Physical activity in older adult women: Relationship to mobility, balance confidence, health locus of control and risk of osteoporosis fractures.

by

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Abstract

There is limited understanding of the relationship between physical activity (PA), mobility and psychological constructs for the prevention/management of osteoporosis fractures in older adult women. PURPOSE: To examine PA patterns and the relationship of PA to mobility, psychological constructs and osteoporosis fracture risk. METHODS: Participants (N=41, ages 70-92, BMI 27.2 (6.1)) completed a general questionnaire, the ABC balance scale, MHLOC locus of control scale, as well as completing mobility tests (TUG and STS). PA was assessed using 5 day pedometry and accelerometry (Biotrainer Pro). RESULTS: The average PA was very low (energy expenditure 225.4 (152.9) kcals/day; activity time 101.8 (42.3) min; step count 4,516 (3,227)). The mobility scores were within the acceptable range (TUG 9.2 (3.8) s; STS 14.2 (6.4) s). Correlations with physical activity: TUG ($p<0.05$); ABC ($p<0.05$); Powerful MHLOC ($p<0.01$, $p<0.05$). No significant correlations with Internal MHLOC. CONCLUSION: Sedentary PA patterns correlated to poor mobility, low balance confidence and greater fracture risk. Pedometry and accelerometry measured PA demonstrated the importance of multiple methods of PA assessment in understanding the lifestyles of this population. The results aid in identification of factors that can be modified to enhance the quality of life of this population.

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Introduction

Osteoporosis is a disease that affects the skeletal system and ultimately results in microarchitectural deterioration of bone tissue (adverse architectural changes) and decreased bone mineral density (Genant et al. 1999). Therefore, bones become more fragile which increases their susceptibility to sustaining a fracture (Cummings & Melton, 2002; Dennison, BChir, Mohamed, & Cooper, 2006). The International Osteoporosis Foundation (2007) reported that approximately 1.4 million Canadians have osteoporosis, which includes one in four women and one in eight men over the age of 50. This disease can result in fractures which have substantive health and well being impacts. According to Brown and Josse (2002) and the International Osteoporosis Foundation (2007), osteoporosis has become a public health concern in Canada and around the world.

The International Osteoporosis Foundation reports that almost 30,000 hip fractures occur each year in Canada, 70-90% of which are caused by osteoporosis. As the world population ages, the incidence of osteoporosis is expected to rise, along with the attendant economic costs of osteoporosis-related fractures (Cummings & Melton, 2002). Hip fractures are considered the most devastating fractures because they are associated with substantial mortality and morbidity and long term disability (Black et al., 2001; Brown & Josse, 2002; Cummings & Melton, 2002).

Prevention and management of osteoporosis involves a number of factors including enhancing physical activity and exercise, having a suitable diet that includes adequate calcium and vitamin D, an elimination of controllable risk factors such as smoking, as well as the use of medications such as bisphosphonates which help to maintain or increase bone density (Brown & Josse, 2002). A major emphasis in prevention and management of osteoporosis is to increase physical activity levels (Hanley & Josse, 1996). Physical activity, in terms of fracture prevention is targeted at increasing or maintaining bone density, muscular strength, flexibility, balance, and fall prevention (Brown & Josse, 2002; Carter et al., 2002; Pinto, Goldstein, Ashba, Sciamanna & Jette, 2005).

Unfortunately, survey research indicates that older adults in general are relatively inactive (Craig, Russell, Cameron & Bauman, 2004; Jette et al., 1999). Inactivity contributes not only to decreased bone mineral density but also to poor muscular strength and poor balance, and all of these variables increase the risk of fractures (Brown & Josse, 2002; Carter et al., 2002). Maintaining good muscular strength and balance are also important to the maintenance of mobility and enhanced participation in community. The maintenance of mobility among older adults is paramount to maintaining their independence, and preventing activity restrictions. Poor mobility has been linked to greater amount of falls, and falls increase the risk of devastating injuries, such as fractures, especially if bone density is poor (Arnold & Faulkner, 2007; Lindsey, Brownbill, Bohannon, & Ilich, 2005; Whitney et al. 2005). In addition, psychological constructs such as low personal perceived control over health (Wallston, 2005; Weinberg, 2001) or decreased balance confidence may also play a role in sustaining a fracture by reinforcing self-imposed inactivity (Carter et al., 2002; Liu-Ambrose et al., 2005; Li, Fisher, Harmer & McAuley, 2005). Perceptions of control (e.g., health locus of control) and self-efficacy (e.g., balance confidence) are two psychological constructs that may be related to patterns of physical activity (Li et al., 2005; Menec & Chipperfield, 1997).

Previous research has investigated physical activity (Brooke-Wavell, Prelevic & Bartram, Ginsburg, 2000; Krumm, Dessieux, Andrews, &Thompson, 2006), mobility (Arnold & Faulkner,2007; Whitney et al., 2005), psychological constructs (Li et al., 2005) and fracture risk or osteoporosis (Carter et al., 2002; Liu-Ambrose et al., 2005) individually in their importance to older adults and health. There is very limited Canadian research on adults 70 years of age or older in any of the aforementioned areas. Additional research is needed to aid in the development of effective prevention and treatment strategies for osteoporosis. In particular, there is a paucity of data on the physical activity levels of older Canadian adults derived from objective means (i.e. pedometers and accelerometers). Further, the relationships of physical activity to common clinical mobility measures, and self report instruments used to assess fracture risk, balance confidence and perceived control are not known. This information has direct application to care of older adults, as well as the development of prevention and treatment strategies, and even for the development of physical activity guidelines.

Relevance

Physical activity has an important role in the prevention and management of osteoporosis and fractures (Brown & Josse, 2002; Carter et al., 2002). Objectively monitoring physical activity can provide important information about the physical aspects of lifestyle, such as identifying active or inactive individuals, and by identification of the characteristics of physical activity behaviours (quantity, magnitude, timing, etc). This can be accomplished using objective tools such as pedometers and accelerometers. Daily step counts can be derived from pedometers, and total daily energy expenditure or other physical activity measures (total activity time, time of day when active, minutes spent in low, moderate and high intensity activity) can be derived from an accelerometer (Berlin, Storti & Brach, 2006; Tudor-Locke & Myers, 2001).

Physical therapists try to motivate and educate individuals to remain active and prevent injuries that may occur in relation to chronic conditions such as osteoporosis (Bennell, Khan & McKay, 2000). Therefore, documentation of the activity patterns of older adults could give physical therapists and other health care professionals insight into means to modify older adults' activity patterns. This physical activity information, and its relationship to other clinical measures and self reports, may then be used to educate and motivate older adults about the benefits of specific physical activity programs, as well as establish guidelines or targets for achievement.

Examining the potential relationships between physical activity, fracture risk, mobility and psychological constructs may provide health care providers with clues into better understanding the activity patterns of their clients. For example, little attention has been given to the potential associations of psychological constructs on physical activity. Psychological constructs may positively or negatively influence exercise and physical activity among older adults (Lachman & Jette, 1997). For example, greater fear of falling and experiencing feelings of loss of personal control over health may create a barrier to adopting an active lifestyle. On the other hand, less fear of falling and having a greater sense of personal control over health may positively influence an active lifestyle (Weinberg, 2001).

Additionally, the relationship of clinical measures of mobility such as the Timed Up and Go test (TUG test) (Podsiadlo & Richardson 1991) and the sit-to-stand test (STS test) (Cummings et al.,1995; Whitney et al., 2005), have not been examined in their relationship to objective measures of physical activity. It is important to document this relationship so as to provide functional relevance to these clinical measures. Hopefully this knowledge can be used to foster enhanced participation of older adults in home and community based activity.

This study monitored activity patterns among older adult women who may be at risk for osteoporotic fractures. Women were studied due to the increased risk of osteoporosis relative to males, and to have a ‘clean’ study and to avoid issues with sex differences in physical activity. This study also explored mobility, fracture risk, balance confidence and health locus of control. More importantly, the potential relationships between physical activity parameters (i.e., daily step count, daily energy expenditure, and daily activity time), the risk of osteoporosis-related fractures, mobility, balance confidence and health locus of control were investigated.

This study extended the literature on the knowledge of objectively monitored physical activity and its relationship to other important heath measures in this population. Potential barriers and facilitators to physical activity may be identified among older adult women who may be at risk of osteoporosis-related fractures.

Literature Review

Osteoporosis

Osteoporosis is a chronic, systemic skeletal disorder characterized by low bone density/mass, and microarchitectural deterioration of bone tissue (Cummings & Melton, 2002). This results in bone fragility and increased risk of fracture (Brown & Josse, 2002; Dennison et al., 2006; Lane, 2006). Common fractures related to osteoporosis occur in the hip, spine, and wrist (Brown & Josse, 2002). The consequences of sustaining a fracture include increased disability and increased morbidity and mortality (Black et al., 2001; Brown & Josse, 2002; Lane, 2006). As the population ages the number of people diagnosed with osteoporosis is predicted to increase. As such, the number of fractures, especially hip fractures, will also increase with enormous physical and social consequences (Brown & Josse, 2002; Cummings & Melton, 2002; Dennison et al., 2006; Lane, 2006). The projected financial burden on the health care system is also expected to increase dramatically with the increasing number of hip fractures (Cummings & Melton, 2002).

Assessment of fracture risk

Bone mineral density assessment had been the cornerstone of osteoporosis assessment and prediction of fracture risk (Black, Steinbuch, Palermo, Dargent-Molina, Lindsay, Hoseyni, et al., 2001; Siminoski, Leslie, Frame, Hodsman, Josse, Kahn, et al., 2005). It has also been reported that clinical risk factors are also effective in predicting fracture risk in postmenopausal women (Black et al., 2001; Dennison et al., 2006; Leslie, Anderson, Metge, Manness, 2007). For example, Dennison et al. (2006) outline constitutional factors (e.g., female gender, age, previous fragility fracture) and lifestyle factors (low body weight, inactivity or sedentary lifestyle, smoking, inadequate calcium and vitamin D intake) as other risk factors for fractures (Benell et al., 2000; Brown & Josse, 2002). Clinical risk factors have also been categorized as major (e.g., age >65 years, tendency to fall, fragility fracture after age 40) and minor (low dietary calcium intake, body mass less than 57 kg, smoker, excessive caffeine consumption) when identifying individuals who may be at risk for osteoporosis (Brown & Josse, 2002).

Black et al. (2001), developed an instrument called the Fracture Index, a simple clinical assessment tool that is based “on a small number of risk factors that could be used by clinicians to assess risk of fractures”. The Fracture Index was developed using data from the Study of Osteoporotic Fractures, which looked at risk factors for hip fractures in white women (Cummings et al., 1995). The intent was to have a tool that could identify high-risk individuals in the population in order to provide appropriate follow-up evaluation and treatment even if bone mineral density testing is not available. The Fracture Index is a valid and reliable instrument that assesses the five year risk of osteoporosis-related fractures among postmenopausal white older adult women and was shown to be predictive of hip, vertebral, and non-vertebral fractures.

The risk factors included in this instrument are age, personal history of fractures after age 50, maternal history of hip fracture after age 50, body mass less than 57 kg, currently smoking, and ability to rise from a chair without using one's hands for assistance. In addition, the Fracture Index can be used with or without clinical bone mineral density testing. Black et al. (2002) reported that using bone mineral density test results improves the predictive value of fracture risk. As such, the index can be scored with or without bone mineral density test results. Each item in the index has a score; the score is added and the higher the score the greater the risk for osteoporotic fractures. The maximum score without bone mineral density testing is 11 and the researchers recommend that postmenopausal women with a total score of 4 or greater without bone mineral density testing should undergo further evaluation. The ability to sit-to-stand was measured objectively and the ability to rise from a chair without using one's hands for assistance was is measured with a yes/no response to this observation (Black et al, 2002 ; Cummings et al., 1995).

Fracture Risk and Mobility

The researchers of the Study of Osteoporotic Fractures study (Cumming et al., 1995) measured the amount of time in seconds it took a participant to perform the STS test with five consecutive repetitions and recorded if participants used their hands, attempted to use their hands or did not use their hands for assistance in standing from a chair. The ability to sit-to-stand from a chair has been described as an important factor for functional independence in older adults

(Whitney et al., 2005). An assessment of the ability to sit-to-stand has been used as a valid mobility test to assess lower extremity strength, balance, risk of falls and proprioception. This test has also been predictive of disability and hip fractures (Lord, Murray, Chapmen, Munro & Tiedemann, 2002; Whitney et al., 2005). Cawthon et al. (2008), reported that a repeated STS test was strongly associated to increased risk of hip fractures in men.

In addition, measuring the ability to sit-to-stand five times has been shown to correlate with the ABC Scale (Whitney et al., 2005). There is lack of agreement in the literature regarding a normal score for sit-to-stand times, most likely because there are many different techniques to assess sit-to-stand (e.g., assessing the time it takes for five times, ten times or one time to sit-to-stand). It is reported in the literature that the slower sit-to-stand times have been related to balance disorders and deficits in activities of daily living and greater disability (Whitney et al. 2005).

Other measures of mobility have also been valuable to health professionals in clinical practice. One example is the TUG test (Podsiadlo & Richardson 1991), which has been used to assess balance and identify individuals at risk of falls (Bischoff et al., 2003; Medley & Thompson, 2005; Podsiadlo & Richardson 1991). Similar to the STS test, the TUG test can identify risk factors for fractures such as poor balance and lack of mobility. However, there are no studies reporting the relationship of the TUG test to the risk of osteoporosis- related fractures, or physical activity levels.

Osteoporosis and Physical Activity

Decreased bone mineral density increases the susceptibility of sustaining a fracture (Bonaiuti et al., 2002; Going et al., 2003). However, other risk factors for osteoporosis, such as falls and outcomes of decreased mobility which lead to falls (e.g., decreased muscle strength, decreased balance and increased pain) also increase the susceptibility of sustaining a fracture (Carter et al., 2002; Liu-Ambrose et al., 2005). The 2002 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada recommends a combination of physical activity, exercise to improve strength and balance and prevent falls, a diet with adequate calcium and vitamin D intake, and when clinically indicated, medications that increase or maintain bone density (Brown & Josse, 2002).

The role of physical activity in osteoporosis prevention and management is to reduce the risk of sustaining a fracture (Brown & Josse, 2002; Carter et al., 2002). Physical activity refers to movement of the body which is produced by muscle contraction and requires energy expenditure to produce this muscle contraction (Aadahl & Jorgensen, 2003). Certain types of physical activities are more commonly recommended not only because of their direct effects on remodelling bone, but because they decrease the risk of fractures by targeting risk factors for falls, such as decreased muscle strength, decreased balance and increased pain (Bennell et al., 2000; Bonaiuti et al., 2002; Carter et al., 2002; Liu-Ambrose et al., 2005).

The effect of physical activity and exercise on preventing bone loss in older adult postmenopausal women is still controversial (Bonaiuti et al., 2002). Whether physical activity actually can increase bone density or just maintain bone density is still being debated in post-menopausal women (Bonaiuti et al., 2002; Bravo et al., 1996; Going et al., 2003; Wayne et al., 2007). For example, the randomised control trial by Bravo et al. (1996) showed positive results for the effect of exercise to increase spinal bone density in the exercise group, but no significant difference in bone density at the hip was observed between the exercise group and non-exercise group. Another prospective control trial showed that bone density at the hip did increase among older women who exercised (Villareal et al., 2003). There have been no systematic studies of the dose-response relationship between exercise (type, intensity, duration and frequency) on bone in post-menopausal women, or any population for that matter.

A review which evaluated RCTs, cross-sectional studies and cohort studies, concluded that to date the effect of Tai Chi on bone density is limited by the quantity and quality of research (Wayne et al. 2007). Another review by Bonaiuti et al. (2002), reviewed only randomised control trials which evaluated the effect of physical activity/exercise to prevent bone loss. These authors of the review reported that there was some evidence to support that physical activity/exercise helped slow bone loss, but could not form any conclusions on whether this slowing of bone loss would be sustained if physical activity was discontinued. It was concluded in this review that weight-bearing (e.g., walking), aerobic and resistance exercises prevented and slowed loss of bone density at the spine compared to no exercise. In addition, walking also prevented and slowed bone loss at the hip.

Activities recommended for the management and prevention of osteoporosis includes: weight-bearing activities such as walking, muscle strengthening activities with the use of free weights or elastic bands, balance re-training activities for example by participating in Tai Chi exercise or specific balance exercises, and activities which improve flexibility and posture (Bennell et al., 2000). Physical activity may be accomplished through a formal program of prescribed exercises and this may involve only a portion of one's total daily activities. In addition, movement that occurs throughout one's daily routine such as walking, using the stairs, cleaning house and shovelling snow can also involve the recommended activities and contributes to the total physical activity and energy expenditure that may occur in a day (Bennell et al., 2000; Bonaiuti et al., 2002; Brown & Josse, 2002; Mazzeo et al., 1998).

Many studies have examined the benefits of physical activity in relation to osteoporosis and fracture prevention. One emphasis has been the use of formal, supervised exercise programs on improving bone mineral density with or without bone enhancing medications (Bonaiuti et al., 2002; Going et al., 2003; Villareal et al., 2003). Some studies using bone enhancing medications have shown that a combination of physical activity (e.g., in the form of exercises such as stretching, balance, aerobic and weight-bearing exercises), and osteoporosis specific medications have a greater effect on bone mineral density than medication alone (Going et al., 2003; Villareal et al., 2003). These studies demonstrated that physical activity is an important part of the management and prevention of osteoporosis and its consequences (i.e., fractures).

Other studies have examined the benefit of a formal exercise program in improving certain risk factors for falls, such as decreased strength and balance, and increased pain (Carter et al., 2002; Liu-Ambrose et al., 2005). For example, Carter et al. (2002) conducted a twenty week study examining the benefit of an exercise program for women aged 65 to 75 diagnosed with osteoporosis who were randomly divided into an exercise group (n=40) or a non-exercise group (n=40). The exercise group was instructed to attend the program twice a week, which included a combination of exercises that targeted balance, strength, coordination and trunk stabilization. The control group was instructed to continue with their daily routine. Assessment of quadriceps strength, static balance, dynamic balance and health-related quality of life were administered at baseline and at the end of the study. Quadriceps strength was measured using a strain gauge that was strapped to the dominant leg. Dynamic balance was measured with a timed 10 meter figure-eight course, using the fastest time of two trials; static balance was measured using a posturography platform to measure the amount of sway. Health-related quality of life was measured with a domain specific (osteoporosis) questionnaire (Carter et al., 2002). The results of this study showed statistically significant improvements both in quadriceps strength and dynamic balance in the exercise group compared to the control group. In addition, the exercise group had improvements in static balance over baseline; however, this was not statistically significant when compared to the control group. There were no significant differences in health-related quality of life (within-group or between-group), which may have been related to high baseline values of health-related quality of life in both groups. The researchers concluded that strength, balance, posture and coordination exercises were beneficial in improving risk factors for falls in women with osteoporosis (Carter et al., 2002). Objective quantification of physical activity was not performed in this study so our understanding of their activities beyond the exercise intervention is limited. Therefore, the impact of the exercise on physical activity participation is unknown in this study.

Most osteoporosis studies involving an exercise program have used a combination of balance, strengthening and weight-bearing exercises (Bennell et al., 2000; Bonaiuti et al., 2002; Carter et al., 2002; Going et al., 2003; Villareal et al., 2003). This activity (i.e., either in an exercise program or daily routine) may be influenced by attitudes and beliefs about osteoporosis and exercise. In other words, these beliefs may positively or negatively influence incorporating physical activity in one's daily routine (Lachman & Jette, 1997). Although quality of life measures have been included in osteoporosis studies involving exercise (Carter et al., 2002), there is limited research which examines other psychological influences such as balance confidence or health locus of control in relation to osteoporosis and physical activity/exercise.

Interestingly, there is a near absence of objective data on physical activity patterns in these groups. Specifically, objective data using pedometers and accelerometers to measure activity patterns, such as daily step counts, daily energy expenditure and daily activity time among older adult women with osteoporosis or at risk of fractures is very limited, especially in Canadian literature.

Psychological Constructs and Physical Activity

Physical activity not only has physical benefits, such as increased strength, increased balance, and increased bone density (Bonaiuti et al., 2005; Carter et al., 2002; Going et al., 2003), but, it also has psychological benefits that may help reinforce an active lifestyle (Mazzeo et al., 1998; Menec & Chipperfield, 1997). Perceptions of control have been associated with engaging in healthy behaviours (e.g., physical activity) Perceptions of control refers to beliefs about the amount of control a person has in a situation, health locus of control (i.e., beliefs about the amount of control over one's health) is an example of perceived control (Masters & Wallston, 2005; Menec & Chipperfield, 1997). Self-efficacy is defined as beliefs about one's capabilities to produce something and balance confidence is an example of self-efficacy. Balance confidence has been associated with improved self-confidence in one's balance during activity (Li et al., 2005; Powell & Myers, 1995). These two psychological constructs may positively or negatively influence an active lifestyle.

