EXPLORING THE ATTENDANCE AND POTENTIAL BENEFITS OF REDUCINC SITTING TIME FOR RESIDENTS IN A CANADIAN LONG-TERM CARE SETTING: A PILOT STUDY

By

Amanda Lee

Previous Degrees, *Bachelor of Science in Kinesiology, University of New Brunswick*

2017

A Thesis Submitted in Partial Fulfilment of the
Requirements for the Degree of

Master of Science in Exercise & Sport Science

In the Graduate Academic unit of *Kinesiology*

Supervisor: Danielle Bouchard, PhD, Kinesiology

Examining Board: Martin Sénéchal, PhD, Kinesiology
Emily Read, PhD, Nursing
Jeff Hebert, PhD, Kinesiology

This thesis is accepted by the
Dean of Graduate Studies
THE UNIVERSITY OF NEW BRUNSWICK

May 2019

Abstract

PURPOSES: To assess the attendance of the proposed intervention to reduce sitting time in a LTC facility, and to explore the potential functional benefits.

METHODS: The intervention consisted of a team visiting long term care residents to promote standing for 10-minute sessions, three times per day (morning, afternoon, evening), four days per week (Mon-Wed-Fri-Sun), for a period of 10 weeks during the period of May-Sep 2018. The main outcome was attendance. Secondary outcomes included walking speed, leg power and leg strength.

RESULTS: The overall attendance was 35% of sessions, highest during the morning session compared with the afternoon, and evening ($p < 0.03$). Weekdays were more attended compared with Sundays ($p < 0.01$). There was a significant improvement in the 30 second chair stand test ($p < 0.05$).

CONCLUSIONS: Attendance was lower than expected but functional benefits are possible and should be tested with the appropriate sample size and study design.

Acknowledgment

I would like to acknowledge the Canadian Frailty Network and New Brunswick Health Research Foundation for my funding during my graduate program; York Care Center for their location and residents, as well as their support; as well as my colleagues at the Cardio-metabolic Exercise & Lifestyle Laboratory for their continuous support with this project. I wish to thank my parents for their love and encouragement, without whom I would never have enjoyed so many opportunities. Lastly, I would like to thank and acknowledge my supervisor Dr. Danielle Bouchard for her support and guidance throughout this process. Without her knowledge, support, experience, and encouragement I would not, and could not, have pursued this degree.

Table of Contents

List of Figures

1.0 Introductory Chapter

Older adults are known to be less active and sit for long durations, especially those in long-term care. These residents have a rapid decline in all spheres of health, including physical functions and overall mobility. There are many reasons for these specific declines, but one of them could be the excessive amount of time spent sitting, also called sedentary behaviour. Sedentary behaviour is defined as prolonged bouts of a sitting, reclining or lying posture characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), and has been associated with undesirable health conditions, a decline in functional abilities, and an increased risk of mortality (Copeland et al., 2017) Older adults who live in the community spend about 80% of their waking time in sedentary activities (Harvey, Chastin, & Skelton, 2015). Older adults in long-term care spend 9% more of their day sedentary than those in the community (Lee, Sénéchal, Hrubeniuk, & Bouchard, 2019). Efforts to reduce sitting time in the community have had some success. To our knowledge, no intervention has been tested in LTC to reduce to reduce sitting time.

Given the high prevalence of sitting time in LTC and the potential health and functional risks associated with sedentary behaviour, it is important to explore strategies to reduce sitting time in this population. The main objective of this research study was to assess the attendance of an intervention to reduce sitting time in a LTC facility and to explore the potential functional benefits. The intervention consisted of a team visiting LTC residents to promote standing for 10-minute sessions, three times per day (morning, afternoon, evening), four days per week (Mon-Wed-Fri-Sun), for a period of 10 weeks. Secondary functional outcomes included walking speed (10-meter walk), leg power (30-sec chair stand), and leg strength (Microfet dynamometer).

1.1 Aging

Aging, in broad terms, is the common phenomenon of the passing of time and functional decline (Op het Veld et al., 2015). The World Health Organization classifies those aged 60 and above as older adults (WHO, 2002). Although chronological age can be used as a marker for social benefits and retirement, it is commonly accepted that chronological age and biological age are not always the same (WHO, 2002).

Canada invests a significant amount of money into their health care systems (Canadian Institute for Health Information, 2018). The department of finance reported that 36 billion of the federal budgets was spent on health care in 2016-2017 and is projected to increase to 39.9 billion in 2019-2020 (Government of Canada, 2017). Canada's health system is financed both publicly and privately, with the public sector accounting for 70% of funding for the total health expenditure. In terms of cost per individual, Canada spends an average of $5,782 per individual across all ages. However, the average cost of health expenditure for adults above the age of 65 in 2015 was more than double the average per individual, and nearly four times the average for those aged 80 and above (Canadian Institute for Health Information, 2018). As our population ages these costs are expected to grow (Canadian Institute for Health Information, 2018). In the past 40 years, the proportion of older adults grew by a consistent 1% per year (Canadian Institute for Health Information, 2018). Assuming this continues, health care costs will increase in parallel (Canadian Institute for Health Information,2018), possibly leading to economic instability.

Canadians are living longer – the current life expectancy of Canadian men is 79 years and Canadian women is 83 years (Government of Canada, 2017). By 2031, this number is expected to rise to 82 and 86 respectively (Government of Canada, 2017).

Living longer does not always mean individuals are living healthier lives. Living longer is often associated with several limitations; the average Canadian is expected to live roughly 10.5 years with some level of disability (Government of Canada, 2013). Frailty is highly associated with age and is thus very common among the aging population (Rockwood & Mitnitski, 2007). The most severe disabilities, which cause functional and health declines, tend to occur around the age of 77 (Government of Canada, 2013). Perhaps this is why the average age of Canadian older adults living in a typical Long-Term Care (LTC) facility is between 80 and 89 years old (Clarke, Chan, Santaguida, & Colantonio, 2009), well within the age of expected functional decline.

In 1981, the percentage of the Canadian population above the age of 65 was 9.7% (Government of Canada, 2007). Twenty-five years later, in 2006, the Canadian Census indicated that the number had increased to 13.7% (Government of Canada, 2007). In 2011 it increased once again to 14.1%, and the most recent report (2016) indicates that 16.9% of the population is above the age of 65 (Government of Canada, 2016). New Brunswick is at the top of the list among provinces with 19% of our population aged 65 and older (Government of Canada, 2017). We expect to see a continual increase in the aging population, largely due to our 'baby boomers'. These are babies born between 1946 and 1965 following the end of World War II (Government of Canada, 2015). Baby boomers currently make up approximately 5.7% of the Canadian population and are presently aged between 53 and 72 years old (Government of Canada, 2016). Therefore, as the baby boomers continue to age, the number of older adults in need of LTC and assisted living is expected to grow. This section clearly demonstrates the rapid rate at which the proportion of older adults in Canada is growing (Government of Canada, 2016). With this increase in the prevalence of older adults, there are many challenges that Canada, as well as many other countries, are facing.

Chronic conditions such as cancer, chronic respiratory diseases, heart diseases, musculoskeletal diseases, as well as cognitive disorders are highly prevalent for older adults (WHO, 2014.) As well, as one ages it is shown that functional abilities decline including muscle strength or muscle mass (Milte & Crotty, 2014), which create challenges such as difficulty performing activities of daily living, increased risk of falls, and increased risk of frailty (Milte & Crotty, 2014; Op het Veld et al., 2015). Often these limitations cause one to move out of their personal home and into an assisted living complex or a LTC facility (Gill & Morgan, 2011). In Canada, it is estimate that approximately 2.6% of older adults live in long-term care (Government of Canada, 2018). This relocation is often the last personal and significant decision an older adult will make, as they are transitioning into a lifestyle that is no longer independent (Gill & Morgan, 2011). Altogether, these physical declines that are common among most older adults lead to economic and social challenges (WHO, 2014)

Aging is also associated with social challenges. Feeling socially connected to other individuals is extremely important for one's well-being (Masi, Chen, Hawkley, & Cacioppo, 2011). There is a high prevalence of loneliness among adults aged 65 and older (de Jong Gierveld, Keating, & Fast, 2015; Masi et al., 2011). Loneliness is associated with various physical health issues and it increases the likelihood of cognitive decline (Masi et al., 2011). Other social challenges occur with aging such as poverty (due to reduced personal resources), a shortage of social networks, low quality interactions, and decreased health; all of which affect older adults as they are at an increased risk of loneliness (Masi et al., 2011).

In summary, aging greatly varies from person to person and can bring about various challenges such as personal economic challenges (Canadian Institute for Health Information, 2018) increased government cost (Government of Canada, 2017), increased risk of chronic conditions (WHO, 2014) decreased quality of life (Gill & Morgan, 2011), decreased social interactions (Masi et al., 2011) and decreased functional abilities (Milte & Crotty, 2014).

1.2 Long-term care

LTC facilities are residences for individuals with complex needs who are no longer able to care for themselves. LTC includes nursing homes and other facilities like special care homes. LTC homes provide care to residents 24 hours a day, seven days a week. They provide help for various activities of daily living such as eating, personal hygiene, dressing, ambulating, toileting, and basic safety (Canadian Healthcare Association, 2009). Simplified, LTC facilities are where people live when they are no longer able to take care of themselves, usually due to age related matters.

Entering a nursing home is not as simple as it may seem, as there is often a long wait period, an assessment, and paperwork that must be completed first. Upon the decision of entering a care home the client must first have their request approved. In New Brunswick, LTC is run by the New Brunswick Department of Social Development, which will determine nursing home eligibility based on individuals' health as well as their social needs and finances. Upon approval of eligibility the client must then undergo an assessment. This assessment is voluntary, meaning that no competent person can be forced into a nursing home; this assessment is completed willingly (Public Legal Education and Information Service of New Brunswick, 2016).

There are currently an estimated 2.6% of older adults in Canada living in LTC (Government of Canada, 2018) in 2577 approximately facilities spread across the country (Canadian Institute for Health Information, 2015). With the number of Canadian older adults expected to rise in the next few decades (Government of Canada, 2015; Canadian Institute for Health Information, 2018) it is estimated that 750,000 Canadians or more may be in need of LTC by 2036 (Canadian Life and Health Insurance Association, 2014).

LTC homes are challenged with capacity issues, as can be noted by the many older adults in Canada who reside in acute care beds at the hospital while waiting for a space in a LTC facility (Canadian Institute for Health Information, 2018). The average cost of an acute care bed being used for LTC in a hospital for one month is $25,000 (Government of Canada, 2018). A retrospective study by McCloskey, Jarrett, Stewart, and Nicholson, (2014) investigated hospitals with patients in acute care beds waiting for a space in LTC in New Brunswick. On average, patients waited 6 to 12 months to be admitted to a LTC facility after an incident such as illness, a fall, or confusion (McCloskey et al., 2014). Patients awaiting entrance to LTC had 4-5 chronic health conditions on average and 63% were diagnosed with dementia (McCloskey et al., 2014). Other studies from other Canadian provinces have reported that 38% of older adults living in LTC report chronic pain, and that women were more likely to have chronic pain regardless of their age or whether they live in LTC or in the community ($p<.05$) (Ramage-Morin, 2008).

In Canada, it is very difficult to establish the actual costs of a LTC home as there are variations across provinces and regions, with variable inclusion of costs related to laundry, building maintenance, prescription charges, and incontinence supplies

(Canadian Healthcare Association, 2009). In the Atlantic Provinces, the average monthly cost covered by the resident or the resident's family ranges from $1,950-2,800, depending on the resident's previous income (Canadian Healthcare Association, 2009). However, New Brunswick's average expenditure is an outlier among provinces, with a staggering average monthly fee of approximately $3437 effective April 1, 2014 (Government of New Brunswick, 2014).

1.3 Physical Function

More than half (51.02%) of the population living in LTC are aged between 80 and 89 years old (Clarke et al., 2009). The majority of them report difficulties completing various activities of daily living (e.g. eating, dressing, grooming, walking, toileting, and transferring), with the most residents reporting difficulties walking (59%), dressing (35%) and transferring (31%) (Clarke et al., 2009).

Mobility disabilities are common in LTC (Clarke et al., 2009). Mobility devices such as walkers and wheelchairs are common in LTC to maintain some level of independence and socialization (Allen, Foster, & Berg, 2001). Clarke et al., (2009) reported that 70% of older adults in LTC use a mobility device. Of that 70%, 53.7% used wheelchairs and 17% used a walker or a cane (Clarke et al., 2009). Physical function difficulties related to mobility are often present in LTC settings and can be either objectively measured or self-reported.

Low physical function refers to restrictions in a person's physical performance that affect activities of daily living such as mobility tasks (Guralnik et al., 2000). Low physical function is associated with higher frequency and duration of hospitalization (Guralnik et al., 2000; Studenski et al., 2003), higher rates of admission to nursing homes (Rist, Nguyen, Whitmer, & Glymour, 2016), greater use of hospital service

(Alley & Chang, 2007), lower quality of life (Zhou et al., 2018) greater risk of all-cause mortality (Kim, Min, & Min, 2019) higher risk of dementia (Brennan et al., 2010), and higher rates of falls (Verghese, Holtzer, Lipton, & Wang, 2009). Many physical functions (e.g. walking speed, muscle strength, endurance) can be safely tested to estimate the risk of important outcomes such as frailty, hospitalizations, or mortality (Fried et al., 2001; Rockwood & Mitnitski, 2007). For example, Jing Song et al., (2015) showed that slow gait speed (< 0.6 m per second) or inability to rise from a chair without using one's arms are associated with frailty status (Jing Song et al., 2015). Measurement of physical function is either self-reported or assessed by performance tests such as standing balance, climbing stairs, or walking speed. Walking speed is one of the strongest predictors of adverse outcomes, such as mobility disability, falls, and hospitalization (Middleton et al., 2017).

Physical functions are associated with the risk of falls and the fear of falling (Auais et al., n.d.; Flacker, 2003; Rockwood & Mitnitski, 2007). Older adults who fear falling tend to reduce their activities and walking speed in an attempt to reduce their risk of falls (Åberg, Frykberg, & Halvorsen, 2010). However, by doing so they actually increase their risk of falling by reducing the natural counter balance of the movement (Åberg et al., 2010). A walking speed lower than 0.6 m/sec has been established as the threshold associated with health risk (Cesari et al., 2015; Studenski et al., 2003). In that same study, gait adaptations such as shorter stride length and speed are also shown to increase risk of falls.

Based on a longitudinal multi-site research project examining the various factors related to mobility among community-dwelling older adults, Auais et al., (2017) concluded that the fear of falling was associated with a higher risk of poor physical performance and incidences of mobility disabilities in older adults. In fact, those with a fear of falling were more likely to report mobility disability (175% increase) and a high risk of developing poor physical performance (62% increase) (Auais et al., 2017).

