidential and only the researchers will have access to information on participants.
A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

(7) **Will the study benefit me?**

We cannot and do not guarantee or promise that you will receive any benefits from the study. All who have participated will be entered into a draw for $100 Westfield voucher.

(8) **Are there any risks associated with this study?**

You may experience some muscle soreness from the assessment of strength, associated with an increase in your level of physical activity. There are no other risks.

(9) **Can I tell other people about the study?**

Yes

(10) **What if I require further information about the study or my involvement in it?**

When you have read this information, Fran Moran will discuss it with you further and answer any questions you may have. If you would like to know more at any stage, please feel free to contact Fran Moran on 8508 3300 extension 306 (Telephone) or (Email).frances.moran@sydney.edu.au

(11) **What if I have a complaint or any concerns?**

Any person with concerns or complaints about the conduct of a research study can contact The Manager, Human Ethics Administration, University of Sydney on +61 2 8627 8176 (Telephone); +61 2 8627 8177 (Facsimile) or ro.humanethics@sydney.edu.au (Email).

This information sheet is for you to keep
PARTICIPANT CONSENT FORM

I, .................................................................[PRINT NAME], give consent to my participation in the research project

TITLE: Physical Activity in Retirement Villages

In giving my consent I acknowledge that:

1. The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s.

3. I understand that being in this study is completely voluntary – I am not under any obligation to consent.

4. I understand that my involvement is strictly confidential. I understand that any research data gathered from the results of the study may be published however no information about me will be used in any way that is identifiable.
5. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher(s) or the University of Sydney or John Paul Village now or in the future.

6. I understand that I can stop my participation in the focus group at any time if I do not wish to continue; however as it is a group discussion it will not be possible to exclude individual data to that point.

7. I consent to:
   • Audio-recording YES ☐ NO ☐
   • Receiving Feedback YES ☐ NO ☐

If you answered YES to the “Receiving Feedback” question, please provide your details i.e. mailing address, email address.

**Feedback Option**

**Address:** ______________________________________________________

_______________________________________________________

**Email:** ______________________________________________________

............................. ...................................................

Signature

............................. ...................................................

Please PRINT name

............................. ...................................................

Date
VOLUNTEERS REQUIRED

Physical Activity in Retirement Villages

We are seeking volunteers to share their ideas on being physically active here at John Paul Village.

If you are interested in participating in the study or for further information please contact Fran Moran on 0414 548 203.

This study has the approval of the University of Sydney ethics committee and Gerry Renouf, CEO, on behalf of the Board of Directors of JPV.
Appendix 5 - SenseWear instructions

PHYSICAL ACTIVITY MONITORS INSTRUCTIONS

As this is a scientific research study it is important that you follow these instructions carefully:

- It is very important that you wear the activity monitors **ALL DAY, EVERYDAY for the specified 7 day period**. If you forget to wear it for a while, please DO wear it for the remainder of the 7 days.

- You do not need to wear the activity monitors to bed at night. Instead, take it off and **put it somewhere where you will be reminded to put it on again** as soon as you wake up in the morning. Please do not shake it when you are not wearing it.

- The activity monitors are weatherproof but not waterproof – **please take it OFF when showering, bathing or swimming** and put it back on afterwards.

- Please handle the activity monitor carefully – try not to drop it, and please do not try to take it apart or misplace it as it is costly!

Please do not worry about any blinking lights or the absence of a light, or any beeping from the devices- this will not tell you if the activity monitor is working or not. You do not need to record anything from the activity monitors as they store all the information we need. When we receive the activity monitors back from you, they will be connected to a computer to download the information.

If you have any questions, please do not hesitate to contact me on 0414548203
It is important that you wear the activity monitor on the back of your upper right arm; check the pictures below for the correct placement.

It is important that the activity monitor fits you snugly because it will not record your activities accurately if it is loose. If your arm begins to tingle or you begin to lose feeling in your arm, loosen the strap and re-fasten. Once you have the right fit, you should be able to slide it on and off without readjusting it.

Ensure the sensors maintain continuous contact with your skin at all times. There is no on/off button- the device will automatically switch on when it is placed in contact with your skin. It will beep, and then vibrate, when contact is made.

You can wear the activity monitor underneath your shirt.

Physical Activity in retirement villages
## Appendix 6 - Data collection form

### Physical Activity in Retirement Villages

PARTICIPANT ID: __ __ __

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<thead>
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<th>PATIENT DETAILS</th>
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<td>Surname:</td>
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<td>Address:</td>
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<td>Contact telephone number:</td>
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Please nominate a relative/friend who lives at a different address to you and may know of your whereabouts in case we can't reach you for follow up.

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<th>CONTACT</th>
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<td>Name:</td>
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Would you like to be contacted for potential participation in future studies in Physical Activity?

☐ Yes  ☐ No
### INFORMED CONSENT

Has written informed consent been obtained from the participant?  Yes  No

Note: Consent must be obtained prior to any study procedures.

Date informed consent obtained:  ______/______/______

        dd  mm  yyyy
Physical Activity in Retirement Villages

Assessment Booklet

What is your date of birth? ____/_____/____ (DD/MM/YYYY)

What is your current age: ______

Weight: ______kg  Height_______ cm  BMI____________

SIGNIFICANT MEDICAL HISTORY

Has your doctor EVER told you that you have: (please tick all that apply)

☐ Cancer  ☐ Heart attack or angina
☐ Asthma  ☐ Osteoporosis / low bone density
☐ COPD  ☐ Depression
☐ Heart disease  ☐ Anxiety
☐ High Blood Pressure  ☐ Parkinson's Disease
☐ High cholesterol  ☐ Osteoarthritis
☐ Stroke  ☐ Diabetes
☐ Blood clot (thrombosis)

Please list any other significant medical history here:

Do any of your conditions limit your ability to: (please tick all that apply)

☐ Walk

☐ participate in physical activity

Where do you live? (Please tick one)

☐ Self Care Unit

☐ Hostel

How long have you lived at this residence?

Do you own a car?
Baseline Physical Measures

Base File name: _______________________

Strength-
Lower limb Strength

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Near tandem Stand

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Date physical activity monitors commence data collection: ______________

Date physical activity monitors conclude data collection: ______________

File name of SenseWear (eg. Sens001jy180610): ____________________________

Has your health changed significantly over the past week?

□ No □ Yes ________________________________
International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

No vigorous physical activities Skip to question 3

1. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis?

Do not include walking.

_____ days per week

No moderate physical activities Skip to question 5
2. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

3. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

No walking Skip to question 7

4. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

Don't know/know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

5. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day

_____ minutes per day

Don't know/Not sure

This is the end of the questionnaire, thank you for participating.
Appendix 7- Focus group lead questions

Focus group lead questions

- What do you think are the barriers to being physically active?
- In particular, is your environment suitable to being physical active?
  - How enjoyable is the scenery in your neighbourhood?
  - How would you rate the walking distance to the park?
  - How accessible is path for walking?
  - Overall how convenient is it to walk in your neighbourhood?
  - How would you rate the walking distance to the shops?
  - How would you rate the walking distance to a bus stop or train station?
  - How much of a problem is traffic when walking in your neighbourhood?
  - How would you rate the general friendliness of the people?
- What activities do you participate in now?
- What aspects of the environment do you think would facilitate participation in physical activity?
- What would make it easier to participate in physical activity?
- How do think people like you could be less sedentary/move more/be more active?
- What type of physical activity do you enjoy?
  - What activities would you consider participating in if offered?