According to Weiner (1994), when a situation is perceived as uncontrollable or unable to change, people will decrease their expectations about the positive outcomes of the situation and future performance in that situation will be reduced. If a situation is perceived as controllable and/or changeable, then expectations about the positive outcomes of the situation increase and future performance in that situation is increased to achieve these positive outcomes. An individual's sense of control and self-efficacy may be challenged by a disease such as osteoporosis (Jette et al., 1999; Lachman & Jette, 1997). Therefore, older adults at risk of osteoporosis may be apprehensive about falling and/or sustaining a fracture and losing further independence or autonomy (Lachman & Jette, 1997; Li et al., 2005; Mazzeo et al., 1998). This apprehension may result in restrictions in activity to avoid falling or sustaining an injury (Li et al., 2005).

Beliefs that falls and loss of mobility related to the disease process are an inevitable part of the aging process can therefore be perceived as uncontrollable circumstances (Lachman & Jette, 1997; Weinberg 2001). Older adults may erroneously believe that physical activity has no role in preventing disease and maintaining mobility and independence with increased age (Lachman & Jette, 1997; Mazzeo et al., 1998). Therefore, older adults with or without osteoporosis may not engage in physical activity because of perceptions of loss of control over their condition (e.g., osteoporosis) or the inevitability of physical deterioration and falls with advancing age (Weinberg, 2001).

The consequences of certain psychological barriers, such as fear of falling, fear of further injury with physical activity or feelings of hopelessness and helplessness about the outcome of diseases like osteoporosis may result in decreased physical activity (Jette et al., 1999; Lachman & Jette, 1997; Mazzeo et al., 1998; Murphy, Dubin & Gill, 2003). Thus, this inactivity will contribute to poor balance, decreased strength, poor mobility and decreased bone density, which in turn increases the risk of fractures (Bonaiuti et al., 2002; Carter et al., 2002; Going et al., 2003). Therefore, perceptions of control (e.g., health locus of control) and self-efficacy (e.g., balance confidence) may be linked to physical activity patterns and may contribute to, or impede, an active lifestyle.

Perceptions of control, such as health locus of control refers to an individual's beliefs and attitudes about control over his/her health and has been associated with engaging in healthy behaviours (Master & Wallston, 2005; Menec & Chipperfield, 1997). Wallston, Wallston, and DeVellis, (1978), describe a Multidimensional Health Locus of Control Scale (MHLOC) which consists of three separate domains: internal health locus of control, powerful others (external) health locus of control, and chance (external) health locus of control. Individual differences in control beliefs may influence motivation and achievement of certain health behaviours (Master & Wallston, 2005; Menec & Chipperfiled, 1997; Weinberg, 2001).

For example, simultaneous strong beliefs in personal and powerful others control over health. This may be beneficial because greater confidence in health professionals' advice may help reinforce health behaviours. An increased belief in chance control over health indicates less control and greater unpredictability over health (Masters & Wallston, 2005). Therefore, individuals with a stronger sense of personal control may be more motivated to engage in physical activities in relation to osteoporosis compared to persons with a weaker sense of control.

Self-efficacy is another psychological construct that may be related to physical activity patterns in people with osteoporosis. For example, balance confidence is a form of self-efficacy that refers to a person's self-confidence in being able to accomplish daily activities without losing his/her balance or falling (Powell & Myers, 1995). A person with decreased balance confidence is more likely to restrict their level of activity and become more inactive due to fear of falling (Li et al., 2005; Powell & Myers, 1995). Fear of falling may be of particular concern for older adults with osteoporosis or at risk of osteoporosis, because of their greater susceptibility to sustaining a fracture. Both perceived control and balance confidence have been examined among older adults (Li et al., 2005; Menec & Chipperfield, 1997; Sattin, Easley, Wolf, Chen & Kutner, 2005; Wallston, 2005). In addition, studies have indicated that participation in physical activity could occur with positive psychological well-being (Lachman & Jette 1997; Mazzeo et al., 1998).

Li et al. (2005) conducted a study which examined the effect of Tai Chi on fear of falling and falls self-efficacy among older adults aged 70-92 years old. Li et al. (2005), hypothesized that older adults who participated in Tai Chi would improve their falls self-efficacy and would be less afraid of falling. The researchers randomized older adults to participate in either a Tai Chi group (n=125) or a stretching group (n=131) (i.e., the control group). The Tai Chi group consisted of various activities which retrained the balance reactions of the older adults. The stretching group consisted of activities such as controlled breathing, seated exercises, or stretches. Both the Tai Chi group and the stretching group attended 60 minutes sessions three days per week for 6 months. Daily physical activity was not measured. A measure of fear of falling and a measure of falls self-efficacy were assessed at baseline, at 3 months and at the completion of the study at 6 months. Fear of falling was assessed with the Survey of Activities and Fear of Falling in the Elderly (Lachman et al., 1998). Falls self-efficacy was assessed using the Activities-Specific Balance Confidence Scale (ABC Scale)

(Powell & Myers, 1995). Li et al. (2005) found that there were no baseline significant differences in fear of falling and falls self-efficacy between the Tai Chi group and the stretching group. On completion of the study, only those older adults who participated in Tai Chi had improved falls self-efficacy and reductions in fear of falling. It was explained that increased falls self-efficacy from participation in Tai Chi resulted in improved personal beliefs about one's capability to participate in regular physical activity without falling and therefore this increased confidence helped reduce fear of falling with activity. Thus, the researchers concluded that falls self-efficacy has a mediating role in the relationship between exercise and fear of falling.

This study provided evidence to support the psychological benefits of exercise, such as improving self-confidence or self-efficacy. Only one type of exercise (i.e., Tai Chi) was assessed for its benefits on improving personal beliefs about falling. Li et al. (2005) did not assess if other specific types of exercises, such as weight-bearing or strengthening exercises offer the same benefits to beliefs about falling. For that matter, whether there is a relationship between daily physical activity levels and beliefs about falling, such as improved beliefs about falling related to increased daily physical activity.

The researchers demonstrated that balance confidence did significantly change from baseline to completion of the study when exercise was introduced, but no analysis was utilized to determine if these two variables are related to one another or are predictive of one another. Therefore, balance confidence could have increased as a result of exercise or as a result of awareness of the scale at the end of the study. No assessment was done through monitoring of daily activities in order to determine if participants' increased confidence resulted in great overall daily activity, such as during periods not in exercise.

Physical Activity Monitoring

Participation in physical activity is recommended for older adults, not only as part of the prevention of chronic diseases such as osteoporosis, but also for the maintenance of mobility, and independence with increasing age (Aadahl & Jorgensen, 2003; Craig et al., 2004; Mazzeo et al., 1998; Pinto et al., 2005; Jette et al., 1999). The American College of Sports Medicine (ACSM) recommends that to achieve health benefits that all adults should accumulate 30 minutes of moderate-intensity physical activity on five or more days of the week (Balady et al., 2000, p. 227). Moderate-intensity activity has been defined as expending 3.5 to 7 kcal/min and includes activities such as a brisk walk (Centers of Disease Control and Prevention, 2007).

A general indicator of health is body mass index (BMI), which is used to categorize normal body composition versus being overweight or obesity. Body mass index is mass in kilograms (kg) divided by height in metres (m) squared (i.e., kg/m^2) (Health Canada, 2007). In addition, it has been reported that BMI is highly correlated to body fat (Health Canada, 2003). It has been also reported in the literature that accumulating 10,000 steps/day is associated with good health (BMI). The controversy with this recommendation is its relation to the accumulation of 30 minutes of moderate-intensity physical activity in a day which has also been used as a health recommendation. For instance, the amount of energy expenditure equivalent to 10,000 steps/day is reported as between 300 and 400 kcal/day, whereas, 30 minutes of moderate-intensity physical activity is equivalent to 150 kcal/day (Jordan, Jurca, Tudor-Locke, Church, & Blair, 2005; Tudor-Locke & Bassett, 2004). In addition, there is also controversy in the literature if 10,000 steps/day is an appropriate measure of physical activity for other populations, such as postmenopausal women (Jordan et al., 2004). Further study of the activity patterns through pedometry and accelerometry is required in this population, as little is known of the actual amounts and distribution of activity levels. There is also no data on the relationship between pedometer derived step data and energy expenditure data in this population.

Tudor-Locke and Bassett (2004) have derived a classification of physical activity levels for adults based on accumulated steps/day and this classification ranges from sedentary to highly active. For example, ‘somewhat active’ is defined as 7500-9999 steps/day, whereas ‘active’ is defined as 10,000 steps/day or greater. It has also been reported that values between 6000-8,500 steps/day are more likely to be expected from healthy older adults (Tudor-Locke and Myers, 2001). The relationships of these guideline to other clinical measures have not been investigated, and these guidelines have not been cross-validated to other physical activity measures. Recently some data has been established relating physical activity to body composition (see below).

One study (Park et al., 2007) suggested that accumulating 7000 steps/day may be a gradient for bone health. This study was conducted among 172 older adults (i.e., 76 men and 96 women) between the ages of 65 to 83 years. The researchers related that a threshold of 7000 steps/day was associated with enhanced bone density of the calcaneous. Whether this gradient is suitable for other bones sites, and its relationship to balance performance is unknown.

The previous studies demonstrated the physical benefits (e.g., increased bone density, muscular strength and balance) (Carter et al., 2002; Going et al., 2003) and the psychological benefits (e.g., improved balance confidence) (Li et al., 2005) from participating in exercise. These studies did not assess if these benefits resulted in an increase in overall day-to-day activity. For example, no measures were used to assess whether increased strength, increased balance and decreased fear of falling resulted in increases in overall daily activity By monitoring physical activity, individual activity patterns and improvements in overall activity levels can be revealed, such as changing from a sedentary lifestyle to a moderately active lifestyle (Talbot, Gaines, Huynh & Metter, 2003; Tudor-Locke & Bassett, 2004).

Daily physical activity encompasses both periods of activity and inactivity (Aadahl & Jorgensen, 2003). For instance, a person may attend an exercise program, but may remain fairly sedentary for the rest of day. In addition, the exercise program may only involve a low level of activity (e.g., stretching) and lack other types of exercises (e.g., resistance, aerobic or weight-bearing exercises). Therefore, examining the ratio between activity and inactivity provides a more comprehensive profile of daily physical activity than examination of only one aspect of physical activity, such as periods of exercise participation and ignoring periods of inactivity (Aadahl & Jorgensen, 2003; Mazzeo et al., 1998).

Subjective and objective methods of monitoring physical activity have been used among older adults to obtain a description of activity patterns (Aadahl & Jorgensen, 2003; Steele et al., 2000; Tudor-Locke & Myers, 2001). Subjective methods include diaries and questionnaires. These methods tend to result in overestimation of physical activity because these methods rely on the person to self-report the information (Tudor-Locke & Myers, 2001). Therefore, greater inaccuracies may occur when subjectively monitoring physical activity, because recalling past activities may be difficult and fatiguing for some, especially if memory is impaired (Steele et al., 2000; Tudor-Locke & Myers, 2001).

On the other hand, accelerometers and pedometers are both reliable and valid tools used to objectively monitor physical activity (Bassett et al., 1996; Tudor-Locke, Williams, Reis & Pluto, 2002; Tudor-Locke & Myers, 2001; Tudor-Locke et al., 2005). Physical activity measured by both devices has shown to correlate in terms of detecting differences in physical activity profiles (Tudor-Locke & Bassett, 2004; Tudor-Locke, Williams, et al., 2002). Unlike questionnaires, accelerometers and pedometers have a greater capability of assessing daily physical activity, because they do not rely on individuals to recall activities. By measuring physical activity in terms of step count and energy expenditure, pedometers and accelerometers provide an objective assessment of daily activity patterns, such as duration of active periods and duration of inactive periods (Berlin et al., 2006; Steele et al., 2000). These two objective devices also have some limitations, in that they are best at monitoring ambulatory activities compared to other physical activities (Tudor-Locke & Myers, 2001; Welk, Almeida, & Morss, 2003). Both have also shown to be affected by the speed of gait (Cyarto, Myers, & Tudor-Locke, 2004; Storti et al. 2008). Despite these limitations, currently both devices have been considered valid and reliable for objectively monitoring free-living physical activity (Cyarto et al. 2004; Welk et al. 2003).

Accelerometers and pedometers have been used in studies with community-dwelling, healthy older adults to monitor physical activity (Pinto et al., 2005, Tudor-Locke & Myers, 2001). In addition, both have been used in studies with older adults with chronic diseases such as osteoarthritis, diabetes, and chronic obstructive lung disease (COPD). In these studies, both devices have been used to establish baseline physical activity values, to determine improvements after rehabilitation or to monitor adherence to a prescribed exercise program (Steele et al., 2000; Talbot et al., 2003; Tudor-Locke, Bell, et al., 2002).

There are limited studies using accelerometers and/or pedometers to objectively examine physical activity among older adults with osteoporosis or at risk of osteoporosis (Brooke-Wavell et al., 2000; Jordan, Jurca, Tudor-Locke, Church & Blair, 2005; Krumm et al., 2006). Brooke-Wavell et al. (2000), conducted a study in postmenopausal women (i.e., mean age 65.8 +/- 6.2 years) who were at risk of osteoporosis or diagnosed with osteoporosis. The researchers wanted to examine if the effect of tibolone (a medication that improves bone density) on bone density at the lumbar spine and hip differed according to different physical activity levels. The participants took Tibolone for five years prior to assessment of physical activity. An accelerometer was worn for three days and participants were categorized into high or low physical activity levels. Brooke-Wavell et al. found that the effect of tibolone on bone density at the hip, but not the spine differed according to physical activity levels. Women with low activity levels (n=26) had greater increases in bone density at the hip, than those with high activity levels (n=16). The researchers theorized that the women with low activity levels had more to gain from the effects of tibolone because these women had lower baseline hip bone density compared to women with high activity levels.

The purpose of this study was primarily to examine the effect of medication, rather than to obtain an understanding of physical activity parameters (e.g., daily energy expenditure and physical activity patterns) in older adults with osteoporosis or at risk of osteoporosis. In addition, physical activity was only monitored for three consecutive days (Brooke-Wavell et al., 2000), which may have lead to decreased validity in the assessment of physical activity. Other researchers recommend that to obtain a valid and reliable assessment of physical activity, monitoring should be greater than three days and should include a weekend (Berlin et al., 2006; Matthews, Ainsworth, Thompson & Bassett, 2002).

Another study by Krumm et al. (2006) used a pedometer (Yamax Digi-Walker SW-200) for monitoring daily step count for 14 days among 93 postmenopausal women age 50 to 75 years old. The researchers examined the relationship between physical activity monitored with a pedometer and body composition. Body composition variables included body mass index (BMI), waist and hip circumferences, waist-hip-ratio, percentage of body fat and trunk fat. The results of this study showed that postmenopausal women who took more steps had lower BMI, smaller waist and hip circumferences, lower waist-hip ratio, lower percentage of body fat, and less trunk fat. The researchers characterized women as ‘least’, ‘intermediate’ or ‘most’ active based on step counts and body composition. For instance, ‘least’ active women took on average 3791 steps/day and had an average BMI of 31.5 kg/m^2, those women with ‘intermediate’ activity levels, took on average 6625 steps/day and had an average BMI of 27.4 kg/m^2, and, lastly, women who were categorized as the ‘most’ active took on average 10,023 steps/day and had an average BMI of 24.1 kg/m^2.

Summary of Literature Review

In summary, objectively monitoring physical activity reveals information about individual energy expenditure, step count and periods of activity and inactivity (Brooke-Wavell et al., 200; Krumm et al., 2006). Assessing psychological factors may reveal information about potential psychological influences that could be affected by physical activity or vice versa (Lachman & Jette, 1997; Li et al., 2005; Menec & Chipperfield, 1997; Powell & Myers, 1995). Screening tools are available to screen for risk of fractures (Black et al., 2001), and tests are available to also assess mobility and balance among older adults (Podsiadlo & Richardson 1991; Whitney et al., 2005). Therefore, a study incorporating objective monitoring of daily activity to describe and characterize the activity patterns is needed. This along with the simultaneous assessment of potential psychological influences on activity among older adult women, while also assessing risk of fracture and mobility, will expand the knowledge about the connections between physical activity, fracture risk, mobility and psychological factors in order to understand how all four variables relate to one another and influence daily activity.

Purpose

The purpose of this study was to describe the daily activity patterns of community-dwelling older adult women using pedometers and accelerometers and to examine the relationships between physical activity, the risk of osteoporosis-related fractures, mobility, balance confidence, and health locus of control.

Objectives

Objective 1. Assessment of Physical Activity

To determine average daily step count (steps/day) with the use of a pedometer and the average daily energy expenditure (kcal/day) and total activity time (min) with the use of an accelerometer.

Objective 2. Osteoporosis Fracture Risk

To determine the risk of osteoporosis-related fractures with the use of the Fracture Index tool (Black et al., 2001).

Objective 3. Mobility

To assess mobility with two mobility measures: The TUG test (Podsiadlo & Richardson 1991) and the STS test (Whitney et al., 2005).

Objective 4. Balance Confidence

To examine the level of balance confidence using the ABC Scale (Powell & Myers, 1995).

Objective 5. Health Locus of Control

To examine health locus of control with the use of the MHLOC scale (Wallston, Wallston, DeVellis, 1978).

Objective 6. Interrelationships

To examine the interrelationships between physical activity, fracture risk, mobility, balance confidence and health locus of control.

Hypotheses

1. Physical activity will be positively correlated to balance confidence (i.e., increased physical activity will be associated to increased balance confidence.

2. Physical activity will be negatively correlated to time to complete mobility measures. (i.e., increased physical activity will be associated with a shorter time to complete a mobility task)

3. Physical activity will be negatively correlated with risk of fracture (i.e., increased physical activity will be associated with a lower risk of fracture.

4. Physical activity will be positively correlated with internal health locus of control (i.e., increased physical activity will be associated with having stronger internal health locus control beliefs.

Methods

Design

A cross-sectional design will be used for this study.

Sample Size

The sample size was derived using tables estimating sample size for correlation studies with a level of significance of 0.05, a power level of 0.80, and an effect size of r =0.40. In addition, previous studies using correlations (i.e., statistical measure of interest) between pedometer and BMI and accelerometer and self-efficacy and the standard deviations from these studies were also used. (Kruum et al. 2006, Steele et al. 2000). A minimum sample size of 40 was established.

Participants

The participants consisted of community-dwelling women, age 70 and older.

Inclusion Criteria

Inclusion criteria are as follows:

1. Age 70 years or older.
2. Living in the city of Winnipeg.
3. Able to speak and understand English.
4. Able to provide written informed consent.
5. Able to ambulate independently with or without an ambulatory aide (e.g., walker or cane).

Exclusion Criteria

Exclusion criteria are as follows:

1. Unable to speak or understand English.
2. Unable to ambulate independently.
3. Any medical or psychological condition which precludes participation in the study.

Recruitment

Potential participants were recruited through posters placed with permission in various seniors' apartment buildings, seniors' centres and fitness centers throughout Winnipeg. In addition, notices were placed in the Growing Older section of the Winnipeg Free Press and select internet sites. The posters/notices asked the participants to contact the principal investigator Dr. Weinberg by phone or e-mail at Dr. Weinberg's *Aging, Rehabilitation and Social Cognition Laboratory,* in the School of Medical Rehabilitation at the University of Manitoba. The time frame of this study was from July 18^{th} to December 7^{th} 2007.

Instruments & Procedures

Pedometer

The SC-01 pedometer (Steps Count Inc.™, Deep River, Ontario) was used to record daily steps. This device uses a spring mechanism to detect motion in the vertical and medial/ lateral planes and has acceptable accuracy characteristics comparable to other research grade pedometers (personal communication, D. Kriellaars, 2007)

The accuracy of placement of the pedometer for this study was tested during the first meeting with the participant. The participant performed a 20 step test as recommended by the manufacturer. The pedometer was placed over the left hip in-line with the middle of the thigh. Then, the participant was asked to walk 20 steps, while 20 steps were also counted and observed. Once 20 steps were taken, the participant was asked to open the pedometer and pedometer measured steps were compared to actual steps. If the pedometer recorded within +/- 2 steps, the pedometer was considered accurate in that position, if not the pedometer position was adjusted and the test was repeated until the best position was found.

Daily step counts were recorded by the participant for five days including two weekend days. The average daily step count was determined for the weekday and the weekend days, as well as the total average daily step count (weekdays and weekends).

Step Carriage: An un-validated estimate of energy expenditure was derived from daily step counts. This measure, termed step carriage, factors in the influence of the amount of body mass carried during stepping. Step carriage is derived as the product of body mass (kg) and average daily step count (step/day). This variable was used as an exploratory variable.

Accelerometer

The Biotrainer Pro™ (IM Systems, Baltimore, MD) is a valid and reliable accelerometer for monitoring daily physical activity (Welk, Blair, Wood, Jones & Thompson, 2000; Welk, et al., 2003; Welk, Schaben & Morrow, 2004). The Biotrainer Pro is a uniaxial accelerometer positioned at 45 degrees from the vertical, enabling it to detect movement in the vertical and horizontal planes (Welk et al., 2000; Welk et al., 2004). Researchers have recommended that the Biotrainer Pro be positioned over the right hip in-line with the mid-thigh (Welk et al., 2000; Welk et al., 2003; Welk et al., 2004). This accelerometer can be programmed to record physical activity at different epochs ranging from 15 seconds to 5 minutes (Welk et al., 2004).