Ultimately, limitations in physical functions and fear of falling lead to older adults living a more sedentary lifestyle (Fleig et al., 2016). Several factors are associated with physical function among older adults (Bouchard, Dionne, Payette, & Brochu, 2009; Katzmarzyk, Church, Craig, & Bouchard, 2009). Some of these factors are modifiable and represent potential strategies to improve physical function. One of the contributors to physical function and the risk of falling that has received more attention recently is the excessive amount of time spent sitting.

For older adults living in the community, sedentary behaviour has been independently associated with chronic conditions, physical function, and premature mortality (Copeland et al., 2017). Specific to LTC residents, sedentary time has been associated with an increased risk of falls and hospitalization, reduced cognitive functions, and contribute to isolation (Copeland et al., 2017). Possibilities for promoting exercise at a moderate-to-vigorous activity level, as proposed for older adults to maintain and improve physical function (Paterson & Warburton, 2010), are limited in this population. However, it is possible that a small reduction in sitting time, could lead to improvements in many outcomes, such as physical function, for residents of LTC.

1.4 Sedentary Behaviour

Historically, individuals meeting the physical activity guidelines would be considered active, even if they spent the majority of their waking time sitting. Currently, there is a debate about whether one could be active, by meeting the physical activity guidelines, but lose the benefits associated with being active if this individual spends the majority of the day sitting (Diaz et al., 2017). For example, van der Ploeg & Hillsdon, (2017) investigated this question. The article outlines the contrast of an individual who sits all day but meets the physical activity guidelines. By the common description of sedentary behavior, this person would be considered sedentary. By the common definition of the guidelines for physical activity from national agencies, that person would be considered as active. They also present the inverse, which is someone who spends the majority of their day standing, such as a hairdresser or cashier, but does not meet the physical activity guidelines, and therefore, is inactive (van der Ploeg & Hillsdon, 2017). van der Ploeg & Hillsdon, (2017) indicated that their research does not support the claim that sedentary behavior leads to poor health, but agree that not moving does, regardless of positioning.

Chang, Fritschi, and Kim, (2013) conducted a study aiming to increase physical activity with an eight-week exercise session but instead resulted also in reduce sedentary time. These results appear to present a 1:1 ratio where sedentary time and physical activity are interchangeable, however this may not be the case for all studies. If someone increased their physical activity, they may not decrease their sedentary time but instead decrease their sleep, therefore not impacting their sedentary time at all.

This debate is important for older adults who represent the age group of the population that is the least likely to meet the physical activity guidelines, and who spend the majority of their time sedentary (Gibbs et al., 2017; Harvey et al., 2015; Matthews et al., 2008). Based on the definitions, sedentary behaviour is not equal to inactivity. The first is related to the accumulation of activities having low energy expenditure while the other one is related to not meeting the guidelines of spending a minimum of 150 minutes of aerobic activities at moderate to vigorous intensity (Jing Song et al., 2015; LeBlanc et al., 2015). Sedentary behaviour and physical inactivity appear to be different, however, both should be targeted when attempting to improve health within a population (van der Ploeg & Hillsdon, 2017). Findings from the women's health initiative (Seguin et al., 2012) support the notion that sedentary behaviour is independent of physical activity levels.

A recent study aimed to clarify the interaction of physical activity and sedentary behaviour with physical fitness by using self-reported measures for sedentary behaviour in 433 Spanish adults aged 55 year and older (Aparicio-Ugarriza et al., 2017). They concluded that sedentary behaviour was associated with mortality and poor health outcomes even when adjusted for physical activity level. Likewise, another study reported that sitting more than six hours per day was associated with mortality and cardiovascular diseases, despite meeting the aerobic exercise guidelines (Katzmarzyk, Church, Craig, & Bouchard, 2009). Other studies have confirmed that health risks and comorbidities such as cardiovascular disease, diabetes, and increased risk of mortality are linked with sedentary behaviour, even after adjusting for exercises done at moderate to vigorous intensity (Bauman, Chau, Ding, & Bennie, 2013; Gibbs et al., 2017).

However, controversy still exists, as other studies have shown that changes in physical activity alone can negate the health effects of a sedentary lifestyle. A study in 2016 involving one million people reported that performing exercise regularly would be associated with benefits even if sedentary time is high (Ekelund et al., 2016). This study reported that regular moderate intensity physical activity overcomes the negative impacts of high amounts of sedentary behaviour. Wu et al., (2017) found that exercising done at moderate to vigorous intensity, measured using accelerometry, was associated with positive musculoskeletal health outcomes in 309 Australian women aged 36 to 57 years old, and not sitting time (Wu et al., 2017). Keevil et al., (2016) also reported that exercising done at moderate to vigorous intensity, measured objectively using accelerometry, but not sedentary time, is associated with higher physical capabilities. They did this by using 8623 participants aged between 43 to 92 years old (Keevil et al., 2016).

To date, only one study has tried to distinguish the benefits of sitting less compared to doing more traditional exercises in an intervention (Gibbs et al., 2017). Gibbs et al., (2017) investigated whether decreasing sedentary time would have a greater effect on physical function in comparison to increasing aerobic exercise. Two groups ($N = 38$, 68 ± 7 years old) were compared: the Get Active group and the Sit Less group. The first aimed to increase the amount of aerobic exercise done at moderate to vigorous intensity, while the other kept the same exercise level but reduced sedentary behaviour. There was no significant decrease in the sedentary behaviour in either the Sit Less group or the Get Active group. However, the Sit Less group was the only group to improve their physical function ($p<.05$). The Sit Less group also reported a reduction in overall pain (Gibbs et al., 2017) suggesting that attempting to reduce sitting time had greater health effects than attempting to increase physical activity, although there was no significant difference in sitting times between the groups (Gibbs et al., 2017).

To conclude, the current literature suggests that more studies need to be conducted to determine whether doing physical activity is associated with different health and functional outcomes, regardless of sedentary time.

1.5 Quantifying Sedentary Behaviour

1.5.1 Definition

Sedentary behaviour is described in different terms such as sitting time, sedentary time, sedentary living, and physical inactivity (Pate, O'Neill, & Lobelo, 2008). However, most studies refer to sedentary behaviour as activities performed between 1.01 and 1.49 metabolic equivalents (METs)] in a sitting or reclining position (Jing Song et al., 2015). Sedentary behaviours tend to be performed while sitting when commuting, at work, at home or while doing leisure activities. Older adults tend to be the age group that spends the most time sedentary (Davis et al., 2014). Older adults in the community tend to spend approximately 80% of their day sedentary (Harvey et al., 2015), and our pilot study in the summer of 2017 indicated that older adults in LTC spend approximately 89% of their day performing sedentary behaviours (Lee et al., 2019).

1.5.2 Methods to measuring Sedentary Behaviour

There are two main methods to assess sedentary behaviour: objectively, with a device, or subjectively, with a questionnaire. Both methods have their advantages. Some advantages of using a questionnaire include the ability to survey a large population, the simplicity of analysis, and the low cost (Dollman et al., 2009). On the other hand, the main advantage of using movement sensors is the absence of memory bias and variation in interpretation of questions (Dollman et al., 2009).

The current literature pertaining to sedentary behaviour relies more on epidemiology, and thus, have predominantly used valid questionnaires to measure sedentary behaviour (Prince, LeBlanc, Colley, & Saunders, 2017). Questionnaires estimating time spent at different intensities of activities often overestimate physical activity as it is difficult to estimate the differences between the intensities (e.g. Light vs Moderate vs Vigorous intensities) by self-report (Downs, Van Hoomissen, Lafrenz, & Julka, 2014). Additionally, participants often report more desirable results than accurate results (Downs et al., 2014). A recent review by Prince et al., (2017) reviewed 35 questionnaires used to report sedentary time in the community. This review concluded that there is a negative association between self-reported sedentary behaviour and physical and psychosocial health in children and adults (Prince et al., 2017). This review made recommendations on the best questionnaires to use based on outcomes. For total sedentary time, it was recommended to use the Salmon Sedentary Behaviour questionnaire (Salmon, Owen, Crawford, Bauman, & Sallis, 2003), as it had excellent reliability for total sedentary behaviour with an ICC of 0.79 (95% CI [0.71-0.85]), and it was recommended *not to use* the International Physical Activity Questionnaire (Cleland, Ferguson, Ellis, & Hunter, 2018), even though it is a frequently used tool, because it relates poorly to objective measures.

1.5.3 Objective Measures to measuring sedentary behaviour

1.5.3.a Accelerometers

Objective measures such as accelerometers have expanded the possibilities of research on sedentary time in past decades. Despite it being an objective measure, there are still drawbacks of using accelerometers (Pate et al., 2008). For example, the number of days for which data are collected, the cut points used to identify different intensity of movements, adherence, or the likelihood of participants' altering their habits when they are aware of being monitored, similar to social desirability bias often present in questionnaires as participants would like more desirable results (Downs et al., 2014). For example, Gorman et al., (2014) noted differences in the proportion of time spent sedentary based on the cut-points selected, ranging between 62%-86% . This notes the importance of choosing cut-points that were developed specifically for the group being studied (Gorman et al., 2014). Pedišić and Bauman (2015) noted other limitations with accelerometers such as generalizability, validity, comprehensiveness, simplicity, affordability, adaptability, between-study comparability, and sustainability based on resources to extract data (Pedišić & Bauman, 2015).

It is important to note that accelerometers are removed for certain parts of the day (e.g., sleep, shower, swimming) and can decrease wear time, and create a bias on daily estimates of sedentary behaviour and activity levels (McGrath et al., 2017). This is especially evident if the number of days where data is collected increases. McGrath et al (2017) found that wearing time decreased by 167.2 minutes per day over seven days of tracking, among 101 participants between the ages of 18-70. Therefore, variation of wear time can be expected due to regular daily tasks for removable non-waterproof devices.

1.5.3.b Inclinometers

Another popular tool to quantify sedentary behaviour objectively is the ActivPAL which uses accelerometers and inclinometers (Chan, Slaughter, Jones, Ickert, & Wagg, 2017). In contrast to other common accelerometers, the ActivPAL tends to have fairly good adherence (average 23 hours) as they are waterproof and fastened on the leg, and only removed to change the tape (Gill & Morgan, 2011). Adding inclinometers is an advantage because the device can report the differences between activities such as sitting, standing, and laying as oppose to relying on movement to assume sedentary behaviour (Edwardson et al., 2017). These devices are accurate for posture and stepping activity (An, Kim, & Lee, 2017). As with other accelerometers, it is accepted that the minimum wear time for recording valid information on sitting time with older adults is four days at 10 hours per day (Edwardson et al., 2017). This amount of time allows the device to record an acceptable degree of repeatability (Barreira et al., 2016).

Chan et al. (2017) conducted a review of the literature and indicated with seven articles that ActivPAL has limitations of data classification specifically with frail older adults. Chan et al. (2017) deems this inaccuracy of classifying lower limb movement as steps due to hesitancy, shuffling, and pausing. Though the authors note a limitation to their own review: the articles were not considered high quality, there was a small quantity of articles, and there is a lack of articles using the ActivPAL with older adults in long-term care.

In contrast, research from Grant, Dall, Mitchell, and Granat, (2008) showed that the ActivPAL was accurate for older adults. They measured the accuracy of the ActivPAL on a treadmill and outdoors with twenty-one participants over the age of 65, who were in an exercise rehab class for cardiac-rehabilitation or osteoporosis and did not use a mobility aid. This was done in comparison with two pedometers, the Digiwalker SW-200 and the NL-2000, as well as video observation using a digital camcorder. The criterion measure was observation of steps for this study. The SW-200 has been used as the criterion pedometer in other studies (Schneider, Crouter, & Bassett, 2004) but was not the criterion measure in this study. They found the absolute percentage of error for the ActivPAL to be below 1% for step number at all walking speeds, indoors and outdoors. Therefore, they suggest that the ActivPAL could be used in the older adult population (Grant et al., 2008).

Although the ActivPAL is a simple and convenient tool, there are some limitations and areas where knowledge is lacking since the tool is somewhat new (Edwardson et al., 2017). For example, it is unknown if users may benefit from longer wear days/times to improve validity (Edwardson et al., 2017). Another limitation is that the software is automatically set to a minimum of 10 seconds for sitting or upright periods; therefore, data collected from an upright transition below 10 seconds may have be missed (Edwardson et al., 2017). There is also debate regarding the feasibility of frail older adults wearing these devices. Reid and Fielding (2012) assessed the feasibility of using these devices with older adults in residential aged care with 31 ambulatory adults, aged 60 years and older, who were not cognitively impaired. They found this device to be feasible within this population and that activity did not vary significantly by day ($p > 0.05$), but stepping did vary hourly ($p = 0.018$) (Reid & Fielding, 2012).

1.5.3c Comparisons between devices

A recent study by Pfister et al (2017) compared different accelerometers, the ActiGraph GT3X+ using different vectors, and the ActivPAL3 accelerometers for measuring physical activity and sedentary behaviour. This trial included 266 women between the ages of 50-74 years. Devices were worn during waking hours for seven days, with a minimum of four days and 10 hours each of those days. They concluded an association ICC ranging from 0.91 (0.81-0.97) (Pfister et al., 2017). Despite this high association, the authors still recommended that the devices should not be used interchangeably because the precision of estimates between methods was low, with wide limits of agreement.

1.5.3d Device Feedback

Traditionally, accelerometers and inclinometers did not provide feedback to users. However, a Sense Wear Pro armband, a tool validated for assessing free-living and total energy expenditure using doubly labelled water (Gibbs et al., 2017), can provide feedback by being connected to the participant's phone via Bluetooth technology. This device is worn on the triceps and can measure acceleration, heat flux, skin temperature, and galvanic skin response (Gibbs et al., 2017). PAL Technologies, the same company that produced the ActivPAL, created a similar device called the SitFIT (Gill et al., 2018). The SitFIT was validated for sedentary behaviour and step count using the ActivPAL with 21 men between the ages of 30 and 65 years, and a body mass index of 26.6 ± 3.9 kg·m^{-2} (Gill et al., 2018). Results were within the 95% agreeable limit and the Pearson correlation was very high for step count (r=0.98) and high for sedentary time (r=0.84) (Gill et al., 2018).

This device is worn in the front pants pocket, is similar in size to the ActivPAL and displays active step feedback and provides a vibration signal when the participant sits too long, as a way to prompt a break in sedentary behaviour (Gill et al., 2018). Although the SitFIT is not currently sold for retail purposes, this device could be beneficial as participants would not have to tape it to their leg, reducing any irritation. The alerts prompting movement may also beneficial to increase activity. The SitFIT is a triaxial accelerometer from PAL Technologies that uses static and dynamic accelerations within the three orthogonal axes to calculate wear time, as well as postural allocation to determine upright and sedentary time (Gill et al., 2018). The ActivPAL uses the same triaxial and postural allocation technology but is taped to the thigh instead of placed in the pocket like the SitFIT (Chastin et al., 2018).

1.6 Sedentary Behaviour and Health

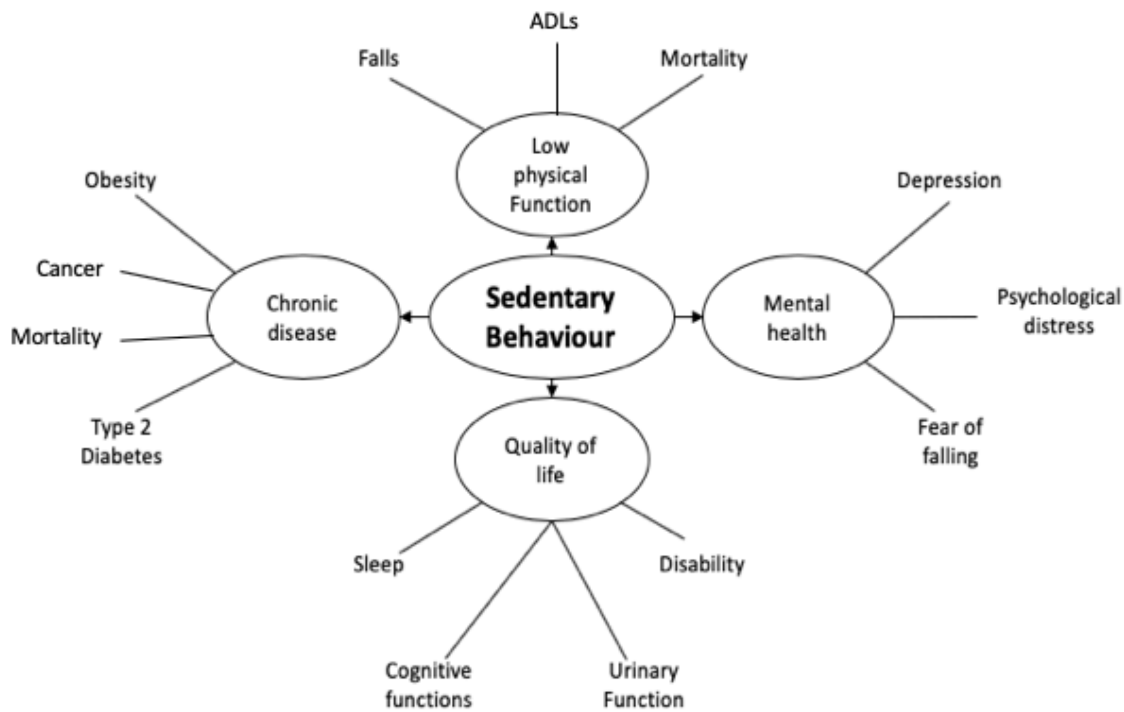

Figure 1. Sedentary Behaviour Health Relations.

1.6.1 Sedentary behaviour and chronic disease

Many epidemiological studies have now investigated the potential association between sedentary time and a diverse list of outcomes. Conflicting results are reported mostly due to the heterogeneity in the measure of sedentary behaviour. Nonetheless, sedentary behaviour has been reported to be associated with mortality risk, obesity, type 2 diabetes (Bauman et al., 2013), cancer (Hildebrand, Gapstur, Gaudet, Campbell, & Patel, 2015), and functional decline (Jing Song et al., 2015).

Studies suggest that sitting can change skeletal muscle rapidly and drastically. One day of prolonged sedentary behaviour may reduce muscle triglyceride uptake and reduce HDL cholesterol production (Bey & Hamilton, 2003). Research suggests sedentary behaviour has a negative impact on health through physiological mechanisms. Seated mental activities tend to increase caloric intake because they require energy and they can often be stressful (Chaput, Klingenberg, Astrup, & Sjödin, 2011). Prolonged bed rest (5+ days) increases plasma triglycerides, LDL cholesterol, and insulin resistance (Hamburg Naomi et al., 2007). Unfortunately, researchers suggest that these changes can happen with prolonged sitting, even if you typically are physically active (Saunders, 2012) leading to cardiovascular disease risk factors and an increased risk of mortality, obesity and type 2 diabetes (Bauman et al., 2013)

Ensrud et al (2014) followed 2,918 individuals for 4.5 years while measuring their activity levels to examine the association between mortality and sedentary behaviour. They concluded that participants who spent more time engaging in sedentary behaviour had an increased risk of all-cause mortality. For example, men who spent 15 or more hours per day sedentary had a 1.5-1.7 fold risk of mortality than those spending 12.7 hours per day, even after accounting for differences in exercise level (Ensrud et al., 2014). Another article by Fox et al (2015) found no significant association between sedentary behaviour and all-cause mortality after adjusting the models for potential confounders (Fox et al., 2015). Katzmarzyk et al (2009) conducted a study with a sample of collectively of 7278 men and 9735 women between the ages of 18-90 years using Canadian data to investigate sitting time and mortality from all-cause; cardiovascular disease, and cancer. Sitting time was analyzed in ages 18-59 and >60. In both age categories, death rates increased across daily sitting categories significantly, suggesting that all-cause mortality and cardio vascular disease are associated with greater daily sitting times. Higher risks for mortality from all causes and cardiovascular diseases were observed with higher levels of sitting time, but not mortality from cancer ($P < 0.01$)

(Katzmarzyk et al., 2009). However, another study by Hildebrand et al (2015) reported an association between sitting time and specific cancers. They reported an association between sitting more than six hours and an increased risk of ovarian cancer in 63,972 postmenopausal women (Hildebrand et al., 2015). It is suggested that extended bouts of sitting result in an increased risk of mortality (Diaz et al., 2017; van der Ploeg & Hillsdon, 2017). Sitting is a natural human action, therefore intermittent sitting is not associated with mortality. Individuals exceeding seven hours of sitting in a waking day showed an increased risk of premature mortality, suggesting that sitting is detrimental in higher doses (van der Ploeg & Hillsdon, 2017). Researchers therefore suggest that guidelines should be developed to promote the importance of reducing excessive sitting time, as well as interrupting long sessions of sitting (Diaz et al., 2017; van der Ploeg & Hillsdon, 2017).

1.6.2 Sedentary Behaviour and physical function

Copeland et al (2017) recently conducted a narrative review about the potential impacts of sedentary time specific to older adults. They noted two important points from the literature. First, there is a strong relationship between sedentary time and disability for activities of daily living in older adults (Dunlop et al., 2015). Second, sedentary behaviour has been shown to be an independent risk factor for low physical function (Gibbs et al., 2017).

Seguin et al (2012) investigated the association between sedentary time (total number of hours spent doing sedentary tasks, as well as total time spent lying down) and a decline in self-reported physical function among women. The study included over 60,000 women in 40 clinical trials across the United States. Quartiles for hours spent sedentary (≤6, 6–8, 8–11, >11hours/day) were created for analysis. Women who reported higher sedentary time reported more chronic conditions, a higher frequency of falls, and more difficulty with activities of daily living. In another study, prolonged sitting (>8 hours/day) was independently associated with falls in the past 12 months (Carlfjord, Andersson, Bendtsen, Nilsen, & Lindberg, 2012), and with the fear of falling (Jefferis et al., 2015). They reported that for every 30-minute increase in sedentary time after 600 minutes per day, the risk of falls increased by 22% (95% CI, 1.07-1.40).

Mañas et al (2018) reported that those spending more time sedentary showed lower grip strength, chair rise speed, standing balance time, and timed-up-and-go scores (Cooper, Simmons, Kuh, Brage, & Cooper, 2015; Fleig et al., 2016). One article by Gennuso, Thraen-Borowski, Gangnon, and Colbert, (2016) found no significant association between sedentary time and physical performance; however, this study did find a statistically significant association between breaks in sedentary time and physical performance (Gennuso et al., 2016), emphasizing the idea that total amount and patterns of sedentary behaviour could be independently important. The importance of sedentary patterns for physical function was confirmed afterwards (Chastin et al., 2018; Gennuso et al., 2016). Gennuso et al (2016) found that the pattern of sedentary behaviour was more important than total sedentary behaviour for physical function. Another study looking at breaks in sedentary time during a typical day in 217 older adults (70+ years of age) in the community who spend 71.3% of their day sedentary reported improved chair raise, balance, and overall lower body function for those taking more breaks in sitting time. In fact, each additional hour of break in sedentary time was associated with an 0.58 increase in these outcomes (Davis et al., 2014). Collectively these articles suggest that altering the patterns of older adults by incorporating breaks from sitting may be more feasible and impactful than total sedentary time, as well as the opportunity to bring about greater improvements physical function. However, older adults in long-term care may not be able to take breaks on their own as they may need assistance to stand. Although it is not necessarily a natural "break" in sedentary time as, planned interruptions in could be conducted in an attempt to obtain similar results. Therefore, scheduled and timed breaks in extended sitting time may be an approach that could be more attainable for this population.

1.6.3 Sedentary behaviour and mental health

The impacts of sedentary behaviour on quality of life, mental health, cognitive function, chronic conditions and activities of daily living for older adults is a relatively new area of research. As of now, there is preliminary data on outcomes on these outcomes. Figure 1 illustrates the various health factors impacted by sedentary behaviour. According to Copeland et al (2017), these associations are complex to establish because many sitting activities stimulate cognitive abilities. Some longitudinal studies found increased sedentary behaviour to be associated with cognitive decline (Lee et al., 2015), while others found the opposite: that more sedentary time was associated with better cognitive function (Rosenberg et al., 2016; Vance et al., 2016).

In addition, sedentary behaviour was associated with a higher risk of adverse mental health outcomes. Some studies show activities such as watching television were associated with negative mental health outcomes (Kikuchi et al., 2014), while other studies indicated no relationship between weekly television viewing and depression or anxiety (Da Ronch et al., 2015), and others even indicated lower depression symptoms (Gautam, Saito, & Kai, 2007; Rosenberg et al., 2016). However, the research also indicated that even cognitively engaging sedentary activities were associated with higher odds of psychological distress when performed in blocks of three hours or more (Da

Ronch et al., 2015), suggesting that activity duration is important to consider. A recent study by Chu et al., (2018) used a large sample of 2653 Asian adults with a wide age range of 18-79 years. They found higher objectively measured sedentary behaviour was associated with higher odds of psychological distress ($p<.05$). However, self-reported sedentary behaviour was not significantly associated with stress. There was not a significant effect by gender, ethnicity or age observed. This suggest that sitting time may play a role in adverse mental health. Again, more research is required in this area.

1.6.4 Sedentary behaviour and quality of life

Studies indicate that sedentary time is associated with lower quality of life and lower satisfaction with life, as well individuals who sit more than five hours a day have lower social quality of life scores (Meneguci, Sasaki, & da Silva Santos, 2015). In addition, self-reported sitting time was inversely related with health-related quality of life and results suggested that replacing 30-60 minutes of daily sitting time could potentially improve quality of life (Balboa-Castillo, León-Muñoz, Graciani, Rodríguez-Artalejo, & Guallar-Castillón, 2011).

No clear association was reported between sleep and sedentary time (Asaoka, Fukuda, Tsutsui, & Yamazaki, 2007; Fragoso et al., 2014; Rosenberg et al., 2016). To our knowledge, only one study investigated the relationship between self-reported sedentary time and urinary incontinence in older women and found no association (Moreno-Vecino et al., 2015).

As shown in this section, most studies investigating the association between sedentary behaviour and outcomes are based on epidemiological studies where the association is unclear. There is currently debate on the association between sedentary behaviour and health outcomes, and whether this association can be eliminated by exercise since reduced sitting behavior automatically equals more activities at either light, moderate and vigorous intensities.

1.6.5 Interventions to reduce sedentary behaviour in older adults

As reported in a review by Copeland et al (2017), at that time only twelve studies aimed to reduce sedentary time in older adults had been published, and none of these studies were in LTC facilities. Some of the studies were conducted in a controlled setting, while others were conducted in the participants' residences. Participants ranged between the ages of 60 and 80 years and were all generally healthy and ambulatory. Sample sizes varied greatly among studies with the smallest study having 48 participants and the largest having 1377 participants. Nine studies used objective measures via accelerometers and/or inclinometers compared to self-reported measured. Six of the studies used an ActiGraph accelerometer, one used an Actiheart accelerometer and two used an actiPAL3 inclinometer. The study designs varied greatly between trials.

As well, the interventions varied greatly. Some interventions targeted a reduction of specific common sedentary behaviour in an attempt to reduce sedentary time. Common sedentary behaviour that was altered included limiting television viewing (Asaoka et al., 2007) and increasing breaks in sitting (Rosenberg et al., 2015). One study used eight weekly exercise sessions to increase physical activity, and consequently, reduce sedentary time (Chang et al., 2013). The majority of studies used interactive techniques such as consultations with trained professionals, informative booklets and pamphlets, and/or interactive devices (Burke et al., 2013; Rosenberg et al., 2015; Fanning et al., 2016; Fitzsimons et al., 2013a, 2013b; Gardiner, Eakin, Healy, & Owen, 2011; Gibbs et al., 2017; Kallings et al., 2009; Lee & King, 2003; Lewis et al., 2016; Matei et al., 2015), suggesting that assistance from professionals and additional resources may be helpful with this population. All interventions included a follow-up between six days to twelve months after the intervention. Four studies included a control group.

Collectively these articles suggest that there are various methods to reducing sedentary time and that there may be more success with reducing sitting time compared to increasing physical activity. Increasing breaks may also be beneficial (Gardiner et al., 2011; Lewis et al., 2016), studies that achieved a reduction in sitting time, varied from a reduction of 51 min/day (Lewis et al., 2016) to 120 min/day (Kallings et al., 2009). Copeland et al., (2017) suggest that with the lacking literature pertaining to those aged 80 and above, research should move forward to address those living in facilities.

1.6.6 Attendance at programs in LTC

Reports regarding attendance for exercise programs with older adults in LTC have shown somewhat conflicting results, with some showing promising attendance and other results deeming exercise with this population to be not feasible (Brach et al., 2017; Chin A Paw, van Poppel, Twisk, & van Mechelen, 2006; Ellard, Thorogood, Underwood, Seale, & Taylor, 2014; Finnegan, Bruce, Lamb, & Griffiths, 2015; Forster, Lambley, & Young, 2010). Although interventions and programs may be offered, to this population this does not mean that people will attend them.