For this study, the accelerometer was positioned over the right hip using a recording epoch of 30 seconds (the time period over which the acceleration data is summed), and a gain factor set to 10. The accelerometer was worn concurrently with the pedometer for five consecutive days.

The 5 day accelerometer data was downloaded and exported to a spreadsheet. Each accelerometer datum is time stamped by the accelerometer during acquisition. The raw accelerometer data is in the form of “activity counts” (corresponding to summed acceleration over the recording epoch). This “activity count” data is used to derive energy expenditure values at each time point by using the manufacturers formula. The manufacturers formula uses scaled body mass and a multiplication constant to convert to activity counts into energy expenditure using the following formula; (EE (kcal/min) = [(0.7863*activity counts) + (0.0659*mass(kg))-3.3377]/2). Any activity count above zero would correspond to energy expenditure from physical activity.

The energy expenditure data was used to derive the total daily energy expenditure (kcals/day) as the sum of all energy expenditure at each time point (kcals/min) within a day (midnight to midnight). The activity time (min) was derived as the amount of time within a day where the accelerometer data was greater than zero (either the activity count or energy expenditure data could be used). Activity time was simply the sum of the number of minutes where activity was detected from midnight to following midnight.

Logs.

Two separate logs were used to monitor daily activity. A five day activity log was used to monitor the types of activities participants were engaging in throughout their daily routine. Participants were instructed to use this activity log to record their daily activities and record the length of time they spent in each activity (e.g., swimming for 30 minutes or watching television for 60 minutes). The activity log also had a space for participants to record the time the accelerometer was put on in the morning and taken off at bedtime. A second log, the pedometer log, was used to record total daily step counts. Participants were instructed to record the time they put the pedometer on in the morning and took it off at night. In addition, participants were instructed to record their total daily step count at the end of each day.

Questionnaires and Scales.

One questionnaire and two scales were used in a face-to-face interview. A general interview questionnaire was administered. This questionnaire was constructed to obtain socio-demographic and health related information. It also assessed beliefs about personal control, exercise, and falls (Weinberg, 2004, 2005).

FRACTURE INDEX: The Fracture Index (Black et al., 2001) was incorporated into the general interview questionnaire to estimate the five year risk of osteoporosis-related fractures. It consists of 6 questions without bone mineral density information or 7 questions with bone mineral density information. For this study, the bone mineral density question was not used. In addition, some of the questions from the Fracture Index (Black et al., 2002) were adapted using information from the Study of Osteoporotic Fractures (Cummings et al., 1995). Specifically, the item in the Fracture Index which asks about the use of one’s hands to perform a sit-to-stand manoeuvre from a chair was performed as a timed mobility test which was originally included in the Study of Osteoporotic Fractures. The researchers of the Study of Osteoporotic Fractures have reported that the inability to sit-to-stand from a chair without the use of one's hands is linked to an increased risk of fractures (Cummings et al., 1995).

BALANCE CONFIDENCE: Balance confidence was measured using the ABC Scale (Powell & Myers, 1995). Participants were asked to rate their level of confidence in their ability to perform 16 indoor/ outdoor activities without losing their balance or becoming unsteady. The level of confidence is rated from 0% (no confidence) to 100% (complete confidence). The maximum possible score is 1,600. This score is then averaged by 16 to provide a balance confidence score out of 100. Higher scores reflect a greater level of balance confidence (Powell & Myers, 1995). This scale has been used in other studies with older adults to assess balance confidence and is a reliable measure of balance confidence (Li et al., 2005; Sattin et al., 2005).

HEALTH LOCUS OF CONTROL: The MHLOC scale (Wallston et al., 1978) is a reliable and valid instrument that has been used in studies to assess health beliefs (Cvengros, Christensen & Lawton, 2005; Masters & Wallston, 2005). The MHLOC scale was used to assess beliefs about control over health. This scale consists of three subscales: internal, powerful others and chance health locus of control. There are 6 statements in each subscale that are rated on a 5-point Likert scale from strongly disagree to strongly agree. Therefore, the summed score of each subscale has a range of scores from 6 to 36, with higher scores indicating stronger belief in either internal, powerful others or chance health beliefs (Cvengros et al., 2005; Masters & Wallston, 2005; Wallston et al., 1978).

Mobility.

TIMED UP AND GO TEST: The TUG test was used to assess mobility and balance (Podsiadlo & Richardson 1991). The TUG has been used in studies with older adults and has shown to be a valid and reliable tool to assess mobility and balance (Bischoff et al., 2003; Medley & Thompson, 2005; Shumway-Cook, Brauer & Woollacott, 2000). The TUG starts with an individual seated in a chair with armrests and is instructed on the word 'go' to stand up from the chair, walk three meters, turn around and walk back to the chair they started from and sit down. The time taken from the word 'go' until the individual sits down again is recorded in seconds. The standard protocol indicates that an individual complete two trials and the fastest time of the two trials be used to characterize their mobility and balance (Podsiadlo & Richardson 1991).

Various researchers have suggested that mobility can be classified based on the length of time needed to complete the task. For instance, a time of 10 seconds or less has been stated as normal mobility, but times up to 20 seconds or less are still considered within normal limits. Taking 30 seconds or longer to complete the TUG may indicate the person needs assistance with mobility and may be at risk for falls (Medley & Thompson, 2005; Podsiadlo, & Richardson, 1991).

SIT TO STAND TEST: The mobility test used to objectively assess the use of one's hands was the 5- repetition sit-to-stand was a five-time-sit-to-stand test (STS test. The standard protocol for this mobility test was followed as stated in the literature. Specifically, participants were instructed to sit in an armless chair with their backs against the chair and to cross their arms over their chest. Participants were then instructed to complete one trial which involved standing up fully and then sitting down fully five times in a row as fast and as safely as they can starting on the word 'Go' (Cummings et al.,1995; Whitney et al., 2005). During the five repetitions the use of hands to assist from sitting to standing was recorded as 'yes' or 'no' as per the Fracture Index (Black et al., 2001) and the Study of Osteoporotic Fractures (Cummings et al.,1995). The literature has reported that 14.2 seconds or longer to complete five repetitions is associated with greater balance dysfunction in adults greater than 60 years old (Whitney et al., 2005).

Body composition.

BMI (kg/m^2) was calculated using measured height and mass. Mass (kg) using a portable digital scale and height (m) using a tape measure.

Protocol

Posters/notices used for recruitment asked interested individuals to contact Dr. Weinberg by phone or e-mail at the *Aging, Rehabilitation and Social Cognition Laboratory at the University of Manitoba.* When an individual contacted the principal investigator by phone or e-mail, the graduate student then conducted an initial screening interview by telephone to assess inclusion/exclusion criteria. Once participants were deemed eligible a first appointment was arranged with the participant to take place either at the participant's residence (i.e., home) or at the

Aging, Rehabilitation and Social Cognition Laboratory, depending on the participant's preference.

During this first appointment, the graduate student conducted the following activities:

1. The participant information and consent was reviewed and discussed.
2. The informed consent form was signed (Appendix A).
3. Questionnaires and scales were administered.
4. Mobility was assessed with the TUG test and the STS test.
5. Height and mass was measured.
6. The pedometer and accelerometer were provided on loan from the researcher and the participant was instructed in how to apply and use each device. These instructions included information on where to place the pedometer and accelerometer and how to secure both devices to their clothing.
7. The daily activity log and pedometer log were provided and the participant was instructed in how to use the logs.

Participants were instructed to record the time each device was put on in the morning and taken off at night and to wear both devices the whole day except to take them off during water activities, such as swimming or bathing. Participants were also instructed that at bedtime they were to record their total daily step count from the pedometer in the pedometer log and to reset the pedometer to zero for use the next morning. In addition, instructions were given to keep a record of daily activities with the use of the daily activity log.

On completion of the five days, a second appointment took place in the participant's home. The second appointment involved reviewing the daily activity log and pedometer log with the participant, retrieving the pedometer and accelerometer, and thanking the participant for taking part in the study. A thank you letter was also given or mailed to each participant.

Statistical Analysis

Statistical analysis was performed using SPSS version 15.0 statistical software. An alpha level of 0.05 was used for all statistical analysis. Statistical analysis consisted of the following:

1. Means, minimums, maximums and standard deviations were computed for all variables.
2. Histograms of continuous variables were analyzed to ensure data followed a normal distribution, along with analysis of P-P and Q-Q plots to ensure data points fell close to a straight line, indicating normalcy of variables.
3. Correlations were calculated to investigate relationships between physical activity parameters, mobility measures, fracture risk, balance confidence and health locus of control.
4. Repeated measures ANOVA was used to compared differences between days for the physical activity variables.
5. Two-tailed paired t-test was used to compare differences between the two trials of the TUG test.

Results

Description of Subjects

A total of 58 women contacted the researcher expressing interest in potentially participating in the study and scheduling a first appointment with the researcher. Of this total number, 9 participants cancelled their first appointment, 2 participants withdrew after the first appointment prior to starting activity monitoring, and 6 participants had incomplete activity data. Therefore, the final sample size consisted of a total of 41 independently mobile women who completed all phases. Table 1 summarizes the characteristics of this study sample.

Table 1. Physical Characteristics of Subjects.

	Mean	**SD**	**Minimum**	**Maximum**
Age	**77.2**	**5.6**	**70**	**92**
Height (m)	**1.57**	**0.06**	**1.44**	**1.69**
Mass (kg)	**67.7**	**16.7**	**39.7**	**117.9**
BMI (kg/m^2)	**27.2**	**6.1**	**18.2**	**44.4**

Thirty seven percent of the subjects were classified as overweight (i.e., BMI= 25-29.9 kg/m^2), whereas, 24% were categorized as obese (i.e., BMI>= 30 kg/m^2). It has been reported that in Manitoba 28.8% are overweight and 26.2% are obese among adults 18 years of age and older (Health Canada, 2007). The women in this study are more obese than the provincial average.

Six of the 41 participants used a walking aid, and of those 6 participants, 3 used a walker and 3 used a cane for their daily mobility.

Health related information was also collected and analyzed. This was collected through self-report with the general interview questionnaire(Appendix B). A summary of the number of self-reported chronic conditions was obtained from this questionnaire. Participants answered yes/no from a list of 19 chronic conditions. The sum of 'yes' responses was calculated and then averaged. The average number of chronic conditions that were self-reported was calculated to be 3.6 chronic conditions and ranged from zero to eleven chronic conditions among participants. Also, some chronic conditions were more prominent among participants then others. For instance, arthritis or rheumatism (61%), eye troubles not relieved by glasses (49%), and high blood pressure (39%) are a few of the more prominent chronic conditions among the participants. The self-reported history of incidence of fractures in the past year from this questionnaire was 19.5% among participants.

Physical Activity

Physical activity was assessed using pedometry and accelerometry and results are described below.

Pedometry

Figure 1 shows the average daily step counts for each of the five days measured. In order to determine if there were differences in day to day step counts a repeated measures ANOVA was performed. There were no significant differences between the five days of monitoring daily step counts. As such, the average of the five daily step counts was derived (i.e., average daily step count) to characterize the sample (Table 2).

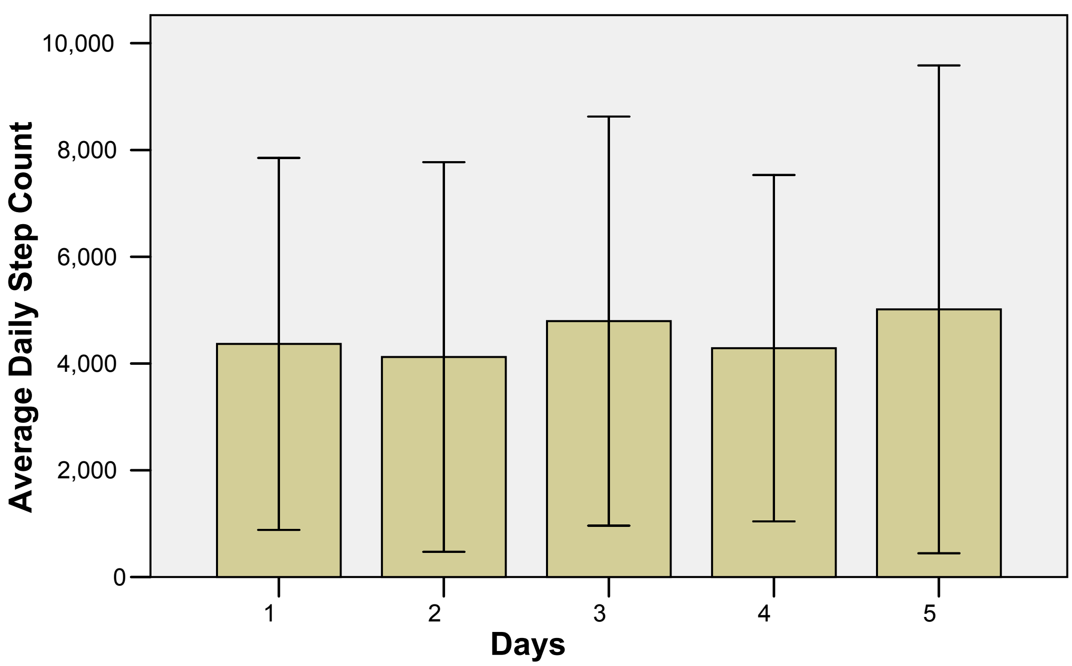

Figure 1. Average daily step counts (SD) over the 5 days. No significant difference between days.

Table 2. Pedometry derived physical activity measures.

	Mean	SD	Minimum	Maximum
5 Day Average Daily Step Count (steps/day)	4,516	3,228	341	12,150
5 Day Average Daily Step Carriage (steps*kg)	292.4	211.7	29.8	891.9

The average daily step count was 4516 steps/day (Table 2). Tudor-Locke and Basset (2004), describe activity levels with less than 5000 steps/day as sedentary. Examination of individual results revealed that a total of 4 participants (i.e., 10%) did have an average daily step count of 10,000 steps/day or more. When 8,500 steps/day was used as the recommended guideline (Tudor-Locke and Myers, 2001) for daily activity, then the number of participants achieving this guideline increased to 6 participants or fifteen percent. Figure 2 illustrates the average daily step counts.

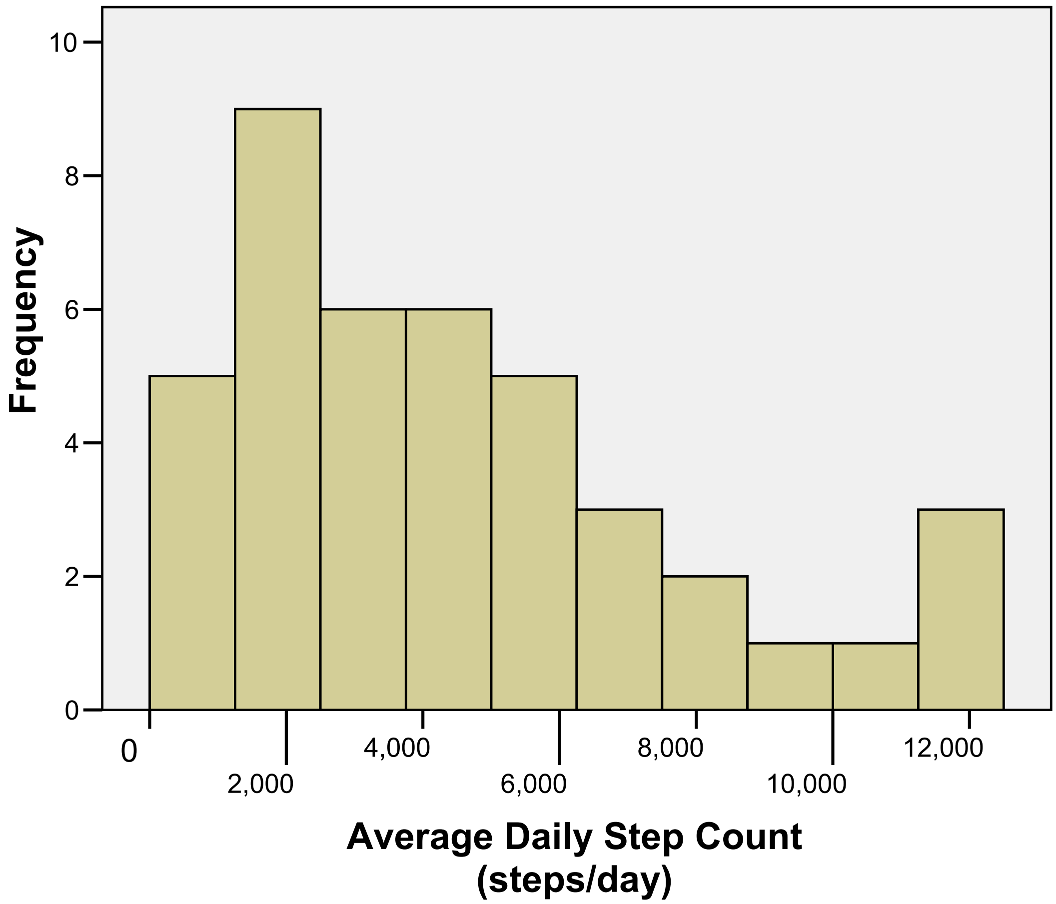

Figure 2. Histogram of average daily step counts.

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Another factor which must be considered when analyzing daily physical activity patterns is weather during the data collection period. Aspects of the weather, such as cold versus hot days, and snowfall have all been reported to affect physical activity patterns, especially in people with varying degrees of chronic conditions and mobility (Chan, Ryan & Tudor-Locke, 2006). Data collection for this study occurred over the summer and fall seasons.

These two seasons in Manitoba are often characterized with varying degrees of temperature, such as very hot humid days and even snowfall, which could begin as early as October. Therefore, there was a wide range in temperature over the data collection period. Weather information specific for Winnipeg during this study period was obtained from the Environment Canada website (www.climate.weatheroffice.ec.gc.ca). The range in temperature during this time was from 35.3 degrees Celsius to -26.5 degrees Celsius. Also, snowfall occurred during the last two months of data collections. No correlations in this study were calculated between physical activity and weather.

Accelerometry.

Figure 3 illustrates the average daily energy expenditure from physical activity for each of the five days of monitoring activity. A repeated measures ANOVA was performed to examine whether there were significant differences in the day to day variability in daily energy expenditure. Consistent with the pedometer data, there was no significant difference between the five days of monitoring energy expenditure among participants. Therefore, a five day average daily energy expenditure from physical activity and activity time was used in the present study as a method to describe activity among participants.

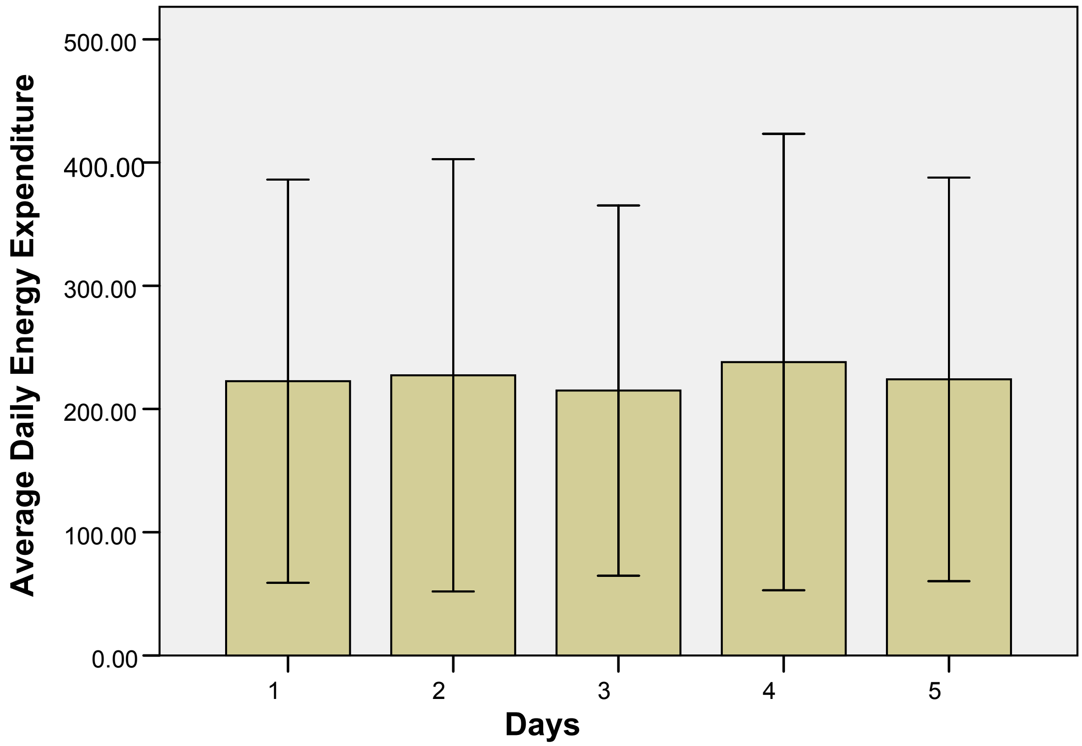

Figure 3. Daily energy expenditure from physical activity (kcal/day, SD) over the 5 days (NS between days).