Finnegan, Bruce, Lamb, and Griffiths (2015) conducted a cohort study in an attempt to find predictors of why or why not older adults in LTC would participate in an exercise study. This study involved 428 older adults with an average age of 88, 326 lived in residential homes, and 102 in nursing homes. They found that in residential homes, attendance was greatly affected by depression, social engagement and socio-economic characteristics; however, none of those factors predicted the attendance in the nursing homes. The data collected suggests that predictors for exercise participation in nursing homes is variable on a case by case basis due to intrapersonal, interpersonal and environmental factors. Attendance rate at the nursing home was 51% while the attendance in the residential homes was 54% (Finnegan et al., 2015). Ellard, Thorogood, Underwood, Seale, and Taylor (2014) suggest that low attendance in nursing home activities can be due to depression, frailty, cognitive decline and lack of staffing. The OPERA study conducted in the UK, aimed to deliver two exercise classes a week in 78 care homes in an attempt to reduce depressive symptoms. They concluded that due to the physical and cognitive abilities of this population, it may be impossible to deliver an effective exercise intervention to help reduce depressive symptoms. The OPERA study had 20% of participants attend 10 classes or less, 36% of participants attend at least one class per week, and 44% of participants attend twice per week (Ellard et al., 2014).

Contrarily, some programs reported high attendance. A systematic review from Forster et al (2010) aimed to determine whether rehabilitation exercise with older adult was effective. They assessed 49 different studies, 17 of which reported attendance, which ranged from 71-97% (Forster et al., 2010). Another exercise programmed in long term care showed attendance rates from 70-76% and suggested that offering exercise more than twice a week is difficult for older adults, but less than one session a week is not enough for functional improvement (Chin A Paw et al., 2006). The study only found improvements in those who attended 75% or more of the classes offered over the 17-week intervention. Moreover, Chin A Paw, et al (2006) suggests that a larger availability of classes could be offered so that residents have more opportunity to attend. With less availability, residents may not see improvements due to lack of exercise exposure. Chin A Paw et al (2006) also noted that is difficult to motivate residents of LTC to exercise, as well as keeping their attention during the class.

High attendance does not always equal best results, as sometimes low attendance can offer significant results if the dosage and demand of the intervention is sufficient. For example, Brach et al (2017) offered “On the Move”, an intervention aiming to improve timing, coordination, strength, endurance and flexibility with nursing home residents. This intervention was offered in comparison to the “usual-care” strength and walking program offered. The “On the Move” program had lower attendance (50.0%) than the usual-care program (65.1%); however, it had greater improvements in gait speed and the 6-minute walk test. Other outcomes between programs showed no significant difference. The “On the Move” program was deemed more effective than the usual-care, despite the lower attendance (Brach et al., 2017).

1.6.7 Motivation

Many of these studies involve changing a habit, but the studies did not consider motivation levels and barriers to reducing sitting time. Lack of motivation is a barrier for engaging in physical activity. A participant in a study by Samra et al., (2018) sums up his lack of motivation by stating: “I used to do six kilometers a day when I worked and you’d think once you retire, you’d have more time but I think motivation is the problem” (Male, 66; pg.11).

For older adults it can often be difficult to find motivation to begin activity when various health conditions are present that affect their ability to participate (Samra et al., 2018; Sandlund et al., 2018). However, older adults acknowledge that staying healthy is a main motivator for engaging in activity (Sandlund et al., 2018). For example, remaining mobile and feeling capable serves as motivating factors for many older adults engaging in movement (Samra et al., 2018). Additionally, older adults state that being diagnosed with a chronic condition serves as a motivator to exercise. As well, visible or noticeable results from exercise were another major motivator for this population. It was noted that fear of injury and vulnerability were barriers for exercise for many older adults (Sandlund et al., 2018). Social interactions, such as being active with others, served as support and a motivator to participate in physical activity (Samra et al., 2018).

In 2014 Chastin, Fitzpatrick, Andrews, and DiCroce conducted a qualitative investigation on the determinants of sedentary behaviour, as well as motivation factors and barriers to reducing sitting time with older adult women. The study asked the women why they sit, the reason they stop sitting to stand up, and a daily strategy they might adapt to help them sit less. Common responses included the environment they were in, a lack of resting places if they were to try walking, a lack of motivation or confidence to be active, and a fear of embarrassment if being caught with shortness of breath (Chastin et al., 2014). The first step should be attempting strategies to encourage less sitting, since motivation to engage in activity, as well as self-confidence, is often increased by improved functional health (Kekäläinen, Kokko, Tammelin, Sipilä, & Walker, 2018).

For now, interventions, especially in the community, have been proposed to reduce sedentary behaviour regardless of one's exercise level. There is a notable gap in the literature in regard to sedentary time and older adults living in LTC (Copeland et al., 2017). It is unknown whether sitting less will improve the quality of life and well-being, mental health, cognitive function, physical function, or sleeping patterns of older adults in LTC. The effectiveness of interventions targeting sedentary time of older adults in the community is outlined in the literature, but there is an absence of literature in regard to interventions for individuals residing in LTC setting. Given the high prevalence of sitting time in LTC, it is important to explore strategies to reduce sitting time.

1.7 Objectives

After reviewing the literature presented in the sections above, the objective of this project was to assess the attendance of the proposed intervention aimed at reducing sitting time in a LTC facility, and exploring the potential functional outcomes. This study was exploratory in nature, so no fixed hypothesis nor sample size were identified.

2.0 References – Introductory Chapter

Åberg, A. C., Frykberg, G. E., & Halvorsen, K. (2010). Medio-lateral stability of sit-to-walk performance in older individuals with and without fear of falling. *Gait & Posture*, *31*(4), 438–443.

Allen, S. M., Foster, A., & Berg, K. (2001). Receiving Help at Home: The Interplay of human and technological assistance. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *56*(6), S374–S382. https://doi.org/10.1093/geronb/56.6.S374

Alley, D. E., & Chang, V. W. (2007). The changing relationship of obesity and disability, 1988-2004. *Journal of the American Medical Association*, *298*(17), 2020–2027. https://doi.org/10.1001/jama.298.17.2020

An, H.-S., Kim, Y., & Lee, J.-M. (2017). Accuracy of inclinometer functions of the activPAL and ActiGraph GT3X+: A focus on physical activity. *Gait & Posture*, *51*(Supplement C), 174–180. https://doi.org/10.1016/j.gaitpost.2016.10.014

Aparicio-Ugarriza, R., Pedrero-Chamizo, R., del Mar Bibiloni, M., Palacios, G., Sureda, A., Meléndez-Ortega, A., González-Gross, M. (2017). A novel physical activity and sedentary behavior classification and its relationship with physical fitness in spanish older adults: The PHYSMED Study. *Journal of Physical Activity & Health*, *14*(10), 815–822.

Asaoka, S., Fukuda, K., Tsutsui, Y., & Yamazaki, K. (2007). Does television viewing cause delayed and/or irregular sleep–wake patterns? *Sleep and Biological Rhythms*, *5*(1), 23–27. https://doi.org/10.1111/j.1479-8425.2006.00253.x

Auais, M., French, S., Alvarado, B., Pirkle, C., Belanger, E., & Guralnik, J. (2017). Fear of falling predicts incidence of functional disability two years later: A perspective from an international cohort study. *The Journals of Gerontology: Series A*. *(73)9, 1212-1215*. https://doi.org/10.1093/gerona/glx237

Balboa-Castillo, T., León-Muñoz, L. M., Graciani, A., Rodríguez-Artalejo, F., & Guallar-Castillón, P. (2011). Longitudinal association of physical activity and sedentary behavior during leisure time with health-related quality of life in community-dwelling older adults. *Health and Quality of Life Outcomes*, *9*(1), 47. https://doi.org/10.1186/1477-7525-9-47

Barreira, T. V., Hamilton, M. T., Craft, L. L., Gapstur, S. M., Siddique, J., & Zderic, T. W. (2016). Intra-individual and inter-individual variability in daily sitting time and MVPA. *Journal of Science and Medicine in Sport*, *19*(6), 476–481. https://doi.org/10.1016/j.jsams.2015.05.004

Bauman, A. E., Chau, J. Y., Ding, D., & Bennie, J. (2013). Too much sitting and cardio-metabolic risk: an update of epidemiological evidence. *Current Cardiovascular Risk Reports*, *7*(4), 293–298. https://doi.org/10.1007/s12170-013-0316-y

Bey, L., & Hamilton, M. T. (2003). Suppression of skeletal muscle lipoprotein lipase activity during physical inactivity: a molecular reason to maintain daily low-intensity activity. *The Journal of Physiology*, *551*(2), 673–682. https://doi.org/10.1113/jphysiol.2003.045591

Bouchard, D. R., Dionne, I. J., Payette, H., & Brochu, M. (2009). Is there a BMI threshold value associated with a lower physical capacity in well-functioning older adults? the Quebec longitudinal study. *The Open Obesity Journal*, *1*(1), 15–22. https://doi.org/10.2174/1876823700901010015

Brach, J. S., Perera, S., Gilmore, S., VanSwearingen, J. M., Brodine, D., Nadkarni, N. K., & Ricci, E. (2017). Effectiveness of a timing and coordination group exercise program to improve mobility in community-dwelling older adults: a randomized clinical trial. *Journal of the American Medical Association Internal Medicine*, *177*(10), 1437–1444. https://doi.org/10.1001/jamainternmed.2017.3609

Brennan, S. L., Cicuttini, F. M., Pasco, J. A., Henry, M. J., Wang, Y., Kotowicz, M. A., Wluka, A. E. (2010). Does an increase in body mass index over 10 years affect knee structure in a population-based cohort study of adult women? *Arthritis Research & Therapy*, *12*(4), R139. https://doi.org/10.1186/ar3078

Burke, L., Lee, A. H., Jancey, J., Xiang, L., Kerr, D. A., Howat, P. A., Anderson, A. S. (2013). Physical activity and nutrition behavioural outcomes of a home-based intervention program for seniors: a randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 14. https://doi.org/10.1186/1479-5868-10-14

Canadian Healthcare Association. (2009*). Home Care in Canada: From the Margins to the Mainstream*. Retrieved from http://www.healthcarecan.ca/wp-content/themes/camyno/assets/document/PolicyDocs/2009/External/EN/HomeCareCanada_MarginsMainstream_EN.pdf

Canadian Institute for Health Information. (2018). *National health expenditure trends.* Retrieved February 1, 2018, from https://www.cihi.ca/en/national-health-expenditure-trends

Canadian Institute for Health Information. (2015, August 18). Residential Long-Term Care Financial Data Tables. Retrieved April 18, 2019, from https://www.cihi.ca/en/search?query-all=long term care&Search Submit=

Canadian Life and Health Insurance Association. (2014). Report on Long-term Care Policy. Retrieved April 5, 2019, from http://clhia.uberflip.com/i/354914-clhia-report-on-long-term-care-policy/0

Carlfjord, S., Andersson, A., Bendtsen, P., Nilsen, P., & Lindberg, M. (2012). Applying the RE-AIM framework to evaluate two implementation strategies used to introduce a tool for lifestyle intervention in Swedish primary health care. *Health Promotion International*, *27*(2), 167–176. https://doi.org/10.1093/heapro/dar016

Cesari, M., Vellas, B., Hsu, F.-C., Newman, A. B., Doss, H., King, A. C., LIFE Study Group. (2015). A physical activity intervention to treat the frailty syndrome in older persons-results from the LIFE-P study. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *70*(2), 216–222. https://doi.org/10.1093/gerona/glu099

Chan, C. S., Slaughter, S. E., Jones, C. A., Ickert, C., & Wagg, A. S. (2017). Measuring activity performance of older adults using the ActivPAL: A Rapid Review. *Healthcare*, *5*(4). https://doi.org/10.3390/healthcare5040094

Chang, A. K., Fritschi, C., & Kim, M. J. (2013). Sedentary behavior, physical activity, and psychological health of korean older adults with hypertension: effect of an empowerment intervention. *Research in Gerontological Nursing*, *6*(2), 81–88. https://doi.org/10.3928/19404921-20121219-01

Chaput, J.-P., Klingenberg, L., Astrup, A., & Sjödin, A. M. (2011). Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obesity Reviews*, *12*(5),12–20. https://doi.org/10.1111/j.1467-789X.2010.00772.x

Chastin, S. F. M., Dontje, M. L., Skelton, D. A., Čukić, I., Shaw, R. J., Gill, J. M. R., Dall, P. M. (2018). Systematic comparative validation of self-report measures of sedentary time against an objective measure of postural sitting (activPAL). *The International Journal of Behavioral Nutrition and Physical Activity*, (*15)*21. https://doi.org/10.1186/s12966-018-0652-x

Chastin, Sebastien F. M., Fitzpatrick, N., Andrews, M., & DiCroce, N. (2014). Determinants of sedentary behavior, motivation, barriers and strategies to reduce sitting time in older women: a qualitative investigation. *International Journal of Environmental Research and Public Health*, *11*(1), 773–791. https://doi.org/10.3390/ijerph110100773

Chin A Paw, M. J. M., van Poppel, M. N. M., Twisk, J. W. R., & van Mechelen, W. (2006). Once a week not enough, twice a week not feasible?: A randomised controlled exercise trial in long-term care facilities [ISRCTN87177281]. *Patient Education and Counseling*, *63*(1), 205–214. https://doi.org/10.1016/j.pec.2005.10.008

Chu, A. H. Y., van Dam, R. M., Biddle, S. J. H., Tan, C. S., Koh, D., & Müller-Riemenschneider, F. (2018). Self-reported domain-specific and accelerometer-based physical activity and sedentary behaviour in relation to psychological distress among an urban Asian population. *International Journal of Behavioral Nutrition and Physical Activity*, 15(36). https://doi.org/10.1186/s12966-018-0669-1

Clarke, P., Chan, P., Santaguida, P. L., & Colantonio, A. (2009). The use of mobility devices among institutionalized older adults. *Journal of Aging and Health*, *21*(4), 611–626. https://doi.org/10.1177/0898264309333313

Cleland, C., Ferguson, S., Ellis, G., & Hunter, R. F. (2018). Validity of the International Physical Activity Questionnaire (IPAQ) for assessing moderate-to-vigorous physical activity and sedentary behaviour of older adults in the United Kingdom. *BMC Medical Research Methodology*, *18*(1). https://doi.org/10.1186/s12874-018-0642-3

Cooper, A. J. M., Simmons, R. K., Kuh, D., Brage, S., & Cooper, R. (2015). Physical activity, sedentary time and physical capability in early old age: British birth cohort study. *PLoS ONE*, *10*(5). https://doi.org/10.1371/journal.pone.0126465

Copeland, J. L., Ashe, M. C., Biddle, S. J., Brown, W. J., Buman, M. P., Chastin, S., Dogra, S. (2017). Sedentary time in older adults: a critical review of measurement, associations with health, and interventions. *British Journal of Sports Medicine*, *51*(21), 1539–1539. https://doi.org/10.1136/bjsports-2016-097210

Da Ronch, C., Canuto, A., Volkert, J., Massarenti, S., Weber, K., Dehoust, M. C., Grassi, L. (2015). Association of television viewing with mental health and mild cognitive impairment in the elderly in three European countries, data from the MentDis_ICF65+ project. *Mental Health and Physical Activity*, *8*(1), 8–14. https://doi.org/10.1016/j.mhpa.2014.11.002

Davis, M., Fox, K., Stathi, A., Trayers, T., Thompson, J., & Cooper, A. (2014). Objectively measured sedentary time and its association with physical function in Older Adults. *Journal of Aging and Physical Activity*. *22*(4), 474-481Retrieved December 31, 2017, from http://journals.humankinetics.com.proxy.hil.unb.ca/doi/10.1123/JAPA.2013-0042 de Jong Gierveld, J., Keating, N., & Fast, J. E. (2015). Determinants of loneliness among older adults in Canada. *Canadian Journal on Aging; Toronto*, *34*(2), 125–136. http://dx.doi.org/10.1017/S0714980815000070

Diaz, K. M., Howard, V. J., Hutto, B., Colabianchi, N., Vena, J. E., Safford, M. M., Hooker, S. P. (2017). Patterns of sedentary behavior and mortality in U.S. middle-aged and older adults: a national cohort study. *Annals of Internal Medicine*, *167*(7), 465. https://doi.org/10.7326/M17-0212

Dollman, J., Okely, A. D., Hardy, L., Timperio, A., Salmon, J., & Hills, A. P. (2009). A hitchhiker’s guide to assessing young people’s physical activity: deciding what method to use. *Journal of Science and Medicine in Sport*, *12*(5), 518–525. https://doi.org/10.1016/j.jsams.2008.09.007

Dori E. Rosenberg, Nancy M. Gell, Salene M. W. Jones, Anne Renz, Jacqueline Kerr, Paul A. Gardiner, & David Arterburn. (2015). The feasibility of reducing sitting time in overweight and obese older adults. *Health Education & Behavior*, *42*(5), 669–676. https://doi.org/10.1177/1090198115577378

Downs, A., Van Hoomissen, J., Lafrenz, A., & Julka, D. L. (2014). Accelerometer-measured versus self-reported physical activity in college students: implications for research and practice. *Journal of American College Health*, *62*(3), 204–212. https://doi.org/10.1080/07448481.2013.877018

Dunlop, D. D., Song, J., Arntson, E. K., Semanik, P. A., Lee, J., Chang, R. W., & Hootman, J. M. (2015). Sedentary time in US older adults associated with disability in activities of daily living independent of physical activity. *Journal of Physical Activity and Health*, *12*(1), 93–101. https://doi.org/10.1123/jpah.2013-0311

Edwardson, C. L., Winkler, E. A. H., Bodicoat, D. H., Yates, T., Davies, M. J., Dunstan, D. W., & Healy, G. N. (2017). Considerations when using the activPAL monitor in field-based research with adult populations. *Journal of Sport and Health Science*, *6*(2), 162–178. https://doi.org/10.1016/j.jshs.2016.02.002

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., Lancet Sedentary Behaviour Working Group. (2016). Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet (London, England)*, *388*(10051), 1302–1310. https://doi.org/10.1016/S0140-6736(16)30370-1

Ellard, D. R., Thorogood, M., Underwood, M., Seale, C., & Taylor, S. J. (2014). Whole home exercise intervention for depression in older care home residents (the OPERA study): a process evaluation. *BMC Medicine*, *12*(1), 1. https://doi.org/10.1186/1741-7015-12-1

Ensrud Kristine E., Blackwell Terri L., Cauley Jane A., Dam Thuy Tien L., Cawthon Peggy M., Schousboe John T., (2014). Objective measures of activity level and mortality in older men. *Journal of the American Geriatrics Society*, *62*(11), 2079–2087. https://doi.org/10.1111/jgs.13101

Fanning, J., Porter, G., Awick, E. A., Wójcicki, T. R., Gothe, N. P., Roberts, S. A., McAuley, E. (2016). Effects of a DVD-delivered exercise program on patterns of sedentary behavior in older adults: a randomized controlled trial. *Preventive Medicine Reports*, *3*(1), 238–243. https://doi.org/10.1016/j.pmedr.2016.03.005

Finnegan, S., Bruce, J., Lamb, S. E., & Griffiths, F. (2015). Predictors of attendance to group exercise: a cohort study of older adults in long-term care facilities. *BMC Geriatrics*, *15*(1), 37. https://doi.org/10.1186/s12877-015-0043-y

Fitzsimons, C. F., Kirk, A., Baker, G., Michie, F., Kane, C., & Mutrie, N. (2013). Using an individualised consultation and activPAL™ feedback to reduce sedentary time in older Scottish adults: results of a feasibility and pilot study. *Preventive Medicine*, *57*(5), 718–720. https://doi.org/10.1016/j.ypmed.2013.07.017

Flacker, J. M. (2003). What is a geriatric syndrome anyway? *Journal of the American Geriatrics Society*, *51*(4), 574–576. https://doi.org/10.1046/j.1532-5415.2003.51174.x

Fleig, L., McAllister, M. M., Brasher, P., Cook, W. L., Guy, P., Puyat, J. H., Ashe, M. C. (2016). Sedentary behavior and physical activity patterns in older adults after hip fracture: a call to action. *Journal of Aging and Physical Activity*, *24*(1), 79–84. https://doi.org/10.1123/japa.2015-0013

Forster, A., Lambley, R., & Young, J. B. (2010). Is physical rehabilitation for older people in long-term care effective? Findings from a systematic review. *Age and Ageing*, *39*(2), 169–175. https://doi.org/10.1093/ageing/afp247

Fox, K. R., Ku, P.-W., Hillsdon, M., Davis, M. G., Simmonds, B. A. J., Thompson, J. L., Coulson, J. C. (2015). Objectively assessed physical activity and lower limb function and prospective associations with mortality and newly diagnosed disease in UK older adults: an OPAL four-year follow-up study. *Age and Ageing*, *44*(2), 261–268. https://doi.org/10.1093/ageing/afu168

Fragoso, C. A. V., Miller, M. E., Fielding, R. A., King, A. C., Kritchevsky, S. B., McDermott, M. M., Gill, T. M. (2014). Sleep–wake disturbances in sedentary community-dwelling elderly adults with functional limitations. *Journal of the American Geriatrics Society*, *62*(6), 1064–1072. https://doi.org/10.1111/jgs.12845

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., McBurnie, M. A. (2001). Frailty in older adults evidence for a phenotype. *The Journals of Gerontology: Series A*, *56*(3), M146–M157. https://doi.org/10.1093/gerona/56.3.M146

Gardiner, P. A., Eakin, E. G., Healy, G. N., & Owen, N. (2011). Feasibility of reducing older adults' sedentary time. *American Journal of Preventive Medicine*, *41*(2), 174–177. https://doi.org/10.1016/j.amepre.2011.03.020

Gautam, R., Saito, T., & Kai, I. (2007). Leisure and religious activity participation and mental health: gender analysis of older adults in Nepal. *BMC Public Health*, *7*(299). https://doi.org/10.1186/1471-2458-7-299

Gennuso, K. P., Thraen-Borowski, K. M., Gangnon, R. E., & Colbert, L. H. (2016). Patterns of sedentary behavior and physical function in older adults. *Aging Clinical and Experimental Research*, *28*(5), 943–950. https://doi.org/10.1007/s40520-015-0386-4

Gibbs, B. B., Brach, J. S., Byard, T., Creasy, S., Davis, K. K., McCoy, S., Jakicic, J. M. (2017). Reducing sedentary behavior versus increasing moderate-to-vigorous intensity physical activity in older adults: a 12-week randomized, clinical trial. *Journal of Aging and Health*, *29*(2), 247–267. https://doi.org/10.1177/0898264316635564

Gill, E. A., & Morgan, M. (2011). Home sweet home: conceptualizing and coping with the challenges of aging and the move to a care facility. *Health Communication*, *26*(4), 332–342. https://doi.org/10.1080/10410236.2010.551579

Gill, J. M. R., Hawari, N. S. A., Maxwell, D. J., Louden, D., Mourselas, N., Bunn, C., Mutrie, N. (2018). Validation of a novel device to measure and provide feedback on sedentary behavior. *Medicine and Science in Sports and Exercise*, *50*(3), 525–532. https://doi.org/10.1249/MSS.0000000000001458

Gorman, E., Hanson, H. M., Yang, P. H., Khan, K. M., Liu-Ambrose, T., & Ashe, M. C. (2014). Accelerometry analysis of physical activity and sedentary behavior in older adults: a systematic review and data analysis. *European Review of Aging and Physical Activity: Official Journal of the European Group for Research into Elderly and Physical Activity*, *11*(1), 35–49. https://doi.org/10.1007/s11556-013-0132-x

Government of Canada. (2018). Transitions to long-term and residential care among older Canadians. Retrieved April 17, 2019, from https://www150.statcan.gc.ca /n1/pub/82-003-x/2018005/article/54966-eng.htm

Government of Canada. (2017). Budget 2017: Details of economic and fiscal projections. Retrieved April 2, 2019, from https://www.budget.gc.ca /2017/docs/plan/anx-01-en.html#Toc477707546

Government of Canada. (2007). A portrait of seniors in Canada. Retrieved March 7, 2018, from http://www5.statcan.gc.ca/olc-cel/olc.action?objId=89-519-X&objType=2&lang=en&limit=0

Government of Canada. (2013). Ninety years of change in life expectancy. Retrieved March 4, 2018, from https://www.statcan.gc.ca/pub/82-624-x/2014001/article/14009-eng.htm

Government of Canada. (2015). Infographic: population estimates, Canada, 2015. Retrieved February 2, 2018, from http://www.statcan.gc.ca/pub/11-627-m/11-627-m2015003-eng.htm

Government of Canada. (2016). Census in brief: A portrait of the population aged 85 and older in 2016 in Canada, Census year 2016. Retrieved February 2, 2018, from http://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016004/98-200-x2016004-eng.cfm

Government of Canada. (2017). Healthy aging indicators, by age group and sex, household population aged 45 and over. Retrieved February 3, 2018, from http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1051200

Government of Canada. (2017). Census profile. Retrieved March 7, 2018, from http://www5.statcan.gc.ca/olc-cel/olc.action?ObjId=98-316-X2016001&ObjType=46&lang=en&limit=0

Government of Canada. (2018). Consumer price index, health and personal care, by province (Canada). Retrieved March 3, 2018, from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ161a-eng.htm

Government of Canada. (2019, January 04). Nursing Home Services. Retrieved March 27, 2019, from https://www2.gnb.ca/content/gnb/en/services/services_renderer.9615.Nursing_Home_Services.html

Grant, P. M., Dall, P. M., Mitchell, S. L., & Granat, M. H. (2008). Activity-monitor accuracy in measuring step number and cadence in community-dwelling older adults. *Journal of Aging and Physical Activity*, *16*(2), 201–214. https://doi.org/10.1123/japa.16.2.201

Guralnik, J. M., Ferrucci, L., Pieper, C. F., Leveille, S. G., Markides, K. S., Ostir, G. V., Wallace, R. B. (2000). Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *The Journals of Gerontology: Series A*, *55*(4), M221–M231. https://doi.org/10.1093/gerona/55.4.M221

Hamburg Naomi M., McMackin Craig J., Huang Alex L., Shenouda Sherene M., Widlansky Michael E., Schulz Eberhard, Vita Joseph A. (2007). Physical inactivity rapidly induces insulin resistance and microvascular dysfunction in healthy volunteers. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *27*(12), 2650–2656. https://doi.org/10.1161/ATVBAHA.107.153288

Harvey, J. A., Chastin, S. F. M., & Skelton, D. A. (2015). How sedentary are older people? A systematic review of the amount of sedentary behavior. *Journal of Aging & Physical Activity*, *23*(3), 471–487.

Hildebrand, J. S., Gapstur, S. M., Gaudet, M. M., Campbell, P. T., & Patel, A. V. (2015). Moderate-to-vigorous physical activity and leisure-time sitting in relation to ovarian cancer risk in a large prospective US cohort. *Cancer Causes & Control; Dordrecht*, *26*(11), 1691–1697. http://dx.doi.org.proxy.hil.unb.ca/10.1007/s10552-015-0656-7

Jefferis, B. J., Merom, D., Sartini, C., Wannamethee, S. G., Ash, S., Lennon, L. T., Whincup, P. H. (2015). Physical activity and falls in older men: the critical role of mobility limitations. *Medicine & Science in Sports & Exercise*, *47*(10), 2119–2128. https://doi.org/10.1249/MSS.0000000000000635

Jing Song, Lindquist, L. A., Chang, R. W., Semanik, P. A., Ehrlich-Jones, L. S., Jungwha Lee, Dunlop, D. D. (2015). Sedentary behavior as a risk factor for physical frailty independent of moderate activity: results from the osteoarthritis initiative. *American Journal of Public Health*, *105*(7), 1439–1445.