The average daily energy expenditure from physical activity was found to be 225.4 (152.9 kcal/day). The range of average daily energy expenditure from physical activity ranged from a minimum of 8.23 kcal/day to a maximum of 806.42 kcal/day. Manini et al. (2007) have described values that are less than 521 kcal/day in a free living environment as low levels of energy expenditure. Figure 4 illustrates the average daily energy expenditure from physical activity (kcal/day) among the participants.

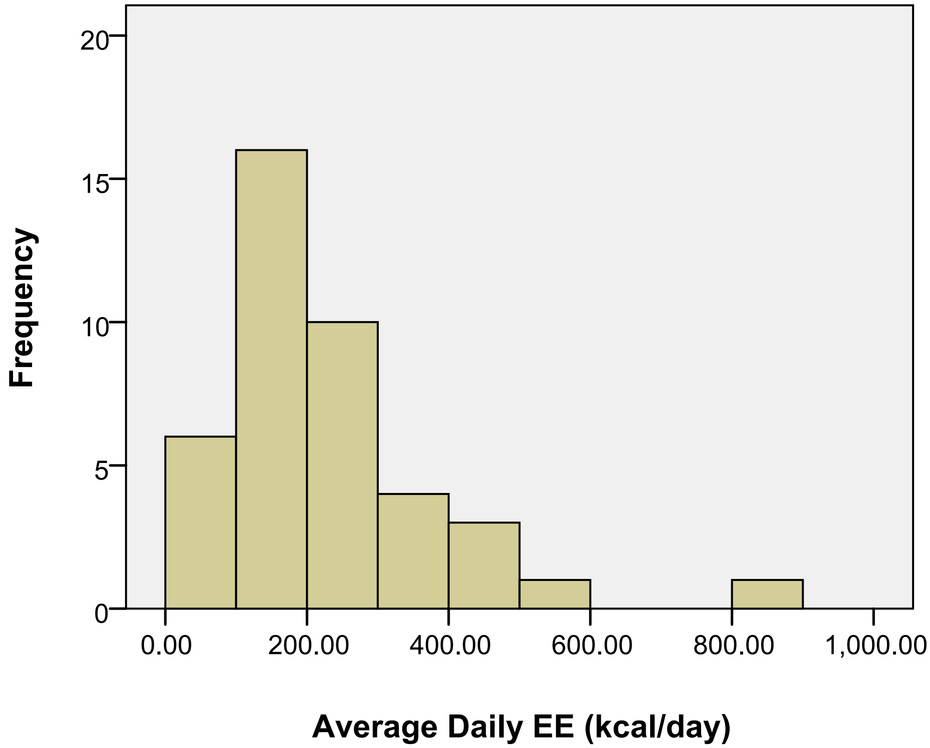

Figure 4. Histogram of average daily energy expenditure from physical activity (kcal/day).

Daily activity time is a measure of the amount of minutes in a day participants were physically active and was calculated from daily energy expenditure data. Figure 5 depicts the average daily activity time for each of the five days. Similar to the energy expenditure from physical activity, no significant differences were found between the five days; therefore average values were used to characterize daily activity time.

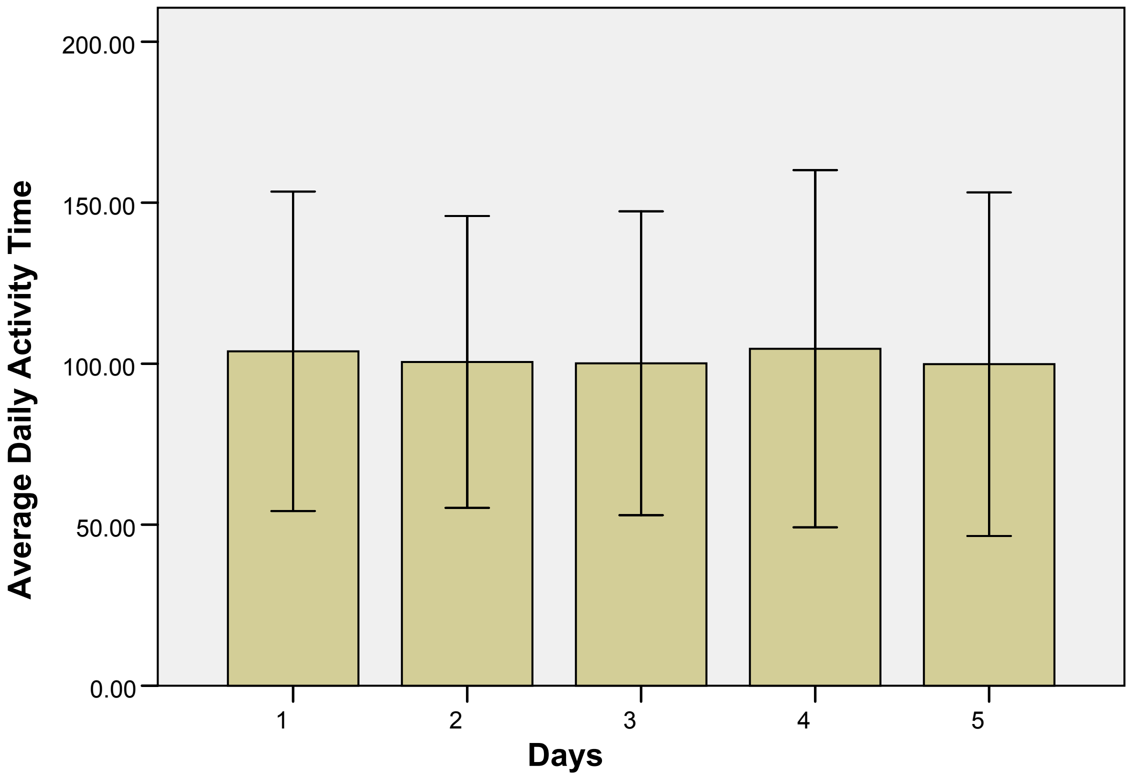

Figure 5. Daily activity time (min, SD) over the 5 days. No significant differences between days.

The average daily activity time was 101.8 (42.4) min and ranged from 15.7 to 276.7 min. Therefore, this means that on average participants were active for about 1 hour and 41.8 minutes per day. Figure 6 illustrates the frequency of daily activity time among participants.

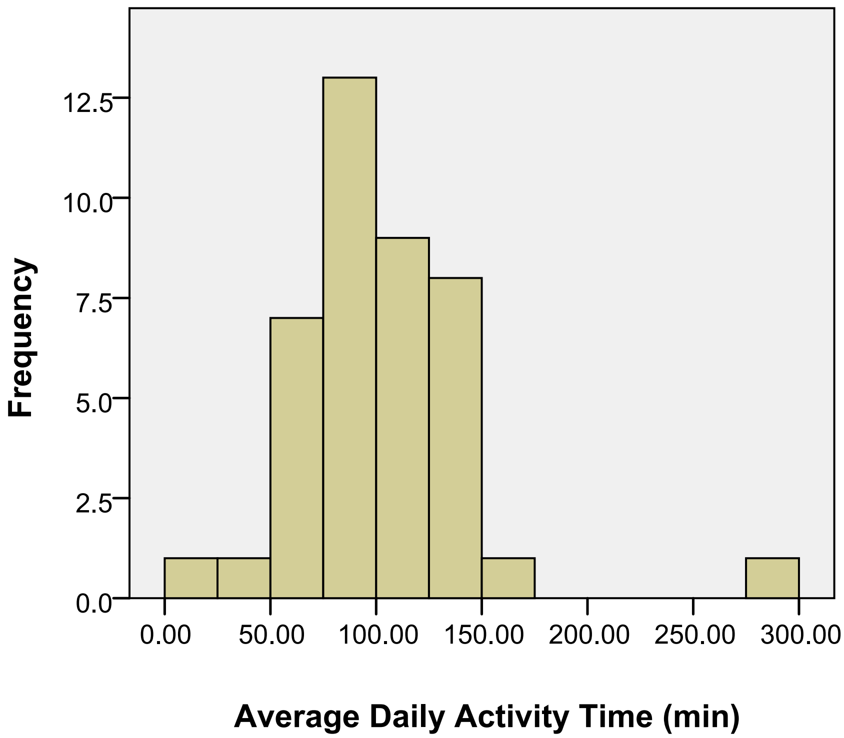

Figure 6. Histogram of average daily activity time (min).

Relationship between Physical Activity Measures.

A major objective of this study was to examine daily physical activity of older adult women. One important aspect of this was the inter-relationship between pedometer and accelerometer derived measures of physical activity. Pearson's correlation coefficients were used to examine the relationships between average daily step count, average daily energy expenditure, and average daily activity time. A summary of the Pearson's correlation coefficients (i.e., r-values, p values) between average daily step count, average daily energy expenditure and average daily activity time are shown in Table 3.

Table 3. Pearson's correlation coefficients between average daily step count, average daily energy expenditure from physical activity (kcal/day) and average daily activity time (min). (* p < 0.05, ** p<0.01).

	Average daily energy expenditure (kcal/day)	**Average daily activity time (min)**
Average daily step count (steps/day)	**0.339 (*)**	**0.637(**)**
Average daily energy expenditure (kcal/day)		**0.72(**)**

Average daily step count and average daily energy expenditure. A significant positive relationship was found between average daily step count and average daily energy expenditure (r = 0.339, p<0.05). This indicates that a greater number of steps taken in a day was associated with expending a greater amount of energy in a day. Figure 7 illustrates a scatter plot of this relationship between average daily step count and average daily energy expenditure.

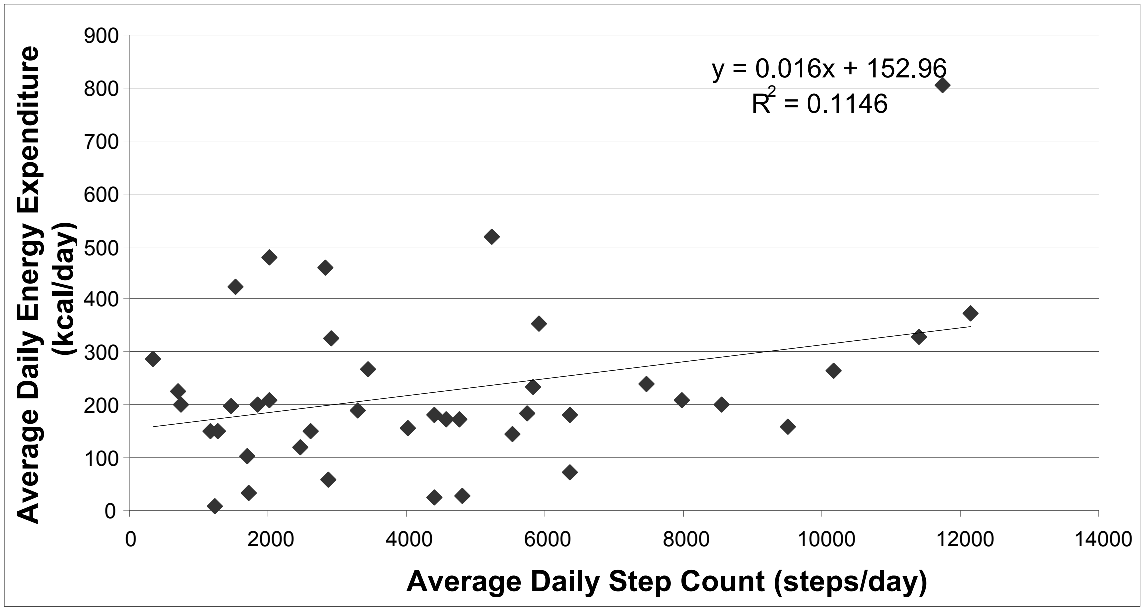

Figure 7. Scatter plot of average daily step count and average daily energy expenditure from physical activity. Best fit line is shown ($p<0.05$).

Average daily step carriage and average daily energy expenditure. When average daily step carriage was used to describe daily activity, an increase in correlation coefficient between daily step carriage and daily energy expenditure ($r = 0.530$, $p<0.01$) was observed relative to the relationship between daily step count and daily energy expenditure. The step carriage correlation was better than the step count correlation with energy expenditure, therefore this warrants further investigation of this parameter as a measure of physical activity.

Average daily step count and average daily activity time. A moderately strong positive correlation was found between average daily step count and average daily activity time ($r = 0.637$, $p<0.01$). Participants who took more steps during the day also tended to spend more time during their day being physically active. Figure 8, demonstrates this positive relationship between average daily step count and average daily activity time.

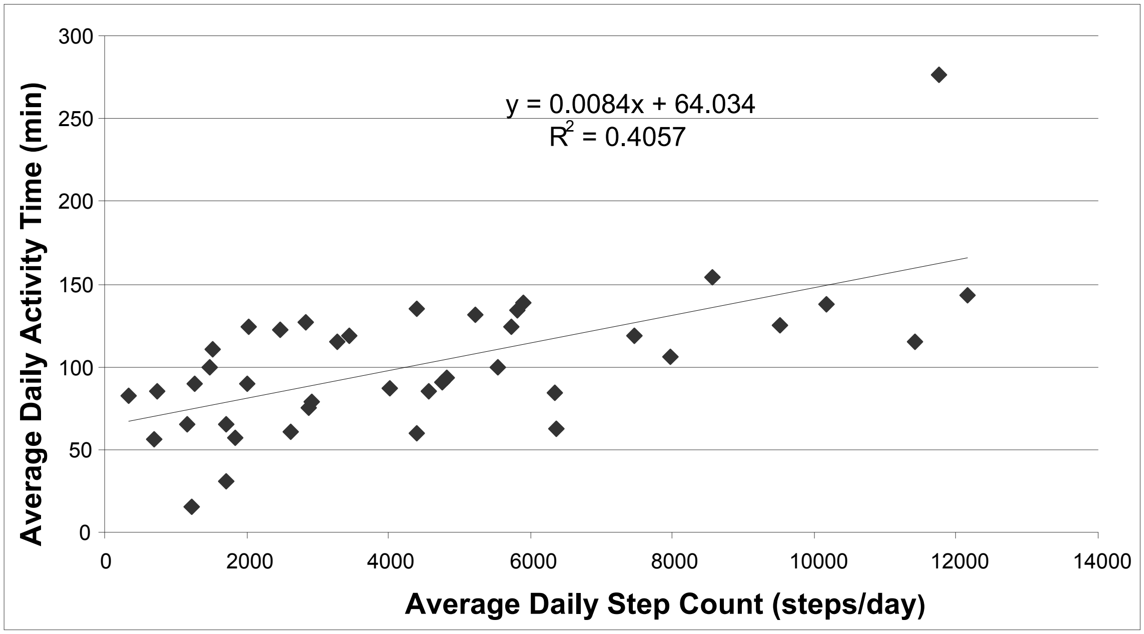

Figure 8. Scatter plot of average daily step count and average daily activity time. Best fit line is shown.

Average daily energy expenditure and average daily activity time. Lastly, a significant positive relationship was also found between average daily energy expenditure and average daily activity time with ($r = 0.72$, $p < 0.01$). Therefore, the participants who expended more energy throughout their day also spent more time being physically active in their day. Figure 9 illustrates the relationship between average daily energy expenditure and average daily activity time.

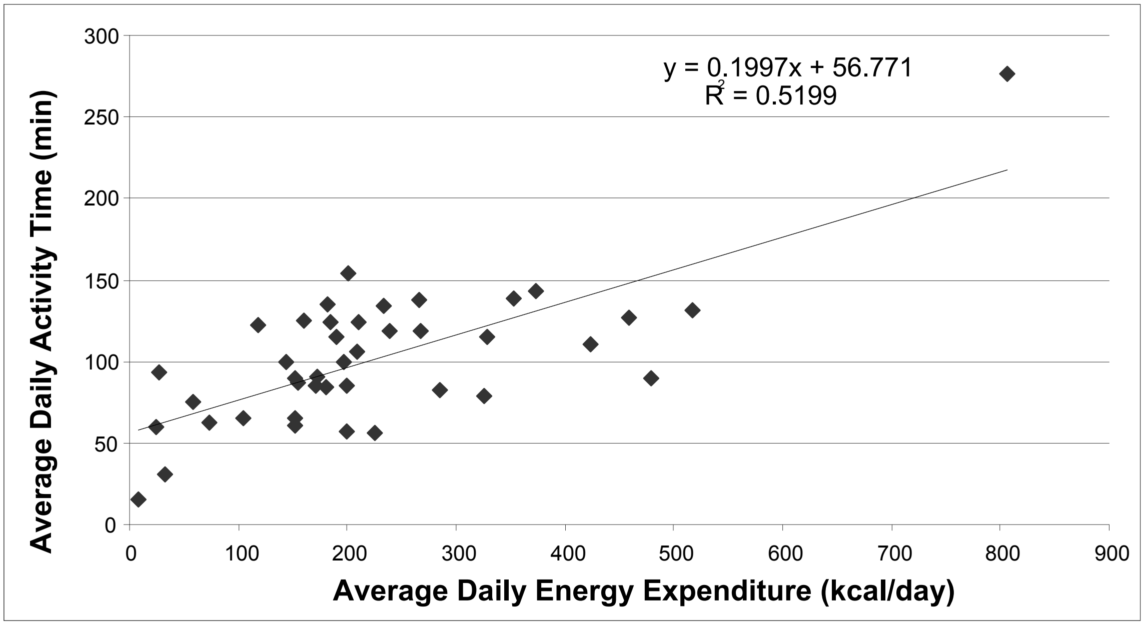

Figure 9. Scatter plot of average daily energy expenditure and average daily activity time. Best fit line is shown ($p<0.01$).

Average daily step count, average daily energy expenditure and BMI. A significant negative correlation was found between BMI and average daily step count ($r = -0.321$, $p<0.05$). Therefore, those participants who took more steps in a day on average, also had a lower BMI. Also, a significant positive correlation was found between average daily energy expenditure and BMI. Therefore, expending more energy in a day was associated with having a higher BMI.

Mobility Measures

In addition to assessing daily physical activity, two mobility measures were administered to assess mobility and balance; the TUG test (Podsiadlo & Richardson 1991) and the five repetition STS test (Cummings et al., 1995; Whitney et al., 2005). Table 4 summarizes the results of both mobility measures.

The difference between the two trials of the TUG test was evaluated (paired t-test). A difference may have arisen due to factors such as fatigue or learning. No significant difference was found between the two trials of the TUG test. For analysis, the fastest time between the two trials was used.

Table 4. Timed Up and Go and Sit to Stand Mobility Measures

	Mean	**SD**	**Minimum**	**Maximum**
TUG (s)	9.2	3.8	5	21.5
STS (s)	14.2	6.4	7	40

Timed Up and Go test. The average time taken to complete the TUG test was 9.2 seconds. A time of 10 seconds or less has been stated as being considered “normal mobility”, but times up to 20 seconds or less are considered within normal limits for good mobility (Medley & Thompson, 2005; Podsiadlo, & Richardson, 1991). Eighty percent of participants (i.e., 33 out of 41) took 10 seconds or less to complete the TUG test. Virtually all participants (i.e., 95 percent) took 20 seconds or less to complete the TUG test, with only 5 percent taking greater than 20 seconds.

Sit-to-Stand test. The average time (14.2 s) taken to complete five repetitions of the STS test was equal to the cut off point for optimal mobility and balance. The literature has stated that taking 14.2 seconds is associated with greater balance dysfunction in adults greater than 60 years (Whitney et al., 2005). Sixty one percent (i.e., 25 out of 41) took less than 14.2 seconds to complete five repetitions of the STS test.

Relationship between the Timed Up and Go and the Sit-to-stand tests. The relationship between mobility measures was analyzed using Pearson's correlation. A significant positive relationship was found between the TUG and STS test ($r = 0.833$, $p<0.01$). The time taken to complete the STS was strongly correlated to the time to complete the TUG. Therefore, a faster time to complete one test meant a faster time to complete the other test.

Self Reports of Balance Confidence, Health Locus of Control and Fracture Risk

Table 5 summarizes the results from the Activity Specific Balance Confidence (ABC) Scale (Powell & Myers, 1995), the 3 subscales of the MHLOC scale (i.e., internal, chance and powerful others health locus of control) (Wallston et al., 1978), and the Fracture Index (Black et al., 2002).

Table 5. Descriptive statistics of the ABC Scale, three MHLOC subscales, and the Fracture Index.