Kallings, L. V., Johnson, J. S., Fisher, R. M., Faire, U. de, Ståhle, A., Hemmingsson, E., & Hellénius, M.-L. (2009). Beneficial effects of individualized physical activity on prescription on body composition and cardiometabolic risk factors: results from a randomized controlled trial. *European Journal of Cardiovascular Prevention & Rehabilitation*, *16*(1), 80–84. https://doi.org/10.1097/HJR.0b013e32831e953a

Katzmarzyk, P. T., Church, T. S., Craig, C. L., & Bouchard, C. (2009). Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Medicine and Science in Sports and Exercise*, *41*(5), 998–1005. https://doi.org/10.1249/MSS.0b013e3181930355

Keevil, V. L., Cooper, A. J. M., Wijndaele, K., Luben, R., Wareham, N. J., Brage, S., & Khaw, K.-T. (2016). Objective sedentary time, moderate-to-vigorous physical activity, and physical capability in a British cohort: *Medicine & Science in Sports & Exercise*, *48*(3), 421–429. https://doi.org/10.1249/MSS.0000000000000785

Kekäläinen, T., Kokko, K., Tammelin, T., Sipilä, S., & Walker, S. (2018). Motivational characteristics and resistance training in older adults: A randomized controlled trial and 1-year follow-up. *Scandinavian Journal of Medicine & Science in Sports*, *28*(11), 2416–2426. https://doi.org/10.1111/sms.13236

Kikuchi, H., Inoue, S., Sugiyama, T., Owen, N., Oka, K., Nakaya, T., & Shimomitsu, T. (2014). Distinct associations of different sedentary behaviors with health-related attributes among older adults. *Preventive Medicine*, *67*(1), 335–339. https://doi.org/10.1016/j.ypmed.2014.08.011

Kim, H.-J., Min, J.-Y., & Min, K.-B. (2019). Successful aging and mortality risk: the korean longitudinal study of aging (2006-2014). *Journal of the American Medical Directors Association*. February Ahead of Print doi: https://doi.org/10.1016/j.jamda.2018.12.010

LeBlanc, A. G., Berry, T., Deshpande, S., Duggan, M., Faulkner, G., Latimer-Cheung, A. E., Tremblay, M. S. (2015). Knowledge and awareness of Canadian physical activity and sedentary behaviour guidelines: a synthesis of existing evidence. *Applied Physiology, Nutrition & Metabolism*, *40*(7), 716–724. https://doi.org/10.1139/apnm-2014-0464

Lee, A., Sénéchal, M., Hrubeniuk, T., & Bouchard, D. R. (2019). Is sitting time leading to mobility decline in long-term care residents? *Aging Clinical and Experimental Research.* February Ahead of Print doi: 10.1007/s40520-019-01148-z.

Lee, R. E., & King, A. C. (2003). Discretionary time among older adults: how do physical activity promotion interventions affect sedentary and active behaviors? *Annals of Behavioral Medicine*, *25*(2), 112–119. https://doi.org/10.1207/S15324796ABM2502_07

Lee, Y., Kim, J., Han, E. S., Chae, S., Ryu, M., Ahn, K. H., & Park, E. J. (2015). Changes in physical activity and cognitive decline in older adults living in the community. *Age*, *37*(2). https://doi.org/10.1007/s11357-015-9759-z

Lewis, L. K., Rowlands, A. V., Gardiner, P. A., Standage, M., English, C., & Olds, T. (2016). Small Steps: preliminary effectiveness and feasibility of an incremental goal-setting intervention to reduce sitting time in older adults. *Maturitas*, *85*(1), 64–70. https://doi.org/10.1016/j.maturitas.2015.12.014

Mañas, A., Pozo-Cruz, B. del, Guadalupe-Grau, A., Marín-Puyalto, J., Alfaro-Acha, A., Rodríguez-Mañas, L., Ara, I. (2018). Reallocating accelerometer-assessed sedentary time to light or moderate- to vigorous-intensity physical activity reduces frailty levels in older adults: an isotemporal substitution approach in the TSHA study. *Journal of the American Medical Directors Association*, *19*(2), 185.e1-185.e6. https://doi.org/10.1016/j.jamda.2017.11.003

Masi, C. M., Chen, H.-Y., Hawkley, L. C., & Cacioppo, J. T. (2011). A meta-analysis of interventions to reduce loneliness. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*, *15*(3) 219–266. https://doi.org/10.1177/1088868310377394

Matei, R., Thuné-Boyle, I., Hamer, M., Iliffe, S., Fox, K. R., Jefferis, B. J., & Gardner, B. (2015). Acceptability of a theory-based sedentary behaviour reduction intervention for older adults ('On Your Feet to Earn Your Seat'). *BMC Public Health*, *15*(1), 606. https://doi.org/10.1186/s12889-015-1921-0

Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., & Troiano, R. P. (2008). Amount of time spent in sedentary behaviors in the United States, 2003–2004. *American Journal of Epidemiology*, *167*(7), 875–881. https://doi.org/10.1093/aje/kwm390

McCloskey, R., Jarrett, P., Stewart, C., & Nicholson, P. (2014). Alternate level of care patients in hospitals: what does dementia have to do with this? *Canadian Geriatrics Journal*, *17*(3), 88–94. https://doi.org/10.5770/cgj.17.106

McGrath, R., Vella, C. A., Scruggs, P. W., Peterson, M. D., Williams, C. J., & Paul, D. R. (2017). The impact of low accelerometer wear time on the estimates and application of sedentary behavior and physical activity data in adults. *Journal of Physical Activity and Health*, *14*(12), 919–924. https://doi.org/10.1123/jpah.2016-0584

Meneguci, Sasaki, & da Silva Santos. (2015). Socio-demographic, clinical and health behavior correlates of sitting time in older adults. *BMC Public Health.15*(65). 1-10. Retrieved April 5, 2019, from https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-1426-x

Middleton, L. E., Ventura, M. I., Santos-Modesitt, W., Poelke, G., Yaffe, K., & Barnes, D. E. (2017). The Mental Activity and eXercise (MAX) trial: Effects on physical function and quality of life among older adults with cognitive complaints. *Contemporary Clinical Trials,64*(1), 161-166. https://doi.org/10.1016/j.cct.2017.10.009

Milte, R., & Crotty, M. (2014). Musculoskeletal health, frailty and functional decline. *Best Practice & Research Clinical Rheumatology*, *28*(3), 395–410. https://doi.org/10.1016/j.berh.2014.07.005

Moreno-Vecino, B., Arija-Blázquez, A., Pedrero-Chamizo, R., Alcázar, J., Gómez-Cabello, A., Pérez-López, F. R., Ara, I. (2015). Associations between obesity, physical fitness, and urinary incontinence in non-institutionalized postmenopausal women: The elderly EXERNET multi-center study. *Maturitas*, *82*(2), 208–214. https://doi.org/10.1016/j.maturitas.2015.07.008

Op het Veld, L. P. M., van Rossum, E., Kempen, G. I. J. M., de Vet, H. C. W., Hajema, K., & Beurskens, A. J. H. M. (2015). Fried phenotype of frailty: cross-sectional comparison of three frailty stages on various health domains. *BMC Geriatrics*, *15*(77). https://doi.org/10.1186/s12877-015-0078-0

Pate, R. R., O'Neill, J. R., & Lobelo, F. (2008). The evolving definition of "sedentary." *Exercise and Sport Sciences Reviews*, *36*(4), 173. https://doi.org/10.1097/JES.0b013e3181877d1a

Paterson, D. H., & Warburton, D. E. (2010). Physical activity and functional limitations in older adults: a systematic review related to Canada's physical activity guidelines. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(38). https://doi.org/10.1186/1479-5868-7-38

Pedišić, Ž., & Bauman, A. (2015). Accelerometer-based measures in physical activity surveillance: current practices and issues. *British Journal of Sports Medicine*, *49*(4), 219–223. https://doi.org/10.1136/bjsports-2013-093407

Pfister, T., Matthews, C. E., Wang, Q., Kopciuk, K. A., Courneya, K., & Friedenreich, C. (2017). Comparison of two accelerometers for measuring physical activity and sedentary behaviour. *British Medical Journal Open Sport & Exercise Medicine*, *3*(1). https://doi.org/10.1136/bmjsem-2017-000227

Public Legal Education and Information Service of New Brunswick. (2016). Going to a Nursing Home. Retrieved February 20, 2019, from http://www.legal-info-legale.nb.ca/en/index.php?page=going_to_a_nursing_home

Prince, S. A., LeBlanc, A. G., Colley, R. C., & Saunders, T. J. (2017). Measurement of sedentary behaviour in population health surveys: a review and recommendations. *Peer-reviewed journal*, *5*(1). https://doi.org/10.7717/peerj.4130

Ramage-Morin, P. L. (2008). Chronic pain in Canadian seniors. *Health Reports*, *19*(1), 37–52.

Reid, K. F., & Fielding, R. A. (2012). Skeletal muscle power: a critical determinant of physical functioning in older adults. *Exercise and Sport Sciences Reviews*, *40*(1), 4–12. https://doi.org/10.1097/JES.0b013e31823b5f13

Rist, P. M., Nguyen, T. T., Whitmer, R. A., & Glymour, M. M. (2016). Modifiable risk factors for nursing home admission among individuals with high and low dementia risk. *Archives of Gerontology and Geriatrics*, *65*(1), 140–145. https://doi.org/10.1016/j.archger.2016.03.016

Rockwood, K., & Mitnitski, A. (2007). Frailty in relation to the accumulation of deficits. *The Journals of Gerontology: Series A*, *62*(7), 722–727. https://doi.org/10.1093/gerona/62.7.722

Rosenberg, D. E., Bellettiere, J., Gardiner, P. A., Villarreal, V. N., Crist, K., & Kerr, J. (2016). Independent associations between sedentary behaviors and mental, cognitive, physical, and functional health among older adults in retirement communities. *The Journals of Gerontology: Series A*, *71*(1), 78–83. https://doi.org/10.1093/gerona/glv103

Salmon, J., Owen, N., Crawford, D., Bauman, A., & Sallis, J. F. (2003). Physical activity and sedentary behavior: a population-based study of barriers, enjoyment, and preference. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, *22*(2), 178–188.

Samra, P. K., Parkinson, L., van Uffelen, J. G., Schoeppe, S., Power, D., Schneiders, A., Alley, S. J. (2018). Physical activity attitudes, preferences, and experiences of regionally-based Australia adults 65+ years. *Journal of Aging and Physical Activity*, 1–21. Ahead of print doi: https://doi.org/10.1123/japa.2017-0426

Sandlund, M., Pohl, P., Ahlgren, C., Skelton, D. A., Melander-Wikman, A., Bergvall-Kåreborn, B., & Lundin-Olsson, L. (2018). Gender perspective on older people's exercise preferences and motivators in the context of falls prevention: a qualitative study. *BioMed Research International*, *2018*(1), 1–11. https://doi.org/10.1155/2018/6865156

Saunders, T. (2012, June 12). Sedentary Physiology Part 4 – How Does Sitting Increase Health Risk? Retrieved December 14, 2018, from https://blogs.plos.org/obesitypanacea/2010/12/09/sedentary-physiology-part-4-how-does-sitting-increase-health-risk

Schneider, P. L., Crouter, S. E., & Bassett, D. R. (2004). Pedometer measures of free-living physical activity: comparison of 13 models: *Medicine & Science in Sports & Exercise*, *36*(2), 331–335. https://doi.org/10.1249/01.MSS.0000113486.60548.E9

Seguin, R., LaMonte, M., Tinker, L., Liu, J., Woods, N., Michael, Y. L., LaCroix, A. Z. (2012). Sedentary behavior and physical function decline in older women: findings from the women's health initiative. *Journal of Aging Research*, *2012*(1). https://doi.org/10.1155/2012/271589

Studenski, S., Perera, S., Wallace, D., Chandler, J. M., Duncan, P. W., Rooney, E., Guralnik, J. M. (2003). Physical performance measures in the clinical setting. *Journal of the American Geriatrics Society*, *51*(3), 314–322.

van der Ploeg, H. P., & Hillsdon, M. (2017). Is sedentary behaviour just physical inactivity by another name? *International Journal of Behavioral Nutrition and Physical Activity*, *14*(142). https://doi.org/10.1186/s12966-017-0601-0

Vance, D. E., Marson, D. C., Triebel, K. L., Ball, K., Wadley, V. G., & Humphrey, S. C. (2016). Physical activity and cognitive function in older adults: the mediating effect of depressive symptoms. *The Journal of Neuroscience Nursing: Journal of the American Association of Neuroscience Nurses*, *48*(4), 2–12. https://doi.org/10.1097/JNN.0000000000000197

Verghese, J., Holtzer, R., Lipton, R. B., & Wang, C. (2009). Quantitative gait markers and incident fall risk in older adults. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *64A* (8), 896–901. https://doi.org/10.1093/gerona/glp033

World Health Organization. (2014, November 06). "Ageing well" must be a global priority. Retrieved from http://www.who.int/mediacentre/news/releases/2014/ lancet-ageing-series/en/

World Health Organization. (2016, October 20). Proposed working definition of an older person in Africa for the MDS Project. Retrieved March 19, 2018, from http://www.who.int/healthinfo/survey/ageingdefnolder/en/

Wu, F., Wills, K., Laslett, L. L., Oldenburg, B., Jones, G., & Winzenberg, T. (2017). Moderate-to-vigorous physical activity but not sedentary time is associated with musculoskeletal health outcomes in a cohort of Australian middle-aged women.

Journal of Bone and Mineral Research: The Official Journal of the American Society for Bone and Mineral Research, *32*(4), 708–715. https://doi.org/10.1002/jbmr.3028

Zhou, Y., Wang, X., An, Y., Zhang, X., Han, S., Li, X., Li, Z. (2018). Disability and health-related quality of life in Chinese patients with rheumatoid arthritis: A cross-sectional study. *International Journal of Rheumatic Diseases*, *21*(9), 1709–1715. https://doi.org/10.1111/1756-185X.13345

3.0 Article

EXPLORING THE ATTENDANCE AND POTENTIAL BENEFITS OF REDUCING SITTING TIME FOR RESIDENTS IN A CANADIAN LONG-TERM CARE SETTING: A PILOT STUDY

Lee AM[1,2] BSc., Sénéchal M[1,2] PhD, Read EA[3] PhD, Bouchard DR[1,2] PhD

[1]Cardiometabolic Exercise & Lifestyle Laboratory, [2]Faculty of Kinesiology, University of New Brunswick, Fredericton NB, [3]Faculty of Nursing, University of New Brunswick, Fredericton NB,

TO BE SUBMITTED at The Canadian Journal on Aging

Danielle Bouchard, Ph.D.

90 Mackay Drive

Faculty of Kinesiology

University of New Brunswick

Fredericton, New Brunswick

E3B 4J9

dboucha1@unb.ca

Acknowledgements

Local long-term care center participated in the study as well as their staff and residents.

Author Contributions

Lee A[1,2]: Acquisition of subjects, data collection, interpretation of data, and preparation of manuscript.

3.1 Abstract

This study aimed to assess the attendance of the proposed intervention aimed at reducing sitting time in a long-term care facility and exploring the potential functional benefits. The intervention consisted of a team visiting long term care residents to promote standing for 10-minute sessions, three times per day (morning, afternoon and evening), four days per week (Monday-Wednesday-Friday and Sunday) over 10 weeks. The main outcome was attendance. Functional outcomes included walking speed, leg power, and leg strength. Participants (N=24) attended an average of 4 sessions per week and averaged 45 minutes of standing weekly. Attendance was highest during the morning session ($p=0.02$) and weekdays ($p<0.01$). There was a significant improvement in the 30-second chair stand test ($p <0.05$) despite that total sedentary time was increased. Attendance was lower than expected but could be improved with the feedback that was collected.

Key words: Aging, Older adults, Long-Term Care, Sedentary, Standing, Attendance

Abstract

Cette étude visait à évaluer la présence à l'intervention proposée visant à réduire le temps assis dans un établissement de soins de longue durée et à explorer les avantages fonctionnels. L'intervention consistait à se lever (avec aide si besoin) 10 minutes par session, trois fois par jour (matin, après-midi et soir), quatre jours par semaine (lundi-mercredi-vendredi et dimanche) pendant 10 semaines. Les participants (N=24) ont assisté en moyenne à quatre séances par semaine et à une moyenne de 45 minutes par semaine. La présence était plus élevée pendant la séance du matin ($p=0.02$) et les jours de semaine ($p<0.01$). Il y a eu une amélioration significative de la puissance des jambes ($p <0.05$) mais le temps sédentaire total n'a pas diminué. En conclusion, le nombre limité de temps debout durant l'intervention pourrait améliorer la santé fonctionnelle des gens habitant un établissement de soins de longue durée.

Mots clés : Soins de longue durée, sédentarité, puissance, endurance

3.2 Introduction

As the Canadian population continues to age, an increasing proportion is set to face the many physical, psychological, and social challenges associated with the aging process. Many policy makers and aging adults are in favour of maintaining independence, autonomy, and the ability to live independently for as long as possible. Unfortunately, this is not possible for the 2.6% of Canadians who already live in some form of long-term care (LTC) facility in Canada (Government of Canada, 2018). Residents in LTC typically experience a rapid decline in all spheres of health, including physical function and overall mobility, often leading to a loss of independence (DiPietro, 2001). Many potential explanations for these declines exist, but one potential explanation is excessive amount of sedentary behaviour. Sedentary Behaviour composes a large proportion of their daily lives and is defined as a prolonged bout of time spent in a sitting or reclined posture (Jing Song et al., 2015; Pate, O'Neill, & Lobelo, 2008).

Aging adults who live in the community spend approximately 80% of their waking time sedentary (Harvey, Chastin, & Skelton, 2015). Spending such a large amount of time sedentary is concerning, as sedentary pursuits are associated with undesirable health conditions, a decline in functional abilities, and increased mortality risk among aging adults (Copeland et al., 2017; Rosenberg et al., 2016). Recent attempts to reduced sedentary time in community-dwelling aging adults have proven successful (Chastin, Fitzpatrick, Andrews, & DiCroce, 2014; Leask, Sandlund, Skelton, & Chastin, 2017; Lewis et al., 2016), and have led to a variety of beneficial health outcomes.

However, attendance at exercise interventions with aging adults in LTC fluctuates and varies greatly from person to person based on their medical conditions and psychological state (Finnegan, Bruce, Lamb, & Griffiths, 2015). Because of this, interventions with aging adults in long-term care may come with additional challenges (Ellard, Thorogood, Underwood, Seale, & Taylor, 2014). Nonetheless, even low attendance may gain valuable improvements for aging adults (Brach et al., 2017).

Rosenberg et al., (2016) found that aging adults in a retirement community were able to increase their 400m walk time by 21 seconds, through an overall reduction of measured sedentary time of 60 minutes which is a clinically meaningful change. Over 8 weeks participants had an average change in standing time of 25 minutes per day (Rosenberg et al., 2016). A study with older women living in the community increased standing activities by approximately 30 minutes per week and found it to be associated with a walking speed improvement of 0.2 m/sec, which is considered clinically meaningful (>0.1m/sec) (Yanagawa, Shimomitsu, Kawanishi, Fukunaga, & Kanehisa, 2016). Similar to community-dwelling aging adults, those living in long-term care spend the majority (89%) of their day sedentary (Lee, Sénéchal, Hrubeniuk, & Bouchard, 2019). Given the success of lifestyle interventions to reduce sedentary time in community-swelling populations, increasing standing time for aging adults in LTC may also result in improved physical function.

To our knowledge, no intervention has attempted to reduce sitting time in LTC settings. In a pilot study done in a local LTC, twenty residents averaging 78 ±14 years of age spent 89 % of their day performing sedentary activities (Lee et al., 2019). When these participants were further classified into groups by using their transfer status (as approved by the rehabilitation team), those classified as having assisted transfer mobility, meaning that they require staff assistance to transfer, spent 10% more of their day sedentary than those who were classified as independent transfer status. As such, our current project will focus on residents classified as having assisted transfer mobility (Lee et al., 2019). These residents will be the focus as their classification status indicated they do not have the capability to stand unassisted but still have the physical functionality to stand. This means that unless assisted, there is no other way for them to safely reduce sitting time.

Given the high prevalence of sitting time in LTC and the association of sedentary behaviour with functional abilities, it is important to explore strategies to reduce sitting time in this setting. The objectives of this study were to assess the attendance of the proposed intervention to reduce sitting time in an LTC facility and to explore the potential functional outcomes.

3.3 Methods

Participants

To have been included in the study, individuals needed to be a resident of the chosen LTC home in New Brunswick, Canada, which had 212 residents. Residents were eligible if they:

- Had the status of independent transfer, or transfer with assistance, a classification done by New Brunswick Worksafe (WorkSafeNB, 2012).
- Provided consent or had a power of attorney agree on their behalf to participate in the study.
- Were able to stand for a minimum of five consecutive minutes.

The only exclusion criteria were if the LTC staff deemed a resident would not be safe and may fall by participating. To minimize the risk of falls, residents had to be able to stand for a minimum of five consecutive minutes, with or without assistance to get into an upright position. This criterion was confirmed by nursing staff from the LTC facility. Because this was a pilot study, we recruited as many participants as possible using a snowball sample recruitment strategy.

Recruitment

Potential participants were informed of the study through word of mouth from LTC exercise and rehabilitation staff. Residents were recruited on an ongoing basis from May 2018 until July 13, 2018 as that was the final date until there were only 10 weeks before the deadline to have the study completed (September 21, 2018). This deadline was chosen because of the limited human and financial resources available at the end of summer and because the design was a pilot study.

If a resident expressed interest in participating, an approval for participation was obtained by the rehabilitation team to ensure safety, as well as the requirement of an assent form was discussed with the LTC nurses. If an assent form was needed, the Clinical Research Coordinator at the nursing home, who was not related to the proposed study, contacted families to inform them of the study and acquire approval. If the participant was able to consent, the research assistant reviewed the consent form with the participant and obtained written consent. Potential participants had the opportunity to discuss their involvement with their family members or the staff before deciding. Once the appropriate paperwork had been received, participants conducted baseline testing prior to the 10-week intervention.

Participant Characteristics

Participant characteristics were obtained from the LTC records after receiving ethics approval: age, height, weight, and transfer status are recorded upon admission to the LTC facility. At this LTC facility, weight is reassessed weekly prior to bathing, height as needed for adjusting equipment and requested by doctors or family, and transfer status every three months or, if required, sooner due to adverse events or a change in health status. The mobility device used was also indicated on their file, such as a cane, walker, or wheelchair. This information was current, as it is updated immediately when residents changed mobility status or mobility device. Whether the participant had a power of attorney or not was also indicated by the LTC nurses, this allowed us to know whether they would need an assent or consent form. Once recruited, participants were classified by their transfer statuses. In New Brunswick, residents in a LTC may have one of three major transfer statuses. Those in the independent transfer group can transfer (from sit to stand) on their own, with or without a walker or cane. Those in the assisted transfer group require staff assistance to transfer, and those in the dependent group require mechanical and staff assistance to transfer (WorkSafeNB, 2012)

Intervention

The intervention was 10 weeks long and used two portable tables as a point of gathering while standing. Attendance of participants were measured at each session. The goal of the intervention was to have participants stand up for 10-minutes per session, three times per day, four days per week (Monday, Wednesday, Friday, and Sunday) for 10 weeks, and measure attendance at the program. A total of 120 sessions were intended to be delivered. The volume of standing time was based on information from previous research at this facility, from the LTC staff, and as informed by the current literature Fitzsimons et al., (2013). The LTC staff recommended standing sessions be broken into 10-minute bouts to avoid falls as a result of fatigue and identified Tuesdays and Thursdays as days to avoid, due to a high volume of extraneous activities and visits from families and community members.

For each standing session research assistants went to the LTC units to stand residents. The start times were approximately 8:30am, 1:00pm, and 5:30pm. During these sessions, there were activities to keep the residents entertained. Each morning session had jokes of the day, the afternoon session had group discussion, and the evening session had a discussion on a topic of the day (e.g. interest for summer festivals, usage of cellular phones). Each session was timed individually with a stopwatch for each participant. Participants aimed to personally accumulate 10 minutes of total standing time. Each session took approximately 10 to 20 minutes on each unit, as it took 10 minutes per participant, but some participants needed to take sitting breaks. There were approximately four locations where residents gathered to stand, some residents requested to stand alone as they were in the middle of an activity or did not want the company of other residents.

Because the participants had decreased mobility and required assisted devices, extra precautions to minimize the risk of falling were taken. There is a risk of falls when bringing aging adults with decreased mobility into an upright position. All residents had been confirmed by a nurse to be capable of standing for a minimum of five minutes with or without assistance. Secondly, research staff interacting with the participants underwent "Back in Form" training, which allowed them to assist in lifts and transfers at the LTC. The "Back in Form" training is a training session for staff at the local LTC home to properly and safely aid residents in transfer from their seat to a standing position (WorkSafe NB, 2012). There was a minimum of two research staff present as the maximum people used for an assisted manual lift is two as per the requirement for transferring a resident (WorkSafe NB, 2012). Finally, to reduce risk, a Steady Mate was used with high risk residents if it was recommended by a staff. A Steady Mate is an elevated walker with wheels underneath. It allows participants to be caught by a support belts when walking or standing if the participant needed the support (BXL, 2013).

Sitting time

The exposure variable was sedentary behaviour. Sedentary time was measured by an ActivPAL the week prior to and the last week of the intervention for each participant. The ActivPAL was taped with Tegaderm tape to the resident's leg, mid-thigh on the front of the body, for seven consecutive days (Taraldsen et al., 2011). This device measured sitting and upright time, as well as the number of steps taken. The minimum wear time for recording valid information for sitting time with aging adults is four days, 10 hours per day (Aguilar-Farías, Brown, & Peeters, 2014). If an ActivPAL appeared non-valid based on these criteria, the ActivPAL data was excluded from the analysis. Baseline testing for ActivPAL outcomes occurred the week prior to the commencement of the research study and during the last week of the research study.

Objectives

The objective of this project was to assess the attendance of the proposed intervention aimed at reducing sitting time in a LTC facility, and exploring the potential functional outcomes.

Outcomes

The main outcome was attendance at the 10-week intervention to reduce sitting time. We expected an attendance of 50% or below of all sessions offered, as other studies with aging adults have shown similar attendance (Brach et al., 2017; Ellard et al., 2014; Falck, Davis, Milosevic, & Liu-Ambrose, 2017; Finnegan et al., 2015). Similar studies typically offered two to three sessions per week, while we are offering four.

To “attend” the session the resident must come to the session and attempt to stand at least once (Falck et al., 2017). Percentage attendance was calculated for the group (Finnegan et al., 2015).

$$Percent\ Attendance = \frac{Number\ of\ sessions\ attended}{Number\ of\ possible\ sessions\ to\ attend} \times 100$$

Lower attendance has the opportunity to still yield beneficial results for our participants, as previous noted in other studies of a similar aging population (Brach et al., 2017). Therefore, creating more opportunities to attend sessions, but also more opportunities to miss sessions.

In addition, the following functional outcomes were measured at baseline and after the 10-week intervention: walking speed (10-meter walk test), leg power (30-sec chair stand), and leg strength (Microfet dynamometer).

Walking speed was measured using the 10-meter walk test (Kempen et al., 2011). This was completed with or without the use of the Steady Mate based on the recommendation from the LTC nurse for the safety of the resident. Two trials were completed, and the average of the two times was recorded. Participants were asked to walk as quickly and safely as possible from start to finish without assistance. To increase safety, the test was done along a railed hallway. The 10-meter path had no turns, no obstacles, no one passing by, and was flat. The time was measured between the 2-meter to 8-meter mark (6-meter total) to allow for acceleration and deceleration. Time to complete the task in seconds was recorded to a maximum of 180 seconds. This test is often used in populations with a decline in mobility and is sensitive to functional decline (Kempen et al., 2011). The minimal clinically important difference (MCID) for walking speed is 0.1 m/sec (Bohannon & Glenney, 2014). Participants were categorized as reaching this change or not.

Power was measured by the chair stand test (Reid & Fielding, 2012). This test measures the capability to rise from a seated to standing position from a chair. The participant has thirty seconds to rise and return to the chair as many times as he/she can without using the arm rests. The chair was secured against the wall so it would not move as the resident stood. The chair stand test is a reliable and valid indicator of lower body strength in aging adults (Millor, Lecumberri, Gómez, Martínez-Ramírez, & Izquierdo, 2013) in addition to being able to classify participants' frailty status (Kempen et al., 2011).

Leg strength was measured using the MicroFET2, a hand-held dynamometer, which is considered industry standard by Hogan Scientific (User Guide to the MicroFET 2 Hand Held Dynamometer, 2019). This device records the force exerted on the device during leg extension when applied against the leg. For this test, residents were seated and asked to extend their leg against the MicroFET2 was held in place by the research assistant. The process was then repeated with the other leg. Hand held dynamometers with a standardized measurement protocol can obtain reliable lower limb strength values, even from novice testers (Wang, Olson, & Protas, 2002)

In addition, we monitored and recorded falls if there were any incidence during the course of the study to determine the safety of the program. Had there been a fall the research staff would notify staff, then information on how the resident fell and the severity of the fall would be recorded.

Statistics

Descriptive data are reported for all measured outcomes using median and the inter-quartile range (25-75th). Pre-post change in ActivPAL data (n=13) for sitting time (hours /day), steps (per day) upright time (hours/day), sit to stand (#/day), and physical function (N=24) for walking speed (m/s), leg strength (kg), and 30 second chair stand (#), were tested via Wilcoxon singed-rank tests. However, for variable that were measured over multiple timepoints (N>24) (e.g., attendance including time of day (i.e. morning, afternoon, evening), day of week, and time standing per week) a one-way repeated measures ANOVA was used. This is because there are many more data points as each N is measured multiple times. Mauchly's test was used to test for sphericity, and a Greenhouse-Geisser correction was applied as necessary. When a significant main effect was detected, Bonferroni Post-Hoc tests were run to identify differences between time points. As some participants removed the ActivPAL before data collection was complete, refused to wear the device, or did not have enough valid days to be considered in the final analysis, Mann-Whitney U test and Chi-square tests were conducted to determine if personal characteristics were different between the two groups.