	Mean	**SD**	**Minimum**	**Maximum**
ABC total score	1,283	292	410	1600
ABC (%)	80	18.	26	100
Internal MHLOC (out of 36)	27	4.	17	36
Chance MHLOC (/36)	16	5	6	27
Powerful Others MHLOC (/36)	18	6	7	28
Fracture Index(/11)	4	2	2	8

Balance Confidence. The average score on the ABC Scale (Powell & Myers, 1995) was 1,283 out of 1,600 or 80%. This indicates, that on average these female participants were 80% percent confident that they could maintain their balance and remain steady during daily activities. Myers and coworkers (1998), have reported that ABC scores above 50% and lower than 80% are indicative of moderate level of functioning and characterize older adults living in retirement homes and people with chronic conditions. A score of 80% and above is characterized as high functioning individuals who usually are physically active. In the present study, 34% participants scored lower than 80% on the ABC Scale, and only 3% of the participants score lower than 50% on the ABC Scale.

Health Locus of Control. The MHLOC subscales data shown in Table 5, reveals that these participants had a stronger sense of belief in internal health locus of control. Higher summed scores toward 36 the subscale, indicates a stronger belief in that particular health locus of control domain (i.e., internal, chance or powerful others). The average internal health locus of control score was 27 out of 36. This indicates that these women had a strong belief that they themselves (i.e., the internal component of health locus of control) have control over their health and believed that external factors (e.g., chance and powerful others) did not control their health.

Fracture Risk. The scoring system of the Fracture Index (Black et al., 2002) indicates that a person is at greater risk of fractures if the sum of the points on the index equals 4 or greater. The average score was 4, which puts this sample as borderline risk of fracture. Thirty four percent of participants (i.e., 14 women in total) scored above 4 on the index, indicating being at greater risk of fracture. Twenty nine percent of the participants (or 12 participants in total) self-reported being diagnosed with osteoporosis. However, those that self-reported being diagnosed with osteoporosis were not all of the same participants who scored above 4 on the Fracture Index.

Interrelationships between Physical Activity, Mobility, and Self Report Measures

One of the main objectives was to examine the interrelationships between the physical activity measures, mobility measures, and the self-report measures. The self-report measures of this study included: balance confidence (i.e., ABC Scale), health locus of control (i.e., MHLOC scale), and the Fracture Index. Pearson's correlation coefficients (i.e., r-values) were calculated to evaluate the interrelationships between the continuous variables (i.e., physical activity, mobility, balance confidence, health locus of control and fracture risk. Spearman's correlations coefficients (i.e., rho-values or r_s-values) were calculated to evaluate the interrelationships between the two categorical variables (i.e., walking aid use and the number of chronic conditions) with the physical activity, mobility, balance confidence, health locus of control and fracture risk. Table 6 summarizes these correlations between physical activity, mobility, and self-report measures.

Table 6. Correlations of physical activity, mobility measures and self-report measures. (*p< 0.05, ** p<0.01).

	TUG (Pearson)	STS (Pearson)	ABC (Pearson)	Powerful others MHLOC (Pearson)	Fracture Index (Pearson)	Walking aid use (Spearman)	Number chronic conditions (Spearman)
Average daily step count (steps/day)	**-0.343(*)**	**-0.277**	**0.319(*)**	**-0.144**	**-0.211**	**-0.414(**)**	**-0.281**
Average daily energy expenditure (kcal/day)	**-0.103**	**-0.02**	**0.037**	**-0.465(**)**	**-0.497(**)**	**-0.175**	**-0.052**
Average daily activity time (min)	**-0.349(*)**	**-0.343(*)**	**0.252**	**-0.299**	**-0.371(*)**	**-0.391(*)**	**-0.409(**)**

Physical activity and mobility measures. Based on Pearson's correlation coefficients (Table 6), both average daily step count (r = -0.343, p<0.05) and average daily activity time (r = -0.349, p<0.05) were found to have significant inverse relationships with the time taken to complete the TUG test. Therefore, taking longer to complete the TUG test was associated with taking less steps during the day and spending less time being physically active during the day.

Average daily energy expenditure from physical activity did not significantly relate to the time take to complete the TUG test.

A significant inverse relationship was found between the STS test and average daily activity time ($r = -0.343$, $p<0.05$). Similarly, those who took longer to complete the STS test also spent less time during their day being physically active. No significant relationships were found between the time taken to complete the STS test and average daily step count, or average daily energy expenditure.

Physical activity and self-report measures. Based on Pearson's correlation coefficients (Table 6), it was found that greater balance confidence positively correlated to average daily step count ($r =0.319$, $p<0.05$). Therefore, having greater confidence in one's balance was associated with taking greater steps in a day . Neither average daily energy expenditure nor average daily activity time were significantly related to balance confidence.

On the other hand, internal health locus of control did not correlate with any of these variables. The amount of internal or personal control these participants believed they had over their health was not associated with their daily physical activity despite a substantial range in this MHLOC subscale (17 to 36/36) . Chance health locus of control did not significantly relate to any of the study variables except to another health locus of control subscale, the powerful others health locus of control. The relationship between these two domains of health locus of control is expected as both are forms of external health locus of control.

A significant inverse relationship between powerful others health locus of control and average daily energy expenditure was observed (r = -0.465, $p<0.01$). Participants who expended more energy were more likely to have weaker beliefs in powerful others controlling their health. Powerful others health locus of control did not relate to any other physical activity measures.

It was found that a greater risk of fracture as measured by the Fracture Index (Black et al., 2002) significantly related to less time spent being physically active in a day (r =0.371, $p<0.05$) and on average expending less energy in a day from physical activity (r = -0.497, $p<0.01$). The number of steps taken on average in a day, was not significantly related to the risk of fracture among these women.

Based on Spearman's (Table 6), it was found that the use of a walking aid was inversely related to the number of steps taken in a day (r_s = -0.414, $p<0.01$), and spending on average less time being physically active in a day (r_s = -0.391, $p<0.05$). Walking aid use was not significantly related to the average amount of energy a person expended in a day from physical activity. Among the three physical activity measures, the only one which had a significant relationship to the number of chronic conditions was daily activity time. A significant inverse relationship was found between average daily activity time and the number of chronic conditions (r_s = -0.409, $p<0.01$). In other words, those participants who took more steps in a day and spent more time being physically active, did not use a walking aid for mobility. Also, those participants who spent more time being physically active, also had less chronic conditions.

Mobility measures and self-report measures. Pearson's correlation coefficients revealed that a significant inverse relationship existed with balance confidence and both the TUG test ($r = -0.703$, $p<0.01$) and the STS test ($r =0.657$, $p<0.05$). Taking a longer time to complete either of the mobility measures was associated with less confidence in one's balance during daily activities. Similarly, both the TUG test and the STS test had a significant positive correlation with the Fracture Index (TUG $r =0.422$, $p<0.01$; STS $r =0.311$, $p<0.05$), walking aid use (TUG $r_s =0.382$, $p<0.05$; STS $r_s =0.359$, $p<0.05$), and the number of chronic conditions (TUG $r_s =0.419$, $p<0.01$; STS $r_s=0.326$, $p<0.05$). Therefore, those participants who took more time to complete either mobility test, also were less confident in their balance, had a greater risk of fracture, used a walking aid for mobility and had a greater number of chronic conditions. Table 7 summarizes the correlations among mobility measures and the self-report measures.

Table 7. Correlations of mobility measures and self-report measures. (* p < 0.05, ** p<0.01).

	ABC (Pearson)	**Fracture Index (Pearson)**	**Walking aid use (Spearman)**	**Number chronic conditions (Spearman)**
TUG	**-0.703(**)**	**0.422(**)**	**0.382(*)**	**0.419(**)**
STS	**-0.657(**)**	**0.311(*)**	**0.359(*)**	**0.326(*)**

Relationships between self-report variables. Based on Pearson's and Spearman's correlations, it was found that balance confidence had significant negative relationships with the Fracture Index ($r = -0.359$, $p<0.05$); walking aid use ($p<0.05$; $r_s = -0.373$, $p<0.05$); and the number of chronic conditions ($p<0.01$; $r_s = -0.470$, $p<0.01$). Therefore, participants with greater balance confidence were more likely to have a lower risk of fracture, less likely to use a walking aid for mobility and to have fewer chronic conditions.

In addition, fracture risk as measured by the Fracture Index was positively related to walking aid use ($r_s =0.379$, $p<0.05$) and the number of chronic conditions ($r_s =0.401$, $p<0.01$). Lastly, a weak, but significant positive relationship was found between powerful others health locus of control and scores on the Fracture Index ($r= 0.360$, $p<0.05$). Therefore, participants at greater risk of fracture also had increased use of a walking aid and had a greater number of chronic conditions. Table 8 summarizes the correlations between the self-report measures.

Table 8. Correlations between self-report measures. (* p < 0.05, ** p<0.01).

	Fracture Index (Pearson)	**Walking aid use (Spearman)**	**Number chronic conditions (Spearman)**
ABC	**-0.359(*)**	**-0.373(*)**	**-0.470(**)**
Powerful others MHLOC	**0.36(*)**	**0.129**	**0.292**
Fracture Index		**0.379(*)**	**0.401(**)**
Walking aid use			**0.295**

The number of chronic conditions variable consisted of the sum of yes/no responses to a list of 19 chronic conditions. One of these conditions was the self-report history of fracture over the past year. It was found that having had a fracture in the past year was positively associated to the risk of fracture as measured by the Fracture Index based on Spearman's correlation coefficients (i.e., r_s = 0.356, $p<0.05$). Therefore, those women who have had a fracture in the past year are at greater risk of sustaining osteoporosis-related fractures.

Correlations with age. In order to examine the effect age may have on the physical activity, mobility, and self-report measures correlations were performed. Age was negatively associated to average daily energy expenditure ($r= -0.485$, $p<0.01$), step carriage ($r= -0.338$, $p<0.05$) and BMI
($r = -0.339$, $p<0.01$), but positively associated to the Fracture Index ($r = 0.854$, $p<0.01$) and powerful others health locus of control ($r = 0.415$, $p<0.01$). These correlations indicated that with increased age, participants expended less energy, had a lower step carriage, had a lower BMI, were at greater risk of fracture and had stronger beliefs that powerful others controlled their health. However, age did not significantly associate with average daily step count, average daily activity time, either mobility test, balance confidence, the number of chronic conditions or internal and chance health locus of control.

Discussion

This study provides insight into the daily physical activity patterns of older women as well as its relationship to mobility, fracture risk, and psychological constructs, such as balance confidence and health locus of control. These four areas (i.e., physical activity, mobility, psychology and fracture risk), have previously been investigated individually in their importance to older adults and health. Previous literature has revealed that older adults have sedentary lifestyles, that is, they are less physically active than they should be, which in turn would lead to developing or advancing chronic conditions (Craig et al., 2004; Jette et al., 1999). In addition, psychological barriers may also contribute to self-imposed inactivity (Li et al. 2005). Older adult women are also more likely to develop chronic diseases which affect bone health, such as osteoporosis (The International Osteoporosis Foundation, 2007).

Physical Activity

A main objective of this study was to describe daily physical activity patterns. Physical activity assessment has revealed that these women are not meeting the recommended guidelines for physical activity and health. Pedometer measured daily physical activity revealed that participants were on average sedentary throughout their day. The average daily step count was just over 4,500 steps per day and daily step counts below 5000 have been classified as sedentary for healthy adults (Tudor-Locke and Basset, 2004).

Tudor-Locke and Myers (2001), recommended that 8500 steps/day as a guideline for older adults to accrue health benefits. Only 15% of participants monitored in this study met this guideline. However, the average daily step count (i.e., 4,516.2 steps/day) is within the recommended range for older adults living with disabilities and chronic illness. Tudor-Locke and Myers (2001) stated that average daily step counts for these individuals are between 3,500-5,500 steps/day. Consistent with this observation, was the fact that the average number of chronic conditions was 3.6 for the women in this study. Further research should be devoted to understanding how each of the conditions influenced the activity patterns of the participants. Interestingly, in the present study, analysis revealed no significant correlation between daily step counts and the number of chronic conditions. This study may have been slightly underpowered to make a firm conclusion regarding this association. Equal weight was given to all 19 chronic conditions during analysis and therefore, this may have affected the above relationship as some conditions were more prominent than other among participants (e.g., arthritis or rheumatism was the most prominent condition).

Other studies examining daily step counts in older adults, other studies have shown somewhat higher daily step counts compared to this Winnipeg based study. One study reported an average daily step count of 4,728.4 steps/day in older adults (n=91) (Rowe, Kemble, Robinson, & Mahar, 2007). In addition, Park et al. (2007) reported an average daily step count of 6,288 for older adult women (n=96). The higher step counts found in these two studies may be explained by age, body mass index and weather differences compared to the present study. Rowe et al. (2007) reported an average age of 74 years and an average BMI of 26.4 kg/m^2 and Park et al. (2007) reported an average age of 72.7 years and an average BMI of 22.7kg/m^2. In the present study, the BMI was higher (27.2 kg/m^2) and the age was older (77.2 years). In addition, the weather was likely substantially colder than these US based studies, and there was also snow cover for a substantial number of measurement days in the present study.

Importantly, the present study supports the notion that carrying excess body fat has a negative impact on the amount of physical activity obtained per day, as we observed a significant negative relationship between daily step counts and BMI (i.e., the greater the BMI, the fewer steps taken per day). This indicates that a factor that may be important to consider is the role of lifestyle modification to reduce excess fat mass so as to facilitate greater physical activity per day.

Consistent with the pedometer results, examination of average daily energy expenditure and average daily activity time supports the findings that older adult women are sedentary or have low activity levels. A study by Manini et al. (2006) indicated that energy expenditure from physical activity that was less than 521 kcal/day is considered 'low activity'. The average daily energy expenditure for this study was 225.4 kcal/day, which is substantially lower than the cut off point for 'low activity'. Only one subject out of forty one achieved a daily energy expenditure greater than 770 kcal/day, which Manini et al. described as 'high activity'. Consistent with this finding, was that this same participant had daily step counts greater than 10,000 steps/day, which is the threshold for active younger adults. For the remainder of the subjects, the low daily energy expenditure values are consistent with the observation of low average daily step counts.

There are limited comparison studies that measured energy expenditure from physical activity in older adults 70 and above. Two studies were found which documented higher average daily energy expenditure in older adults compared to the present study. One study used an accelerometer to measure energy expenditure at two time periods in 43 older adults. The average daily energy expenditure at the first measurement period was 352 kcal/day and at second period was 337 kcal/day (Sieminski, Cowell, Montgomery, Pillai, & Gardner, 1997). Unlike the present study, the study by Sieminski et al. (1997), included a sample of only 3 women and 40 men, and therefore, would not be representative of energy expenditure among women. Nonetheless, it provided a reference point for comparison, as the women in this study had almost 120 kcals/day less energy expenditure than the majority male group reported by Sieminski and coworkers. Also, the average age of the subjects in the Sieminski et al. study was only 65.7

years, which is substantially lower than the average age in the present study. The differences in energy expenditure seen in the study by Sieminski et al. may be explained by sex differences, younger participants and possibly weather effects. Effects of weather, such as snow cover (which occurred in the present study), could potentially decrease the amount of step taken in a day. This less than optimal outdoor condition for some older adults may restrict them to their home, especially if transportation is not available to get to other indoor facilities (e.g., malls or fitness centres) where one may be able to accumulate greater daily step counts. Therefore, a restriction to one's home due to poor weather conditions would reduce daily step counts.

In another study examining energy expenditure, the researchers used the doubly labelled water technique and found that women between the ages of 65-74 years (N=15) expended on average 767 kcal/day and women age 90 years and above (N=11) expended on average 381 kcal/day (Frisard et al., 2007). The age related decline in energy expenditure can be determined to be 19.3 kcals/day per year of age. With an average age of 77.2 years in the present study, this being 7 years above the median of that reported for the 65-74 year old group, we can derive that the average daily expenditure from physical activity would be 631 kcals/day which is still substantially above the average reported in the present study (225 kcals/day). Examination of the histogram of activity levels observed in this study reveals a relatively normal distribution but shifted to the left (low activity). This distribution may have been a result of restricted activity to the home fostered by the weather and environment (snow) for some participants.

In comparison to reference values, the average daily energy expenditure of the participants in the present study (i.e., 225.4 kcal/day) is just above 150 kcal/day which is defined as the energy expended during 30 minutes of moderate intensity physical activity. Therefore, it may appear that these women are meeting the minimal recommendations for health as defined by energy expenditure. However, 150 kcal/day is recommended **in addition** to normal daily routine activities. Taken this into consideration, the women in the present study are accumulating just over 30 minutes of activity in their entire day and then considered sedentary for the rest of the day.

The activity patterns of the women were also assessed using activity time; that is, the time spent moving within the day. This is the first study to report daily activity time information as a measure of physical activity among women age 70 years and older. Current guidelines indicate that adults should be participating in 30 minutes of moderate physical activity on most days (Balady et al., 2000, p. 227).

Results from this study indicated that these participants spent on average 101.8 minutes/day (or 1 hr and mins) being physically active (above resting metabolic rate) during the course of a typical day that lasted about 12 hours (reported from activity logs). Although women in this sample are physically active for longer than 30 minutes, when examined in combination with step count and energy expenditure, the time spent was at very low activity levels. Therefore, these women were not meeting the guideline of 30 minutes of moderate intensity physical activity on most days. Further analysis of the data is warranted in examining the amount of time spent in low, moderate and intense physical activity. Even though the number of chronic conditions did not relate to daily step counts, further consideration with other activity measures should be investigated. There is evidence from this study that supports a negative relationship between daily activity time and the number of chronic conditions. It appears that the greater number of chronic conditions a person has, the less amount of time a person is likely to spend being active in a day.

Mobility

Another aim of this study was to objectively assess mobility. Maintaining mobility in older adults is important because a person's level of mobility can dictate participation or avoidance of certain activities (Whitney et al., 2005). Interestingly, these women scored within normal limits based on mobility measured with the TUG test and the STS test. Differences among the times taken to complete these tests in other studies in comparison to the times taken in the present study may be the result of factors such as age differences and the presence of a greater number of chronic conditions and the greater use of walking aids.

One study which examined the association of physical mobility measures with bone mineral density measured by DEXA in postmenopausal women, reported that it took on average 8.8 seconds to complete the STS test (Lindsey, et al., 2005). This score is substantially faster than the women in the present study, who took on average 14.2 seconds to complete the test. The women in the study by Lindsey et al. (2005) were also on average younger (average age was 68.3 +/-

6.8 years) than the women in the present study, which may provide an explanation for the faster time seen in their study. In another study which included both men and women with an average age of 73, the researchers reported an average time of 13.4 seconds (Whitney et al. 2005). In either of these two studies (Lindsey et al.; Whitney et al.) it was not reported if the participants had any chronic conditions or used walking aids, both of which may affect the time to complete the STS test. Results from the present study indicate that the number of chronic conditions and the use of a walking aid are positively related to the time taken to complete the STS test and even the TUG test.

On the other hand, the researchers of one Australian study reported that women in different age groups from 75 years of age and older took between 12.1 and 17.2 seconds (Lord et al., 2002), which seems consistent with the results found in the present study. Similarly, the women in the present study ranged in age from 70 to above 90 years of age in comparison to the Australian study. However, tow of the three studies indicate that the time to complete the STS test in the present study was slower in comparison to the times stated in two of these above studies and this may have been due to age differences..

The women in this present study were faster at completing the TUG test in comparison to other studies with older adults. For example, one Canadian study reported (n=106) that on average older adults took 12.8 seconds to complete the TUG test (Arnold & Faulkner, 2007). Another study reported older adult women (n=272) taking 12.6 seconds to complete the TUG test (Talley, Wyman, & Gross, 2008). Although, these two studies reported slower times to complete the TUG test compared to the present study; a sex effect may not be an explanation because one study included both men and women (Arnold & Faulkner, 2007), whereas the other study only included older adult women (Talley et al., 2008).

One possible explanation for the different faster times in the present study may be fewer participants using walking aids (i.e., 14%). There was a greater percentage of participants in the two studies using walking aids, specifically 38% in the study by Arnold & Faulkner, (2007) and 18% in the study by Talley et al. (2008). The number of chronic conditions among female participants was also greater in the study by Talley et al. (i.e., 4.6) compared to the present study (i.e., 3.6).

One study did report faster times compared to the present study. The researchers of this study reported that on average older adult women (n=104) took 8.0 seconds to complete the TUG test. However, the use of walking devices or the number of chronic conditions was not reported for their sample (Arai, Obuchi, Inaba, Shiba, Satake, 2007). Despite some contrast to other studies, the women in the present study have good mobility as measured by the TUG and STS tests, even though their activity patterns depict a sedentary or low activity lifestyle.

Psychological Constructs

In addition to a person's level of mobility influencing participation or avoidance of certain activities, psychological constructs are also known to promote or become a barrier to participation in activities (Menec & Chipperfield, 1997; Liu-Ambrose et al. 2006). Specifically, the amount of balance confidence and/or perception of control over one's health are two psychological constructs that may promote or become a barrier to an active lifestyle (Li et al., 2005; Menec & Chipperfield, 1997). Therefore, more attention given to these two psychological constructs may give further insight into potential barriers or facilitators to activity among older adults.

The results of the MHLOC scale in the present study indicated that the women had on average a strong sense of personal/internal control over their health. Two studies were identified using the MHLOC scale among older adults and assessing physical activity. Calnan (1988) used the MHLOC scale and reported results for older adults (i.e., both men and women) age 60 years and older (i.e., internal= 24; powerful others= 22; chance= 19). Menec & Chipperfield (1997), reported an internal health locus of control score of 18 out 36 among a sample of older adult men and women also ages 60 years and older. Despite the sample of women in the present study being older (i.e., 70 years and older), they had a stronger sense of internal health locus of control (i.e., 27/36) compared to the older adults in the two studies. Compared to the study by Calnan, the women in the present study also had a weaker sense of powerful others (i.e., 18/36) and chance (i.e.,16/36) health locus of control. However, in both the present and that by Calnan, the older adults had stronger beliefs that they themselves control their health and had weaker beliefs that external factors (e.g., chance and powerful others) controlled their health. Having the strongest belief in internal health locus of control, would therefore appear to be most favourable to following a healthy lifestyle which includes being physically active, since previous research has reported this positive relationship (Menec & Chipperfield, 1997).

In addition, to higher internal health locus of control, the women in our study also exhibited on average a high sense of balance confidence in their daily activities (i.e., 80%). Talley et al. (2008) reported that the women in their study who were on average 78.7 years older, were on average were 78% confident that they could maintain their balance during daily activities. The average level of balance confidence in another study was 77% among women who were on average 79.3 years old with diagnosed osteoporosis or osteopenia (Liu-Ambrose et al. 2006). The slightly less balance confidence in these other two studies compared to the present study may be explained by the age of participants compared to the participants in the present study, as well as the fact that only 12 participants reported a self-diagnosis of osteoporosis. The women in the present study were slightly younger (i.e., on average were 77.2 years old) than the other two studies. The difference in balance confidence between studies may be age dependent and further examination of this is required.

One Canadian study reported that older adults who scored 80% or above on the ABC Scale were characterized as high functioning and physically active (A.M. Myers, Fletcher, A.H. Myers & Sherk, 1998). The researchers administered the ABC Scale among older adults from different settings (i.e., home care setting, community exercise programs and postoperative joint replacement individuals). These different settings represented different levels of activity and function among older adults and comparisons among the results of the ABC Scale from the different settings were made. No objective measures of physical activity were used. Conclusions about the relationship between objectively measured physical activity and mobility in relation to balance confidence (ABC Scale), cannot be made from the results found in the Myers et al. (1998) study.

In fact, the opposite appears to be true of the present study. The women in the present study were shown to be high functioning based on mobility tests, yet objective monitoring of physical activity demonstrated they have sedentary activity levels, even though they have a high level of balance confidence. Future studies need to examine how physical activity, mobility and psychological constructs interact with each other. Other barriers to physical activity must be identified in order for these women to obtain the necessary levels of activity to promote lifelong health.

Interrelationships between Physical Activity, Fracture Risk, Mobility, and Psychological Constructs

Another main objective of this study was to examine the interrelationships between physical activity, fracture risk, mobility and psychological constructs. Results of this study reveal that participants were inactive, but had on average good mobility, a high sense of balance confidence and internal health locus of control, and a borderline threshold value for fracture risk. Correlations analysis revealed some interesting relationships.

The results demonstrated that physical activity measured by daily step count and daily activity time negatively correlated with the time to complete the TUG test. Therefore, taking more steps and spending more time being active in a day, was associated with faster/shorter times to complete the TUG test and the opposite is also true. This negative correlation between physical activity measured by daily step count and daily activity time with the TUG test time is good and provides support to the literature that physical activity helps maintain good mobility (i.e., faster test times). However, no significant correlation was found between the TUG test and daily energy expenditure.

The significant negative correlations outlined above between physical activity (i.e., step count and activity time) and the TUG test may be explained by common factors linking the three variables (i.e., step count, activity time and TUG). The TUG test is a test that involves a stepping action from the walking component in the test and this stepping action could be a linking factor with pedometer measured step counts accumulated from walking throughout the day, and therefore, this may be a reason for the present observed relationship. The

TUG test also measures time to complete the test. Similarly, daily activity time measures how much time is spent being active. Therefore, the common factor of time in both variables may explain the association between these two variables. The action of stepping is not measured in the variable of energy expenditure. Daily energy expenditure measures physical activity from how many kilocalories are expended over the day and kilocalories is not measured in the TUG test and this may be the reason for the absent association between daily energy expenditure and the TUG test.

Lending support to this absent association (i.e., daily energy expenditure and TUG test) is the fact that the average BMI was 27.2 (overweight), and energy expenditure is strongly influenced by body mass. Women that are heavier may move less but expend more energy due to having excess mass. The above is consistent with the step carriage results, as this indicates that those who carry more mass actually took fewer steps because of the excess mass they carry with them. Even though heavier women expend more energy due to excess mass, this excess mass actually translates into taking less steps. Having excess fat mass is heavier and harder to carry around, therefore fewer steps may be taken because fatigue may occur from the greater work placed on the body from excess fat, compared to a lean individual. Taking less steps would also relate to taking more time when stepping (slower time) which is supported from the positive correlation between daily step count and daily activity time, therefore supporting the negative relationship between the TUG test and physical activity as measured by step count and activity time.

The results reveal a significant negative relationship between daily activity time and mobility measured by the STS test. Therefore, spending more time being physically active in a day was associated with shorter times to complete the STS test and the opposite is also true. Similar to the reasoning for the association with the TUG test, the common factor of 'time' between both STS test and daily activity time is one potential explanation for the significant relationship between these two variables. On the other hand, the lack of a 'stepping' action or energy expenditure in the STS test and the lack of the 'time' factor in daily step counts and 'stepping' in daily energy expenditure may explain the lack of significant relationships between these three variables (i.e., the STS test, daily step counts and daily energy expenditure). The STS test does not involve a walking component (i.e., stepping) as the TUG test, nor does the STS test measure energy expenditure. In addition, time is not measured with pedometer measured daily step counts and stepping is not directly measured with accelerometer measured daily energy expenditure.

All measures of physical activity did relate to both measures of mobility (i.e., energy expenditure did not associate with either mobility test times), however, we know that all three methods of objectively measuring physical activity significantly relate to each other (i.e., daily step counts, daily energy expenditure, and daily activity time). Since the correlations between physical activity measures were not excellent (i.e., high), this study certainly supports the use of both the pedometer and accelerometer to measure daily physical activity as there was additive information from each measure of physical activity by the use both instruments.

In summary, the results from this study show that physical activity measured by daily activity time and daily step count associated with the time taken to complete the TUG test. Further, daily activity time associated with the time taken to complete the STS test. Therefore, the hypothesis that physical activity would negatively correlate with the time to complete mobility test is supported from the results of this study.

To build upon the link between physical activity and mobility, results from this study also provided evidence linking physical activity and psychological constructs. Significant positive correlations between daily step counts and balance confidence measured from the ABC Scale were found. Therefore, taking more steps in a day is associated to having more confidence in being able to maintain balance and remain steady during daily activities. In addition, the opposite statement would also be true. This positive association is good, because it supports the psychological benefit of being physically active.

Good balance is required for walking and performance of daily activities without falling. Further, confidence in balance is also required to accomplish these tasks as measured by the ABC Scale. Therefore, balance is a common factor that may explain this relationship and therefore linking these two variables together. This evidence supports the hypothesis that physical activity positively correlates with balance confidence and therefore, provided a possible link between physical activity and psychological constructs. This psychological component may be especially important among those that are de-conditioned, and may require an aid for mobility for increased balance and support. This is supported with the results which indicate a significant negative relationship between the use of a walking aid and both daily step counts and balance confidence. Therefore, those who used a walking aid, not only took fewer steps in a day, but also had decreased confidence in their balance during activity.

Physical activity measured by daily energy expenditure significantly related to fracture risk (i.e., negative correlation). Therefore, spending more energy in a day (being more active) is associated with having a lower risk of osteoporosis fracture. This association supports the importance of physical activity in the prevention and management of osteoporosis fractures. Therefore, there is evidence from this study to support the hypothesis that physical activity will negatively correlate with fracture risk.

Similarly to physical activity, balance confidence also significantly correlated with fracture risk as measured by the Fracture Index (i.e., negative correlation) and with (i.e., negative correlation) to both measures of mobility (i.e., the TUG and STS tests). Therefore, having greater confidence in one's balance perform daily activities is associated with a lower risk of osteoporosis fracture and faster (i.e., shorter) time to complete mobility tests. The opposite would be true for both associations (i.e., physical activity and fracture risk and balance confidence, fracture risk and mobility).

Balance confidence and physical activity were associated in the positive direction to each other and both had the same associations with fracture risk and time on mobility tests (i.e., negative). One may speculate that moving more in the day (i.e., being active) and having more confidence that one is able to move without falling (i.e., balance confidence) may help protect against fractures and maintain mobility. Naturally, if less movement in the day occurred because of having less confidence and being afraid of falling, this would be favourable to sustaining a fracture and needing assistance for mobility due to the result in decrease strength and balance from restricted activity. Therefore, relationships (i.e., through correlations) between physical activity, mobility, balance confidence and fracture risk have emerged from the results of this study. The potential linking properties may be explained through common factors between variables.

The common factors between balance confidence, mobility, and fracture risk may be the component of balance. Poor balance will result in longer times needed to complete both the TUG test and the STS test, and is also considered a risk factor for fractures. On the other hand, the common factor between physical activity and fracture risk may be the component of mass (kg), because mass was used in both the calculation of daily energy expenditure, daily activity time and the Fracture Index. The common factor of mass may be what relates these two variables to each other and results in their significant relationship.

This study is unique in examining the relationships between physical activity, fracture risk, mobility and psychological constructs. Two other studies were identified which examined the relationship between balance confidence with the ABC Scale and mobility with the TUG test. Talley et al. (2008) reported a significant inverse correlation (r=-0.39) between the ABC Scale and the TUG test.

The other study reported a significant negative correlation with an r of -0.61 (Cho, Scarpace, Alexander, 2004), both correlations from these two studies were lower than the correlation found in the present study (i.e., r= -0.703).

In contrast to the existing literature (Calnan, 1998; Menec & Chipperfield,1997) regarding the relationship between internal health locus of control and physical activity, the present study found no relationship between these two variables. The participants in the present study had a higher sense of internal health locus of control, although this higher belief did not appear to influence the amount of daily physically active as measured by step count, energy expenditure and activity time. In fact, internal health locus of control as measured by the MHLOC scale did not correlate with any of the study variables in the present study. Thus, evidence from this study failed to support the hypothesis that physical activity is positively correlated to internal health locus of control. Also, chance health locus of control did not significantly correlate with any of the study variables in this present study.

Menec & Chipperfield (1997) reported that results from their study indicated that internal health locus of control significantly related to physical activity measured subjectively using a questionnaire. It may be that self-report of physical activity is really a surrogate for a locus of control measure rather than an actual reflection of physical activity levels. More study is needed to better understand the significance of the relationship between physical activity and internal health locus of control.

Calnan (1998) reported significant relationships between physical activity and all three components of health locus of control on the MHLOC scale (i.e., internal, powerful others and chance). This study was conducted in 4224 adults, ages 18 years and older. In order to measure health locus of control and physical activity, questionnaires were mailed to interested participants. This indicates that subjective measures of physical activity were used and, therefore the results found may not be comparable to a study using objectively measured physical activity.

The method of measuring physical activity may be one potential explanation for the lack of correlation between health locus of control and physical activity seen in the present study in contrast to other studies. In both the study by Menec & Chipperfield (1997) and Calnan (1998), physical activity was measured subjectively using a numbered scale which is similar to how the MHLOC scale is administered. This similar administration system may be a common factor linking the two variables. Subjective measurements of physical activity rely on recall of physical activity history, and which can lead to underestimations or overestimation of physical activity (Steele et al., 2000; Tudor-Locke & Myers, 2001). It may be natural for a person to believe they are more physically active during their day. Therefore, if participants are overestimating the amount of daily activity, this could affect the relationship between health locus of control and physical activity. Objectively measured physical activity measures a specific variable of interest, such as daily step count or daily energy expenditure regardless if the participant remembers a specific activity, and objective measures have been known to be more accurate (Tudor-Locke & Myers, 2001).

The present study found a weak, but significant negative correlation between powerful others health locus of control with daily energy expenditure, and a weak positive relationship with fracture risk. Therefore, these results suggest that if an older adult woman is physically active, they are less likely to feel that powerful others control their health. However, if they are at high risk of fracture, then they are more likely to feel that powerful others control their health.

Theoretically, if a person is more active, they may be helping to prevent chronic conditions, such as osteoporosis, because this activity helps maintain healthy bones. Therefore, the active person may have less need to see powerful others, such as health professionals. On the other hand, if someone has a chronic condition (e.g., osteoporosis) or is presenting to be at greater risk for this condition (e.g., fractures) with increased risk factors, then that person would have more contact with health professionals to help control this condition (i.e., management or treatment). Further investigation would be valuable to better understand the present relationships or lack of relationships found with health locus of control and to further investigate if these relationships are meaningful or were seen by chance.

A look at the common factors between these variables provides links to explain why these variables may relate to one another. In addition, the relationships found provide awareness or clues to health care providers working with older adult women. For example, if someone performs poorly on mobility tests, the results from this study may alert the health care provider not only to potential links to inactivity, but also to a potential psychological barrier, such as the link to decreased balance confidence. This indicates that addressing decreased balance confidence may be needed along with addressing poor mobility and inactivity. By directly addressing these three variables, the health care provider is also indirectly addressing fracture risk, because of it's the link to physical activity, mobility and balance confidence. Therefore, a multi-level approach may be needed when working with older adult women regarding the goal towards a healthy lifestyle.

Potential confounders of related measures

Correlations between physical activity measures. A significant positive association was found between average daily energy expenditure and average daily activity time. Therefore, expending more energy in a day on average was associated to spending more time on average being physically active. The component of mass is calculated into daily activity time, because the equation for the conversion of energy expenditure from activity counts is based on a person's mass (kg). This indicates that mass may be potentially confounding the association between the two variables.

However, the association between these two variables is not perfect (i.e., r=1) and therefore, an increase in activity time cannot be entirely accounted for by the association in energy expenditure (or in that fact the mass component of energy expenditure). In addition, if the component of mass entirely explained the association between activity time and energy expenditure one would expect that both of these variables would have associated similarly with the other variables. These similar associations did not occur with the other variables, as average daily activity time had significant associations with the time to complete both mobility tests and average daily energy expenditure did not associate with these tests.

Lastly, mass could not have entirely accounted for the association between energy and activity time, because even though you expend more energy from just carrying extra fat mass, this extra fat mass would also be heavier and harder to carry around throughout the day. Therefore, one would expect that having excess fat mass to carry would result in getting tired faster and this fatigue would decrease the amount time being active in a day would, not increase as defined by a positive association.

Correlations with age. In order to examine the associations of age on the study variables and therefore, if age was a confounding variable among the significant interrelationships between physical activity, mobility, fracture risk and psychological constructs, correlations with age were analyzed. Age did significantly associate with only some variables and these associations would be expected. Age positively correlated with fracture risk, this is expected as age is a risk factor for fracture and loss of bone mass is a natural process of ageing (Dennison et al., 2006).

Also an increase in age was significantly correlated to a decrease in BMI (i.e., a negative correlation), this would also be expected to some extent as loss of appetite and malnutrition are concerns with increased age and therefore a loss of mass would occur with increased age. In addition, a loss of height is a natural part of aging (Kane, Ouslander,Abrass, 2004). Therefore, these two natural losses could explain the association with a decrease in BMI with increase age. This potential decrease in mass with age would affect the associations between age and energy expenditure, and between age and step carriage as both variables are affected by mass. Lastly, a potential reason to explain the increase in beliefs in powerful others health locus of control with increased age (i.e., positive association), maybe that as adults get increasingly older, they rely more on health care professionals and caregivers (i.e., powerful others) for help and support in daily living.

However, it is important that the significant associations with age are not perfect associations. Therefore, a change in either BMI, fracture risk, energy expenditure, step carriage and powerful others health locus of control, can not entirely be accounted for by the association with age. More importantly, age did not associate with the time to complete mobility tests, the level of balance confidence, the number of chronic conditions or physical activity measured by step count or activity time.

Interrelationships between physical activity, mobility, balance confidence, and fracture risk still exist that are not confounded by age, (i.e., between average daily step count, average daily activity time, mobility tests, balance confidence and fracture risk). In addition, the differences in significant correlations and lack of correlations among the variables with age solidifies the need of multiple measures of analysing physical activity, and its potential influences of physical activity (i.e., mobility, fracture risk, and psychological constructs) among older adults. No one measure provided the true picture to truly understand the effects these health variables have on daily living among older adults.

Summary

In summary, three of the four hypotheses were supported from the results of this present study. First, higher physical activity measured by daily step count was associated with greater balance confidence. Therefore, taking more steps in a day was associated with having greater confidence in being able to maintain balance during daily activities. Secondarily, higher physical activity was associated with to the time taken to complete the mobility measures. Specifically, greater daily step counts and greater daily activity time associated related to the faster (shorter) times to complete the TUG test, whereas greater daily activity time associated to the faster (shorter) times to complete the STS test. Thirdly, physical activity associated correlated to fracture risk. Therefore, being more physically active in a day was associated to a lower risk of osteoporosis fracture. The results from this study did not support the last hypothesis and therefore, there was no evidence to support that greater physical activity is associated to greater internal health locus of control.

Limitations

Potential limitations in this study.

1. There may be a potential effect of seasonal weather which could affect the results. This study was conducted from the months of July to December and warmer or colder weather may affect physical activity patterns among participants (Chan, Ryan & Tudor-Locke, 2006).
2. This study only included older adult women and did not include older adult men. Therefore, the results of this study are limited to examining the relationships between physical activity, mobility, psychological construct and fracture risk among older adult women in the city of Winnipeg.
3. The relationships of this study are based on correlations only. Therefore, any conclusions regarding predictive information among the variables cannot be made.
4. The analysis of interrelationships with the number of chronic conditions was calculated with each of the 19 chronic conditions given equal weight. Equally weighted chronic conditions may have affected the results, because some conditions were more prominent among participants, than others.
5. The smaller sample size could affect the associations found, since having a bigger sample size may have provided more evidence to understand if the relationships between energy expenditure and powerful others health locus of control was significant or seen by chance. Further, a larger sample size may have increased strength of the correlations seen in the study.

Conclusion

This Winnipeg based study has provided a description of physical activity patterns among older adult women. Low daily step counts, low daily energy expenditure and low daily activity time indicate that these women have a very sedentary lifestyle. A sedentary lifestyle was shown to be associated with poor mobility, low balance confidence and greater risk of fracture in this study.

The relationships found provide evidence of components that influence each other in different ways. However, none of the components were the sole determining factor among older women's activity patterns. Interestingly enough, not only did objectively measured physical activity relate to objectively measured mobility, but both of these related to subjective measures of fracture risk and psychological constructs (i.e., balance confidence).

Despite borderline fracture risk and a number of chronic conditions among these women, they had a high sense of balance confidence and good mobility, which are both favourably related to being active. Therefore, these women are primed to become active and this provides an area of encouragement despite potential risk of chronic diseases.

This study provides a next step in understanding aspects of achieving a healthy lifestyle by providing preliminary information about the relationships among physical activity, fracture risk, mobility and psychological constructs. When assessing physical activity patterns, more than one method may be needed since different aspects of physical activity contributed differently to the relationships found among physical activity, mobility, balance confidence and fracture risk. Consideration of other variables is shown to be just as important, because variables such as, fracture risk, mobility and even balance confidence may be influencing these patterns.

Recommendations

Recommendations based on the results of this study are as follows:

1. Results from screening tests such as the TUG test and the STS test for example may alert health professionals to consider other areas that may need further investigation, such as fracture risk, balance confidence and physical activity. For example, taking longer to complete mobility test, indicating poor mobility, could alert health professionals that further examination of fracture risk and physical activity are needed with more objective tests (i.e., DEXA and pedometers and accelerometers).
2. Programs developed to encourage physical activity in older adults and educate them regarding fracture risk, may need to consider addressing mobility and psychological constructs such as balance confidence.

Future Studies

1. Examination of the predictive nature among physical activity, fracture risk, mobility and psychological constructs.
2. Examination of physical activity in relation to fracture risk, mobility, and psychological constructs among older adult men.
3. A study which further investigates the relationship between health locus of control and physical activity, mobility and fracture risk.

Appendix A: Participant Consent Form

REARCH PARTICIPANT INFORMATION AND CONSENT FORM

Research Project Title: Assessment of physical activity in older adult women: Relationship to risk of osteoporosis fractures, balance confidence, health locus of control and functional mobility.

Principal Investigator: Dr. Leah Weinberg, Ph.D., School of Medical Rehabilitation, R106-771 McDermot Ave., Wpg., MB., R3E 0T6.
Phone: 787-2741.

Office: RR309B, Rehabilitation Hospital, 800 Sherbrook Street

You are being asked to participate in a research study. Please take your time to review this consent form and discuss any questions you may have about the study with the study staff. You may take your time to make your decision about participating in this study and you may discuss it with your friends or family or (if applicable) you doctor before you make your decision. This consent form may contain words that you do not understand. Please ask the study staff to explain any words or information that you do not clearly understand.

Purpose of Study:
This research study is being conducted to study mobility (the amount a person walks or moves about in a day) in older adult women by using two activity monitoring devices called a pedometer and an accelerometer. These are small, simple devices that are worn at the waist. The pedometer records the number of steps a person takes. The accelerometer records when you are walking and when you are resting. Each person will be asked to wear the pedometer and accelerometer at the same time for five days.

The research study is also examining attitudes and beliefs that individuals may have about physical activity, exercise, falls, osteoporosis, health, and balance. This will involve answering three questionnaires. In addition, each person will be asked to perform a simple, short walking test and a sit-to-stand test.

A minimum total of 40 individuals will participate in this study.

Study Procedures:
Participation in the study will involve two appointments. The first appointment will last on average two hours and the second appointment approximately one hour.

The appointments can take place at the Rehabilitation Hospital or in your home according to your preference.

At the Rehabilitation Hospital, the appointments will take place in the Aging, Rehabilitation, and Social Cognition Research Laboratory in the School of Medical Rehabilitation at the University of Manitoba. The laboratory is located on the third floor of the Rehabilitation Hospital, 800 Sherbrook St, Winnipeg, MB., in room RR309C. If you take part n this study you will have the following procedures administered by a trained graduate student research assistant:

At the first appointment you will be asked to answer some questionnaires and this will take approximately one hour to complete. The questionnaires will ask about your health, and your attitudes and beliefs about physical activity, exercise, falls, osteoporosis, health, and balance. For example, you will be asked the extent to which you agree or disagree with certain statements such as “The main thing which affects my health is what I myself do”. You will also be asked questions about how confident you are that you can maintain your balance and not feel unsteady while you do different activities inside and outside of your home.

After the questionnaires are completed, the research assistant will ask each person to perform a short walking test where you will start from a seated position, you will get up, walk to a point 3 metres away, turn around and walk back to the chair and sit down. You will be timed as you walk as quickly and safely as you can from the word “start” until you sit down again. Next, you will be asked to perform a sit-to-stand test where you will stand up from a chair and sit down again five times in a row as quickly and as safely as you can. You will be timed as you perform this test. The research assistant will then record your height and your weight.

Next, each person will be instructed in how to use the pedometer and accelerometer that the researcher will loan to each participant for the five days of the study. The pedometer measures how many steps you take in a day and each person will be instructed in how to record this information in the “Pedometer Log” and how to reset the pedometer to zero at the end of each day.

The accelerometer measures your activity, that is, when you are active and when you are sitting or resting. This device does not have to be reset daily as it records continuously for the five day period. Each person will next receive instructions about recording the time each device is put on in the morning and the time they are taken off at night. These devices are not worn when a person is sleeping or when bathing or swimming.

Each person will also be given a “Daily Activity Log” to record what type of activities you participate in during the day and the length of time you spend in each activity. For example, you might write down that you spent 40 minutes walking outside or watching television. The research assistant will phone each person after the first day to answer any questions or concerns that may arise once a person starts wearing the pedometer and accelerometer. The research assistant is able to come to your home if necessary to solve any problems with wearing the devices.

At the second appointment, lasting approximately one hour or less, the research assistant will review both logs with each person. The research assistant will then take the logs and the pedometer and the accelerometer back to the research laboratory.

Risks and Discomforts:
The likelihood of injury from this type of testing is very low. However, you do not have to do any test if you feel that I will cause you discomfort or pain. In addition, if you are uncomfortable answering any of the questions on the questionnaires, you are free not to answer them.

Benefits:
There may or may not be direct benefit to you from participating in this study. We hope the information learned from this study will benefit other people in the future. However, you may find it informative to see how many steps you take in a day. At the end of the study, after all the data is analysed we will provide each participant with general results from the study.

Costs:
All the procedures which will be performed as part of this study, are provided at no cost to you.

Payment for participation:
You will receive no payment or reimbursement for any expenses related to taking part in this study

Confidentiality
Information gathered in this research study may be published or presented in public forums, however your name and other identifying information will not be used or revealed. Your information will be assigned a study number and all study related documents will only contain your assigned study number and/or your initials. All health information provided will comply with the Personal Health Information Act (PHIA) guidelines. Despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

The University of Manitoba Health Research Ethics Board may review records related to the study for quality assurance purposes.

All records will be kept in a locked secure area and only those persons identified by the principal investigator (e.g., project coordinator, research assistants) will have access to these records. No information revealing any personal information such as your name, address or telephone number will leave Dr. Weinberg's laboratory in the Rehabilitation Hospital.

Voluntary Participation/Withdrawal from the Study

Your decision to take part in this study is voluntary. You may refuse to participate or you may withdraw from the study at any time. Your decision not to participate or to withdraw from the study will not affect you in any way. You can stop participating in the study at any time. You can stop participating in the study at any time . If the study staff feels that it is in your best interest to withdraw you from the study, they will remove you without your consent.

Questions

You are free to ask any questions that you may have about any activities you are asked to participate in and your rights as a research participant. If any questions come up during or after the study principal investigator Dr. Leah Weinberg, at 787-1099 or the study coordinator Ms. Tania Giardini, at 787-2741.

For questions about your rights as a research participant, you may contact The University of Manitoba, Bannatyne Campus Research Ethics Board Office at (204) 789-3389

Do not sign this consent form unless you have had a chance to ask questions and have received satisfactory answers to all of your questions.

Statement of Consent:

I have read this consent form. I have had the opportunity to discuss this research study with Dr. Leah Weinberg and/or her study staff. I have had my questions answered by them in language I understand. The risks and benefits have been explained to me. I believe that I have not been unduly influenced by any study team member to participate in the research study by any statements or implied statements. Any relationship I may have with the study team has not affected my decision to participate. I understand that I will be given a copy of this consent form after signing it. I understand that my participation in this study is voluntary and that I may choose to with draw at any time. I freely agree to participate in this research study.

I understand that information regarding my person identity will be kept confidential, but that absolute confidentiality is not guaranteed. I authorize the inspection of any of my records that relate to this study by the University of Manitoba Research Ethics Board for quality assurance purposes.

By signing this consent form, I have not waived any of the legal rights that I have as a participant in a research study.

Participant signature:______________ Date:_________ (dd/mm/yy)

Participant printed name :_____________

I agree to be contacted for future follow-up in relation to this study or other studies conducted by Dr. Weinberg.   Yes___________ No___________

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has knowingly given their consent.

Printed name:__________________ Date: (dd/mm/yy)

Signature:_________________________

Role in the study: ___________________

Appendix B: Chronic Conditions Data

INTERVIEW QUESTIONNAIRE

Record of Contact:

1. Participant Identification Number: ____________________________

2. Date of Interview (day/month/year): ________/_________/_________

3. Time Interview Started (Code time in 24 Hr. clock): _______:________

4. Time Interview Finished (Code time in 24 Hr. clock): ______:________

5. Length of Interview (Code in Minutes): _________________________

6. Place of Interview:

   a. Home

   b. Laboratory (RR309C) Rehabilitation Hospital

7. Interviewer: ____

8. Started/Not finished: (Reason):_____________________________

<u>Introduction to Respondent</u>

INTERVIEWER: Introduce yourself to the respondent. Select the proper form of address from the respondent list.

HELLO (MR./ MRS./ MS.): ___________________________________
MY NAME IS: ____

I am a graduate student at the University of Manitoba in the School of Medical Rehabilitation.
I am conducting this study as part of the requirements for my Masters of Science in Rehabilitation degree.

- I am interested in talking to people of your age about their physical activity and their health.
- You are one of about 40 people who I will be interviewing.
- Today, I am going to spend about an hour talking with you and asking you a variety of questions related to physical activity and health.
- **You may feel that some of the questions do not seem to apply to you.**
- **However, I ask the same questions of everybody in order to be consistent**.
- **Keep in mind, there are no right or wrong answers to these questions.**
- **Just answer the questions to the best of your ability. However, if there are any questions you would rather not answer, please do not feel obligated to do so.**
- **I have 3 questionnaires. The first is the longest.**

<u>INTERVIEWER:</u> I WOULD LIKE TO START BY ASKING YOU SOME GENERAL QUESTIONS ABOUT YOURSELF.

9. First, what is your current AGE? ________ (mark down exact age in years and circle answer below)

	Points
Less than 65	0
65-69	1
70-74	2
75-79	3
80-84	4
85 or older	5

10. What is your exact birth date (code: dd/month/yy)
__________/____________________/_______________

11. At the present time, are you: (circle answer) (CARD# 1)

1 = Married
2 = Separated
3 = Divorced
4 = Widowed
5 = Single, never married
9 = MV

12. What are your current living arrangements? DO YOU LIVE ALONE OR WITH ANOTHER PERSON OR PERSONS?(CARD# 2)

0 = Alone (**Skip Q#13 and go to Q#14**)
1 = With one other person (**Go to Q#13**)
2 = With more than one person (**Go to Q#13**)
9 = MV

13. What is the relationship of the other person or persons to you? (circle answer).

1 = Spouse
2 = Daughter
3 = Son
4 = Other (List other): ________________________________
7 = NA
9 = MV

14. EDUCATION: (IF EDUCATION OBTAINED OUTSIDE OF CANADA, HAVE RESPONDENT SPECIFY CANADIAN EQUIVALENT IF POSSIBLE)

Note: Schooling refers to formal primary, secondary, and post-secondary education.

a) **How many years of schooling do you have**?
(Mark number of years): _________

b) **What is the highest level of formal schooling you completed?**

1 = No formal schooling
2 = Some primary school (**grade:**__________)
3 = Finished primary school (**grade:**________)
4 = Some secondary/ high school (**grade:** _________)
5 = Completed secondary/ high school (**grade:** _______)
6 = Some community or technical college, or other program
7 = Completed community or technical college, or other program (**specify other program:** ______________)
8 = Some university (**number of years:** _______________)
9 = Bachelor's degree
10 = Masters degree
11 = PhD
12 = Other (Specify): ________________________________
77 = NA **88** = DK **99** = MV

INTERVIEWER: THE NEXT TWO QUESTIONS RELATE TO VARIOUS ASPECTS OF PEOPLE'S LIVES AND HOW THEY ARE FEELING.

HAPPINESS:

15. a) Taking things all together, how would you say you FEEL these days? Would you say you FEEL: (CARD# 3)

1 = Unhappy
2 = Not very happy
3 = Somewhat happy
4 = Very happy
5 = Extremely happy

b) Mark down all comments:
____

LIFE SATISFACTION:

16. a) In general, how satisfied are you with your life at the present time? Would you say you are: (CARD# 4)

1 = Not at all satisfied
2 = Not very satisfied
3 = Somewhat satisfied
4 = Very satisfied
5 = Extremely satisfied

b) Mark down all comments:
____

HEALTH CONDITIONS:

17. Now I have a list of **health conditions** that people may have. I will read them and you tell me **if you have had any of them within the last year, or still have any after effects from having them earlier.** You just need to answer **YES** or **NO** to each condition.

(**Interviewer:** if the problem began long ago and the symptoms lasted into the past year, check "yes". Do not read the examples in parentheses unless the respondent asks for clarification). **NO = 0 YES = 1 (circle answer)**

	NO	YES
High blood pressure	0	1
Heart and circulation problems (e.g., hardening of arteries, heart troubles, blood diseases)	0	1
Stroke or effects of a stroke	0	1
Arthritis or rheumatism (joints, back, orthopaedic)	0	1
Parkinson's Disease	0	1
Other neurological problems. Specify:	0	1
Eye trouble not relieved by glasses (glaucoma, cataracts)	0	1

	NO	YES
Ear trouble (hearing loss)	0	1
Dental problems (Teeth need care).	0	1
Chest problems (asthma, emphysema, bronchitis, TB, breathing problems)	0	1
Trouble with your stomach or digestive system	0	1
Kidney or bladder troubles	0	1
Diabetes	0	1
Trouble with your feet or ankles	0	1
Trouble with your nerves (includes mental illness/ emotional problems)	0	1
Skin problems	0	1
Cancer. (specify type):	0	1
Fractures. Specify:	0	1
Other. Specify:	0	1

<u>INTERVIEWER:</u> NEXT I WOULD LIKE TO ASK A QUESTION ABOUT YOUR HEALTH.

GENERAL HEALTH

18. a) Overall, how do you see your health at the present time? **IN GENERAL** would you say your health is: (Do not read explanation in parenthesis, unless asked for explanation). **(CARD# 5)**

1 = **Bad** (health troubles or infirmity all the time prevents most activities or requires confinement to bed)
2 = **Poor** (very often prevent activities)
3 = **Fair** (occasionally prevents some activities)
4 = **Good** (rarely prevents activities)
5 = **Excellent** (never prevents activities)

b) Is there any reason you rate your health this way?

____

____

OSTEOPOROSIS

Now I want to ask you some general health questions. I will read each question to you and you can answer YES or NO to each question.
(**Interviewer:** Circle correct answer given by respondent and circle points. If answer is NO, circle NO; if answer is don't know, circle don't know)

19. Have you broken any bones after age 50?

	Points
Yes	1
NO/ don't know	0

20. Has your mother had a hip fracture after age 50?

	Points
Yes	1
NO/ don't know	0

21. Are you currently a smoker?

	Points
Yes	1
NO/ don't know	0

22. Have you ever been diagnosed as having **osteoporosis**?

0 = NO (**Skip Q#23 and go to Q#24**)

1 = YES (**Go to Q#23**)

23. If **YES**. **I'm wondering, by whom have you been diagnosed**?

1 = Physician/Doctor **7** = NA

0 = Other (specify) _______________

PAIN

INTERVIEWER: Now I would like to turn to the topic of PAIN and ask you about any pain you may be experiencing.

24. Are you usually free of pain?

0 = No (**Go to Q# 25**)

1 =Yes (**Skip Q# 25 to 28 and Go to Q#29**)

25. During the past week, have you experienced any pain?

0 =No **7** = NA

1 =Yes

26. How would you describe the usual intensity of your pain? (CARD # 6)

1 = Mild **7** = NA
2 = Moderate
3 = Severe
4 = Fluctuates

27. How many activities does your pain prevent you from participating in? (CARD # 7)

1 = None (**Skip Q#28 and Go to Q#29)**
2 = A few
3 = Some
4 = Most
5 = All
7 = NA **8** = DK **9** = MV

28. Can you tell me what these activities are? (List all that are mentioned)

7 = NA

____
_

INTERVIEWER:
Now I would like to ask you a question about your FUNCTIONAL ABILITY. Functional ability is about your ABILITY TO CARRY OUT YOUR EVERYDAY ACTIVITIES. Everyday activities include activities like dressing and bathing, and other activities such as cooking, housekeeping, shopping, driving, etc.

29. a) In **general**, how would you rate your **functional ability** to do everyday activities at the present time? Would you say your functional ability is: **(CARD# 8)**

1 = Bad
2 = Poor
3 = Fair
4 = Good
5 = Excellent

b) Comments: Is there any reason you rated your functional ability this way?

____

____

FALLS

INTERVIEWER: Now I would like to talk to you about FALLS.

30. In the past **WEEK** have you experienced a fall where you have landed on the ground or a lower surface?

0 = NO (**Skip Q#31 and #32 and Go to Q#33**)

1 = YES (**Go to Q#31**)

Comments:
____

31. If **YES**, how many falls have you had in the **past week**?______________ **7** = NA

32. Did any of these falls result in injuries (e.g., fractures, etc.)? **7** = NA
0 = NO
1 = YES (specify):____

33. In the past **3 months** have you experienced a fall where you have landed on the ground or a lower surface?

0 = NO (**Skip Q#34 and #35 and go to Q#36**)

1 = YES (**Go to Q#34**)

34. If **YES**, how many falls have you had in the past **3 months**?____________ **7** = NA

35. Did any of these falls result in injuries (e.g., fractures, etc.)?

0 = NO
1 = YES (specify):_______________________________________ **7** = NA

36. **INTERVIEWER:** **We are just about finished**. The next questions are to learn a little more about your **thoughts** regarding **EXERCISE, FUNCTIONAL ABILITY and FALLS**. I will read you a series of statements and I will ask you to tell me the extent to which you agree or disagree with each statement I read. **(CARD #9)**

1 = Strongly disagree (SD)
2 = Moderately disagree (MD)
3 = Slightly disagree (D)
4 = Slightly agree (A)
5 = Moderately agree (MA)
6 = Strongly agree (SA)

	SD	MD	D	A	MA	SA
a) I can learn to do exercises despite any health problems I may have.	1	2	3	4	5	6
b) I feel helpless about maintaining my future functional ability.	1	2	3	4	5	6
c) In order to improve my balance, I have to put effort into exercising.	1	2	3	4	5	6

	SD	MD	D	A	MA	SA
d) It is not important for me to do exercise on a regular basis.	1	2	3	4	5	6
e) I feel helpless about preventing falls.	1	2	3	4	5	6
f) There is not much I can do to keep my functional ability from going downhill.	1	2	3	4	5	6
g) If I really work at it by putting effort into exercising, I can improve or maintain my strength.	1	2	3	4	5	6
h) If I exercise regularly I can help myself prevent falls.	1	2	3	4	5	6
i) No matter how much I exercise, my functional ability is bound to get worse as I get older.	1	2	3	4	5	6
j) There is no way I can change the loss of strength that comes with older age.	1	2	3	4	5	6
k) It is what I do to help myself that's really going to make all the difference to maintaining my functional ability.	1	2	3	4	5	6
l) It does not matter how much help you get - in the end it's your own efforts that count in preventing falls.	1	2	3	4	5	6
m) I have little or no control over preventing falls.	1	2	3	4	5	6
n) Falls are an inevitable part of aging.	1	2	3	4	5	6
o) Functional ability gets worse with age no matter what people do.	1	2	3	4	5	6

CONTROL

INTERVIEWER: WE ARE ALMOST FINISHED THIS QUESTIONNAIRE. I HAVE ONE MORE SHORT SET OF QUESTIONS TO ASK YOU

37. I am going to read you a series of statements that people might use to describe how they feel. Please tell me to what extent you agree or disagree with the following statements. (CARD# 10)

1 = Strongly disagree (SD)
2 = Moderately disagree (MD)
3 = Slightly disagree (D)
4 = Slightly agree (A)
5 = Moderately agree (MA)
6 = Strongly agree (SA)

	SD	MD	D	A	MA	SA
a) I have little control over the things that happen to me.	1	2	3	4	5	6
b) I often feel helpless in dealing with problems of life.	1	2	3	4	5	6
c) What happens to me in the future mostly depends on me.	1	2	3	4	5	6
d) I can do just about anything I really set my mind to.	1	2	3	4	5	6
e) I have a great deal of control over my life in general.	1	2	3	4	5	6

This completes our first questionnaire. Do you have any comments you would like to add?

____
____
____
____
____
____
____

<u>Interview evaluation BY INTERVIEWER:</u>

38. How would you rate the reliability of the information provided in the interview

1 = Satisfactory
2 = Fair
3 = Poor

39. If **fair or poor**: what contributed to the less than satisfactory reliability?

1 = Mental confusion
2 = Speech, language problem
3 = Confusion about the interview questions
4 = Fatigue
5 = Other __________________ **7** = NA

<u>Interviewer comments:</u>

____
____

Questionnaire Construction:

Questions	References
30-35	Definition of fall from Carter et al. (2002); Consulted Fink & Kosecoff (1998) for question construction.
9; 19-21	FRACTURE INDEX : Black et al. (2001); Cummings et al. (1995); Whitney et al., 2005
24-28	Adapted from Statistics Canada (1996)
37	Weinberg (2001)
14	Weinberg (2004)
1-8; 10-13; 15-18; 29; 36; 38; 39	Weinberg (2005)
22-23	Consulted Fink & Kosecoff (1998), for question construction.

Summary of each chronic condition

	Mean	SD	Minimum	Maximum
Number of Chronic Conditions	**3.6**	**2.5**	**0**	**11**

Q17a High Blood Press

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	25	61.0	61.0	61.0
	YES	16	39.0	39.0	100.0
	Total	41	100.0	100.0	

Q17b Heart or circulation problembs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	30	73.2	73.2	73.2
	YES	11	26.8	26.8	100.0
	Total	41	100.0	100.0	

Q17c Stroke or effects of a stroke

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	38	92.7	92.7	92.7
	YES	3	7.3	7.3	100.0
	Total	41	100.0	100.0	

Q17d Arthritis or rheumatism

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	16	39.0	39.0	39.0
	YES	25	61.0	61.0	100.0
	Total	41	100.0	100.0	

Q17e Parkinson's Disease

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	40	97.6	97.6	97.6
	YES	1	2.4	2.4	100.0
	Total	41	100.0	100.0	

Q17f Other neurological problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	41	100.0	100.0	100.0

Q17g Eye troubles not relieved by glasses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	21	51.2	51.2	51.2
	YES	20	48.8	48.8	100.0
	Total	41	100.0	100.0	

Q17h Ear troubles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	31	75.6	75.6	75.6
	YES	10	24.4	24.4	100.0
	Total	41	100.0	100.0	

Q17i Dental problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	37	90.2	90.2	90.2
	YES	4	9.8	9.8	100.0
	Total	41	100.0	100.0	

Q27j Chest problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	34	82.9	82.9	82.9
	YES	7	17.1	17.1	100.0
	Total	41	100.0	100.0	

Q17k Stomach or disgestive troubles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	30	73.2	73.2	73.2
	YES	11	26.8	26.8	100.0
	Total	41	100.0	100.0	

Q17l Kidney or bladder troubles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	37	90.2	90.2	90.2
	YES	4	9.8	9.8	100.0
	Total	41	100.0	100.0	

Q17m Diabetes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	38	92.7	92.7	92.7
	YES	3	7.3	7.3	100.0
	Total	41	100.0	100.0	

Q17n Feet or ankle troubles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	35	85.4	85.4	85.4
	YES	6	14.6	14.6	100.0
	Total	41	100.0	100.0	

Q17o Trouble with your nerves

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	35	85.4	85.4	85.4
	YES	6	14.6	14.6	100.0
	Total	41	100.0	100.0	

Q17p Skin problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	39	95.1	95.1	95.1
	YES	2	4.9	4.9	100.0
	Total	41	100.0	100.0	

Q17q Cancer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	35	85.4	85.4	85.4
	YES	6	14.6	14.6	100.0
	Total	41	100.0	100.0	

Q17r Fractures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	33	80.5	80.5	80.5
	YES	8	19.5	19.5	100.0
	Total	41	100.0	100.0	

Q17s Other

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	37	90.2	90.2	90.2
	YES	4	9.8	9.8	100.0
	Total	41	100.0	100.0	

References

Aadahl, M., & Jorgensen, T. (2003). Validation of a new self-report instrument for measuring physical activity. *Medicine and Science in Sports and Exercise*, 35, 1196-1202.

Arai,T., Obuchi, S., Inaba,Y., Shiba, Y., & Satake, K. (2007). The relationship between physical condition and change in balance functions on exercise intervention and 12-month follow-up in Japanese community-dwelling older people. *Archives of Gerontology and Geriatrics*, (2007, October).

Arnold, C.M., & Faulkner, R.A. (2007). The history of falls and the association of the timed up and go test to falls and near-falls in older adults with hip osteoarthritis. *BMC Geriatrics,* (2007, July).

Balady, G. J., Berra, K. A., Golding, L. A., Gordon, N. F., Mahler, D. A., Myers, J. N., et al. (2000). *ACSM's guidelines for exercise testing and prescription* (6^{th} ed.). Baltimore, Maryland: Lippincott Williams & Wilkins.

Basset, D. R., Jr, Ainsworth, B. E., Leggett, S. R., Mathien, C. A., Main, J. A., Hunter, D. C., et al. (1996). Accuracy of five electronic pedometers for measuring distance walked. *Medicine and Science in Sports and Exercise*, 28, 1071-1077.

Bennell, K., Khan, K., & McKay, H. (2000). The role of physiotherapy in the prevention and treatment of osteoporosis. *Manual Therapy*, 5, 198-213.

Berlin, J. E., Storti, K. L., & Brach, J. S. (2006). Using activity monitors to measure physical activity in free-living conditions. *Physical Therapy*, 86, 1137-1145.

Bischoff, H. A., Stähelin, H. B., Monsch, A. U., Iversen, M. D., Weyth, A., von Dechend, M., et al. (2003). Identifying a cut-off point for normal mobility: A comparison of the Timed Up and Go test in community-dwelling and institutionalised elderly women. *Age and Ageing*, 32, 315-320.

Black, D. M., Steinbuch, M., Palermo, L., Dargent-Molina, P., Lindsay, R., Hoseyni, M. S., et al. (2001). An assessment tool for predicting fracture risk in postmenopausal women. *Osteoporosis International*, 12, 519-528.

Bonaiuti, D., Shea, B., Iovine, R., Negrini, S., Robinson, V., Kemper, H. C., et al. (2002). Exercise for preventing and treating osteoporosis in postmenopausal women (Review). *The Cochrane Collaboration.* Wiley.

Bravo, G., Gauthier, P., Roy, P., Payette, H., Gaulin, P., Harvey, M., et al. (1996). Impact of a 12-month exercise program on the physical and psychological health of osteopenic women. *Journal of the American Geriatrics Society,* 44, 756-762.

Brooke-Wavell, K., Prelevic, G. M., Bartram, C., & Ginsburg, J. (2002). The influence of physical activity on the response of bone mineral density to 5 years of tibolone. *Maturitas, The European Menopause Journal,* 35, 229-235.

Brown, J. P., & Josse, R. G. (2002). 2002 clinical practice guidelines for the diagnosis and management of osteoporosis in Canada. *Canadian Medical Association Journal,* 167(Suppl. 10), 1-34.

Calnan. M. (1988). The health locus of control: an empirical test. *Health Promotion*, 2, 323-330.

Cawthon, P.M, Fullman, R.L., Marshall, L., Mackey, D.C., Fink, H.A., Cauley, J.A., et al. (2008). Physical performance and risk of hip fractures in older men. *Journal of Bone and Mineral Resarch*,23, 1037-1044.

Carter, N. D., Kahn, K. M., McKay, H. A., Petit, M. A., Waterman, C., Heinonen, A., et al. (2002). Community-based exercise program reduces risk factors for falls in 65 to 75 year old women with osteoporosis: Randomized controlled trial. *Canadian Medical Association Journal,* 167, 997-1004.

Centers of Disease Control and Prevention. (2007). *Measuring Physical Activity Intensity.* Retrieved May 20, 2007 from http://www.cdc.gov/nccdphp/dnpa/physical/measuring/index.htm

Chan, C. B., Ryan, D, A., & Tudor-Locke, C. (2006, August). Relationship between objective measures of physical activity and weather: A longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*, 3 (21). Retrieved February 2, 2007, from http://www.ijbnpa.org/content/3/1/21

Cho, B., Scarpace, D., & Alexander, N.B. (2004). Tests of stepping as indicators of mobility, balance, and fall risk in balance-impaired older adults. *Journal of the American Geriatrics Society,* 52, 1169-1173.

Craig, C. L., Russell, S. J., Cameron, C., & Bauman, A. (2004). Twenty-year trends in physical activity among Canadian adults. *Canadian Journal of Public Health*, 95, 59-63.

Cummings, S.R., Newitt, M.C., Browner, W.S., Stone, K., Fox, K.M., Ensrud, K.E., et al. (1995). Risk factors for hip fracture in white women. *The New England Journal of Medicine*, 332, 767-773.

Cummings, S. R., & Melton, L. J. (2002). Epidemiology and outcomes of osteoporotic fractures. *The Lancet*, 359, 1761-167.

Cvengros, J. A., Christensen, A. J., & Lawton, W. J. (2005). Health locus of control and depression in chronic kidney disease: A dynamic perspective. *Journal of Health Psychology*, 10, 677-686.

Cyarto, E.V., Myers, A.M., & Tudor-Locke, C. (2004). Pedometer accuracy in nursing home and community-dwelling older adults. *Medicine and Science in Sports and Exercise,* 36, 205-209.

Dennison, E., BChir, Mohamed, M. A., & Cooper, C. (2006). Epidemiology of osteoporosis. *Rheumatic Disease Clinics of North America*, 32, 617-629.

Environment Canada. (2007). Retrieved March 3, 2008 from www.climate.weatheroffice.ec.gc.ca.

Fink, A. & Kosecoff, J. (1998). *How to Conduct Surveys. A Step-by-Step Guide* (2nd ed.). California: SAGE Publications, Inc.

Frisard, M.I., Fabre, J.M., Russell, R.D., King.C.M., DeLany.J.P., Wood, R.H., et al. (2007). Physical activity level and physical functionality in nonagenarians compared to individuals aged 60-74 years. *Journals of Gerontology: Medical Sciences*, 62A, 783-788.

Genant, H. K., Cooper, C., Poor, G., Reid, I., Ehrlich, G., Kanis, J., et al. (1999). Interim report and recommendations of the world health organization task-force for osteoporosis. *Osteoporosis International*, 10, 259-264.

Going, S., Lohman, T., Houtkooper, L., Metcalfe, L., Flint-Wagner, H., Blew, R., et al. (2003). Effects of exercise on bone mineral density in calcium-replete postmenopausal women with and without hormone replacement therapy. *Osteoporosis International*, 14, 637-643.

Hanley, D. A., & Josse, R.G. (1996). Prevention and management of osteoporosis: Consensus statements from the Scientific Advisory Board of the Osteoporosis Society of Canada: 1. Introduction. *Canadian Medical Association Journal*, 155, 921-923.

Health Canada (2003). Canadian Guidelines for Body Weight Classification in Adults (Catalogue H49-179) Ottawa.

Health Canada (2007). Data for Manitoba. *Food and Nutrition*, Retrieved August 8 2008 from http://www.hc-sc.gc.ca/fn-an/survell/atlas/province/data-donnees-manitoba-eng.php

International Osteoporosis Foundation. Facts and statistics about osteoporosis and its impact. Retrieved April 11, 2007 from http://www.iofbonehealth.org/facts-and-statistics.html.

Jette, A. M., Lachman, M., Giorgetti, M. M., Assmann, S. F., Harris, B. A., Levenson, C., et al. (1999). Exercise-it's never too late: The Strong-for-Life program. *American Journal of Public Health,* 89, 66-72.

Jordan, A. N., Jurca, G. M., Tudor-Locke, C., Church, T. S., & Blair, S. N. (2005). Pedometer indices for weekly physical activity recommendations in postmenopausal women. *Medicine and Science in Sports and Exercise*, 37, 1627 -1632.

Kane, R.L., Ouslander, J.G., Abrass, I.B. (2004). *Essentials of clinical geriatrics* (5th ed.). The McGraw-Hill Companies, Inc.

Krumm, E. M., Dessieux, O. L., Andrews, P., & Thompson, D. L. (2006). The relationship between daily steps and body composition in postmenopausal women. *Journal of Women's Health*, 15, 202-210.

Lachman, M. E., Howland, J., Tennstedt, S., Jette, A., Assmann, S., & Peterson, E. W. (1998). Fear of falling and activity restriction: The Survey of Activities and Fear of Falling in the Elderly (SAFFE). *Journals of Gerontology: Psychological Sciences,* 53B, P43-P50.

Lachman, M. E., & Jette, A. (1997) A cognitive-behavioural model for promoting regular physical activity in older adults. *Psychology, Health and Medicine*, 2, 251-262.

Lane, N. E. (2006). Epidemiology, etiology, and diagnosis of osteoporosis. *American Journal of Obstetrics and Gyneocology*, 194 (Suppl. 1), 3-11.

Leslie, W.D., Anderson, W.A., Metge, C.J., & Mannes, L.-J. (2007) Clinical risk factors for fracture in postmenopausal Canadian women: A population-based prevalence study. *Bone*, 40, 991-996.

Li, F., Fisher, K. J., Harmer, P., & McAuley, E. (2005). Falls self-efficacy as a mediator of fear of falling in an exercise intervention for older adults. *Journals of Gerontology: Psychological Sciences*, 60B, P34-P40.

Lindsey, C., Brownbill, R.A., Bohannon, R.A. & Ilich, J.Z. (2005). Association of physical performance measures with bone mineral density in postmenopausal women. *Archives of Physical Medicine and Rehabilitation,* 86, 1102-1107.

Liu-Ambrose, T., Khan, K. M., Eng, J. J., Lord, S .R., Lentle, B., & McKay, H. A. (2005). Both resistance and agility training reduce back pain and improve health-related quality of life in older women with low bone mass. *Osteoporosis International,* 16, 1321-1329.

Liu-Ambrose, T., Khan, K.M., Donaldson, M.G., Eng, J.J., Lord, S.R., & McKay, H.A. (2006). Falls-related self-efficacy is independently associated with balance and mobility in older women with low bone mass. *Journals of Gerontology: Medical Sciences*, 61A, 832-838.

Lord, S.R., Murray, S.M., Chapman, K., Munro, B., & Tiedemann. (2002). Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. *Journals of Gerontology: Medical Sciences*, 57A. M539-M543.

Manini, T.M., Everhart, J.E., Patel, K.V., Schoeller, D.A., Colber, L.H., Visser, M., et al. (2007). Daily activity energy expenditure and mortality among older adults. *Journal of the American Medical Association*, 266, 171-179.

Master, K. S., & Wallston, K. A. (2005). Canonical correlation reveals important relations between health locus of control, coping, affect and values. *Journal of Health Psychology*, 10, 719-731.

Mazzeo, R. S., Cavanagh, P., Evans, W. J., Fiatarone, M., Hagberg, J., McAuley, E., et al. (1998). ACSM position stand: Exercise and physical activity for older adults. *Medicine and Science in Sports and Exercise*, 30, 992-1008.

Medley, A., & Thompson, M. (2005). Usefulness of variations of the Timed Up and Go in apparently healthy individuals. *Physical and Occupational Therapy in Geriatrics*, 23, 1-23.

Menec, V. H., & Chipperfield, J. G. (1997). Remaining active in later life: The role of locus of control in seniors' leisure activity participation, health, and life satisfaction. *Journal of Aging and Health*, 9, 105-125.

Murphy, S. L., Dubin, J. A., & Gill, T. M. (2003). The development of fear of falling among community-living older women: Predisposing factors and subsequent fall events. *Journals of Gerontology: Medical Sciences*, 58A, 943-947.

Myers, A.M., Fletcher, P.C., Myers, A.H., & Sherk, W. (1998). Discriminative and evaluative properties of the activities-specific balance confidence (ABC) scale. *Journals of Gerontology: Biological Sciences and Medical Sciences,* 53, M287-M294.

Park, H., Togo, F., Watanabe, E., Yasunaga, A., Park, S., Shephard, R.J., & Aoyagi, Y. (2007). Relationship of bone health to yearlong physical activity in older Japanese adults: cross-sectional data from the Nakanojo study. *Osteoporosis International, 18, 285-293.*

Pinto, B. M., Goldstein, M. G., Ashba, J., & Sciamanna, C. N. & Jette, A. (2005). Randomized controlled trial of physical activity counselling for older primary care patients. *American Journal of Preventive Medicine*, 29, 247-255.

Podsiadlo, D., & Richardson, S. (1991). The Timed "Up & Go": A test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, 39, 142-148.

Powell, L. E., & Myers, A. M. (1995). The Activities-Specific Balance Confidence (ABC) Scale. *Journals of Gerontology: Medical Sciences*, 50A, M28-M34.

Rowe, D.A, Kemble, C.D., Robinson, T.S., & Mahar, M.T. (2007). Daily walking in older adults: day-to-day variability and criterion-referenced validity of total daily step counts. *Journal of Physical Activity and Health,* 4, 434-446.

Sattin, R. W., Easley, K. A., Wolf, S. L., Chen, Y., & Kutner, M. H. (2005). Reduction in fear of falling through intense Tai Chi exercise training in older, transitionally frail adults. *Journal of the American Geriatrics Society*, 53, 1168-1178.

Shumway-Cook, A., Brauer, S., Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the Timed Up and Go test. *Physical Therapy*, 80, 896-903.

Sieminski, D.J., Cowell, L.L, Montgomery, P.S., Pillai, S.B., & Gardner, A.W. (1997). Physical activity monitoring in patients with peripheral arterial occlusive disease. *Journal of Cardiopulmonary Rehabilitation,*17, 43-47.

Siminoski, K., Leslie, W.D., Frame, H., Hodsman, A., Josse, R.G., & Khan, A. (2005). Recommendations for bone mineral density reporting in Canada. *Journal of the Canadian Association of Radiologists*, 56, 178-188.

Statistics Canada, Health Statistics Division. (1996). *National Population Health Survey Questionnaire.* Retrieved March 13, 2007 from http://www.statcan.ca/english/sdds/instrument/5003_Q1_V5_E.pdf

Steele, B. G., Holt, L., Belza, B., Ferris, S., Lakshminaryan, S., & Buchner, D. M. (2000). Quantitating physical activity in COPD using a triaxial accelerometer. *Chest,* 117,1359-1367.

Storti, K.L., Pettee, K.K., Brach, J.S., Talkowski, J.B., Richardson, C.R., et al. (2008). Gait speed and step-count monitor accuracy in community-dwelling older adults. *Medicine and Science in Sports and Exercise*, 40, 59-64.

Talbot, L. A., Gaines, J. M., Huynh, T. N. & Metter, E. J. (2003). A home-based pedometer-driven walking program to increase physical activity in older adults with osteoarthritis of the knee: A preliminary study. *Journal of the American Geriatrics Society*, 51, 387-392.

Talley, K.M.C., Wyman, J.F., & Gross, C.R. (2008). Psychometric properties of the activities-specific balance confidence scale and the survey of activities and fear of falling in older adults. *Journal of the American Geriatrics Society*, 56, 328-333.

Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine*, 34, 1-8.

Tudor-Locke, C. E., Bell, R. C., Myers, A. M., Harris, S. B., Lauzon, N., & Rodger, N. W. (2002). Pedometer-determined ambulatory activity in individuals with type 2 diabetes. *Diabetes Research and Clinical Practice*, 55, 191-199.

Tudor-Locke, C., Burkett, L., Reis, J. P., Ainsworth, M. P. H., Macera, C. A. & Wilson, D. K. (2005). How many days of pedometer monitoring predict weekly physical activity in adults? *Preventive Medicine*, 40, 293-298.

Tudor-Locke, C. E. & Myers, A. M. (2001). Challenges and opportunities for measuring physical activity in sedentary adults. *Sports Medicine*, 31, 91-100.

Tudor-Locke, C. E. & Myers, A. M. (2001). Methodological considerations for researchers and practitioners using pedometers to measure physical (ambulatory) activity. *Research Quarterly for Exercise and Sport*, 72. 1-12.

Tudor-Locke, C., Williams, J. E., Reis, J. P., & Pluto, D. (2002). Utility of pedometers for assessing physical activity. Convergent validity. *Sports Medicine*, 32, 795-808.

Villareal, D. T., Binder, E. F., Yarasheski, K. E., Williams, D. B., Brown, M., Sinacore, D. R., et al. (2003). Effect of exercise training added to ongoing hormone replacement therapy on bone mineral density in frail elderly women. *Journal of the American Geriatrics Society*, 51, 985-990.

Wallston, K. A. (2005). The validity of the Multidimensional Health Locus of Control Scales. *Journal of Health Psychology*, 10, 623-631.

Wallston, K. A., Wallston, B. S. & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) scales. *Health Education Monographs*, 6, 160-170.

Wayne, P. M., Kiel, D. P., Krebs, D. E., Davis, R. B., Savetsky-German, J., Connelly, M., & Burning, J. E. (2007). The effects of Tai Chi on bone mineral density in postmenopausal women: A systematic review (Review). *Archives of Physical Medicine and Rehabilitation,* 88, 673-680.

Weinberg, L.E. (2001). The effects of attributional retraining, age, and perceived control on health-related cognitions: A longitudinal field study of older adults attending geriatric day hospitals. Ottawa: National Library of Canada. ISN 061251675X. AMICUS No. 25078766. Retrieved March 13, 2007 from www.collectionscanada.ca/amicus/index-e.html.

Weinberg, L. E. (2004). A pilot investigation into the benefits of a fall prevention program for older adults-Questionnaire. Winnipeg, MB: Ageing, Rehabilitation, and Social Cognition Research Laboratory, University of Manitoba. Unpublished manuscript.

Weinberg, L. E. (2005). Leg movements during driving among older adults with and without a total knee replacement-Perceived control questionnaire. Winnipeg, MB: Rehabilitation, and Social Cognition Research Laboratory. Unpublished master's thesis, University of Manitoba, Winnipeg, Manitoba, Canada.

Weiner, B. (1994). Integrating social and personal theories of achievement striving. *Review of Educational Research*, 64, 557-573.

Welk, G. J., Almeida, J., & Morss, G. (2003). Laboratory calibration and validation of the Biotrainer and Actitrac activity monitors. *Medicine and Science in Sports and Exercise*, 35, 1057-1064.

Welk, G. J. Blair, S. N., Wood, K., Jones, S., & Thompson, R., W. (2000). A comparison evaluation of three acceleromtery-based physical activity monitors. *Medicine and Science in Sports and Exercise*, 32 (Suppl.), 489-497.

Welk, G. J., Schaben, J. A., & Morrow, J. R. (2004). Reliability of acclerometery-based activity monitors: A generalizability study. *Medicine and Science in Sports and Exercise*, 36, 1637-164.

Whitney, S.L., Wrisley, D.M., Marchetti, G.F., Gee, M.A., Redfern, M.S., & Furman, J.M. (2005). Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the five-times-sit-to-stand test. *Physical Therapy,* 85, 1034-1045.