3.4 Results

Descriptive statistics for the sample are presented in Table 1. The group was predominately female (n=15, 62.5%) and had a body mass index (BMI) of 26.0kg/m^2. The median age of the sample was 82.5 years and the majority of participants were able to consent for themselves (58.3%). Based on transfer status, the majority of the sample was independent, and 29.2% of them were ambulating with a wheelchair.

Figure 1 displays the process of recruiting participants as well as drop out of participants. Out of the beds available at the LTC, the staff selected units of the LTC facility to implement the intervention based on the need and potential interest of the residents. Out of 80 potential residents, a total of 41 participants were recommended by the staff. Of these, 42% required an assent form. Ten residents recommended by the LTC staff could not participate because a family member refused. Of these ten residents, four had family members respond that they did not feel their family member would be interested, three had family members state they did not want to risk their family member falling, and three had family members say they would prefer not to be bothered with research. The 31 remaining participants were recruited. Three these participants never started the intervention, even after consenting. Therefore, a total of 28 participants were enrolled. During the study, two participants left due to a lack of interest, and two due to illness. The final number of participants that completed the entire study is 24. Of these 24, a sub sample of 13 wore had valid ActivPAL at both pre and post evaluation. Data related to physical function was analyzed for all participants (N=24).

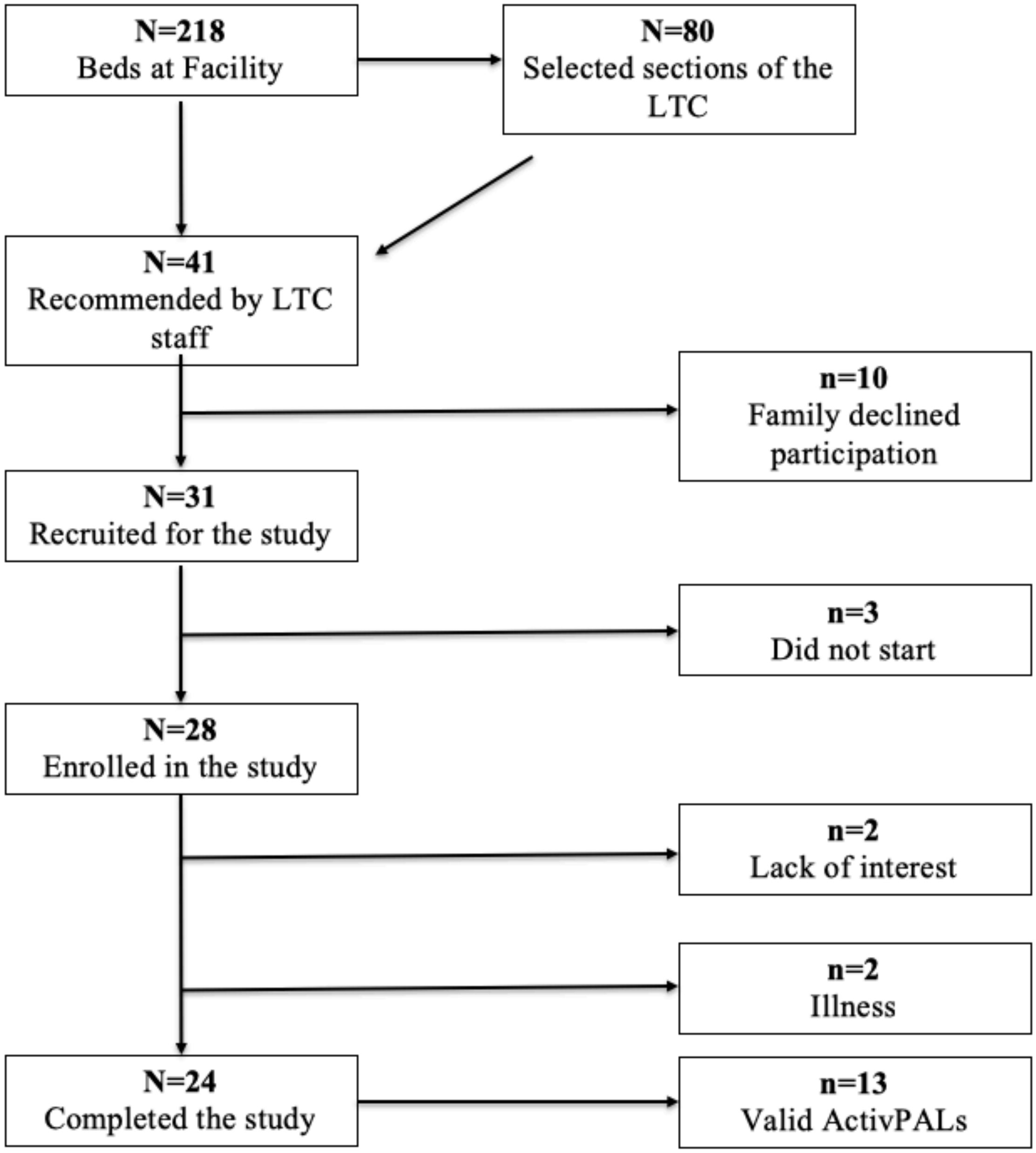

Figure 1. Participant Flow Chart

Thirteen participants who completed the intervention wore ActivPALs pre- and post-study. For some, this was because the equipment irritated their skin (n=1), their condition resulted in them being forgetful and frightened by the ActivPAL (n=4), or they did not meet the valid wear days criteria (more than four days) (n=6). Participants who did not wear the ActivPAL (n=11) (Median age =88 years), at follow-up were older than those participants who did (n=13) (Median age = 69 years), $p = 0.03$. Differences were also observed between those requiring an assent forms (8 of 13) and not wearing the ActivPAL ,with those not requiring an assent form (5 of 13) and wore the ActivPAL ($p = 0.01$).

Outcomes

Figures 1-3 present information on attendance of the participants (N=24) during the study in terms of time of day (Figure 1), day of the week (Figure 2), time standing per week (Figure 3). On average participants attended 35% of the sessions (38 sessions out of 108), attended 4 times per week (out of 12) and spent an average of 45 minutes standing per week. When standing, the average time per session was 10.66 minutes. There was a significant main effect of time of day on participant attendance p = 0.01. Morning sessions (M = 15.96, SE = 1.66) were more highly attented than lunch sessions (M = 11.79, SE = 1.32), p = 0.02, and evening sessions (M = 7.04, SE = 1.3) p = 0.01. There was also a significant main effect of day of the week on participant attendance *(*p = 0.01). Post-hoc analysis showed no difference in attendance between Monday (M = 11.96, SE = 1.28) Wednesday (M = 12.04, SE = 1.35), or Friday (M = 10.8, SE = 1.23) attendance. However, attendance was significantly reduced on Sunday (M = 7.38, SE = 1.22), when compared to the other days (Figure 4; p=0.01). There was a significant main effect of week on the overall (p = 0.03). However, post-hoc analysis found this difference only existed between week 1 (M = 5.33, SE = 0.58) and week 7 (M = 3.54, SE = 0.56), p = 0.03. There was no effect of week of participation on time spent standing *(* p = 0.22).

Table 2 depicts the results of pre- and post-tests for those who completed the intervention (N=24). Surprisingly, the sitting time (n=13) increased significantly (p=0.03), the number of steps (n=13) decreased significantly (p=0.01) and the number of sit to stand movements (n=13) also decreased significantly (p=0.05). No significant improvement was observed in the median value of the functional tests (N=24) with the exception of the 30-second chair stand test (N=24) that improved for a median of three (p<.05).

Despite that no significant improvement was observed for walking speed, eight of the participants (N=24) improved their walking speed above the clinical minimal important difference of 0.1m/sec (Bohannon & Glenney, 2014).

3.5 Discussion

The main objective of this study was to assess the attendance of the proposed intervention to reduce sitting time in a LTC facility, and to explore the potential functional benefits. On average, participants attended 35% of the sessions offered (38/108), averaged 4 sessions per week and spent an average of 45 minutes upright per week during treatment sessions. This represents about 11.25 minutes per active day, but this average was higher when excluding Sundays and evenings. The attendance was at its highest during the morning session (p=0.02) compared with the afternoon and evening session (p<0.01). Weekdays were more attended compared with Sundays (p<0.01). The second objective was to explore the potential functional benefits. There was a significant improvement in the 30 second chair stand test (p <0.05), and despite the fact that no significant improvement was observed on the leg strength and the walking speed, eight participants improved their walking speed above the clinical minimal important difference.

If this intervention was to be repeated, perhaps five days per week only offering morning and afternoon sessions should be offered. Doing so, the average time standing could increase to 62 minutes per week based on our data. Currently there are no standing trials in LTC reporting attendance with aging adults. Other studies in the literature with similar recruitment to ours (N=27) have shown a greater attendance and total standing minutes when receiving an intervention that was daily, and used personal goals, (Lewis et al., 2016). However, these participants were community dwelling (Lewis et al., 2016). It is possible that our sample was less likely to attend because of greater health issues or the fact that the sample was older compared with participants in the community (average age 60-80 years old) aiming to reduce sitting time through an intervention (Copeland et al., 2017). Bodily pain tends to be associated with low adherence for participation in exercise interventions with aging adults, which can be common for LTC residents (Cadmus-Bertram et al., 2014). Another reason that could explain the difference in attendance could be the fact that our sample needed to stand on a schedule and standing time in the community is often self-reported (Kallings et al., 2009). Finally, in our study the cognitive state of participants was unclear as 41.7% of participants needed a power of attorney to sign assent for them. However, their exact conditions were unknown. It was common for residents to attend the session, forget why they were there, then walk away. This suggests that cognitive impairment was a factor influencing attendance for some participants.

A small increase in standing time, and significant improvement in the 30-second chair stand was observed for the entire group (N=24). The observed increase in the 30-second chair stand brought these aging adults in LTC closer to the average number of stands typically observed in community-dwelling aging adults between the age of 80 – 84 years (Rikli & Jones, 2013). Improvement can range from 9-14 (25^{th}-75^{th} percentile) (Rikli & Jones, 2013). An increase of three stands in 30 was both statistically and clinically significant, as an increase of two is typically accepted as the MCID (Wright, Cook, Baxter, Dockerty, & Abbott, 2011), and would represent a 5% increase across the population norm (Rikli & Jones, 2013)

This result is consistent with studies showing that aging adults can improve physical function by increasing standing time (Yanagawa et al., 2016) or standing more (Rosenberg et al., 2016). For example, Yanagawa et al., (2016) reported that older women living in the community showed that increasing standing activities by about 30 minutes per week was associated with a significant improvement on a similar test.

The walking speed improved by a median of 0.03 m/sec. This number sounds small, but the MCID is fixed to 0.1m/sec (Bohannon & Glenney, 2014), and some even suggest that this MCID could even be smaller in older frail adults (Perera, Mody, Woodman, & Studenski, 2006). Even if walking speed did not improve significantly, it is possible that this is due to a type II error as we did not have the sample size to show significance or that the time standing was not sufficient to improve significantly. In fact, Rosenberg et al., (2016) observed that for every overall decrease in 60 minutes of measured sedentary time, aging adults in retirement communities improved their 400 m walk test by 21 seconds, which is a clinically meaningful difference (Rosenberg et al., 2016). Our sample stood on average 45 minutes per week but were a slightly lower level of physical functioning. Therefore, it may be possible to see more improvements in physical function if other tests were used, and if participants stood slightly more per week.

Despite the intervention, participants (n=13) did not decrease their sedentary behavior, as noted when analyzing the ActiPAL data; contrarily, it increased significantly by a median of 82 minutes per day. This is shocking at first glance, but not when you take a closer look at data. The ideal situation would have been a decrease in sitting time of 120 minutes per week due to the intervention or an average of 17 minutes per day. In other words, the time standing as part of the intervention could lead to, at the most, a decrease in sitting time of 16.8 minutes in a day; down to 1236 minutes total sitting time per day. This means that the intervention did not affect enough time of their week to give it the opportunity to be significant.

Although it is now clearer why residents could not significantly reduce their sitting time, it is still unclear why it significantly increased. We suspect that LTC staff may have reduced the number of times they offered to stand or walk participants that were in the study, as the staff knew these residents were already offered to stand for the research. Additionally, residents may have declined other opportunities to stand or walk as they knew that they may stand with us. Perhaps residents increased sitting time on their own as it is known that mood and activity level vary considerably from day to day in this population (DiPietro, 2001) or with the progression of their illnesses.

Lastly, it is important to note that this intervention had success in gathering aging adults in LTC to conduct standing sessions. Moreover, there were no falls or adverse events and the staff as well as the family members were encouraging and supportive. Therefore, this intervention appears safe and well-accepted.

3.6 Future Studies

As part of the study, we were able to gather information that may help future studies involving aging adults in LTC with the goal of reducing sitting time. Information such as most attended time of day, most attended days, and the assurance of safety was gathered. The participants showed increased attendance on weekdays over weekends ($p<.01$), and morning session over other sessions ($p<.01$) and the morning and lunch sessions over evening sessions (p<.01). As a result, future interventions in LTC homes should focus on morning and afternoon sessions, as well as weekdays sessions. Some residents leave on weekends or have visitors. It would be helpful to have activity staff assist in bringing residents to the standing locations. It would also be beneficial for their activities to be scheduled at different times than the intervention, to prevent conflicts. Future studies could also take advantage of the gathering for sedentary activities to have the participants stand before or after that activity. It would also be helpful to have the staff dress the participants first so they can attend the morning session.

Residents tended to dislike the originally proposed standing table, as they enjoyed being able to be closer to one another to talk and interact while they stood. It was removed. Not having the table in between the participants, made it easier to be provide assistance, if needed. Therefore, it is not recommended to use a standing table for a standing intervention with this population.

To conduct the study, the time requirement for research was about two hours per session as participants had to be located if they were not in their room, and some participants had to split the 10-minute standing time into several bouts. As a result, each session took about two hours for a total of 24 hours per week. The research staff was composed of two students for each session. To implement this study into the regular routine of an LTC facility volunteers or staff would have to be mobilized. This may be challenging given the resources available to these facilities.

During standing, strategies were used to keep residents engaged and safe such as positive language and reinforcement. A one-arm length policy was implemented. Even if a participant was not attending a session, the research staff visited them. To keep residents engaged, jokes, topics of the day (e.g., sports, holidays, or Netflix), riddles, and facts were used.

Altogether, residents seemed to enjoy standing together. Some even cheered for one another, encouraging them to stay standing. Many of the residents also enjoyed the social interactions and getting to know residents that were not in the same section of the LTC. In joining this study, residents also felt a sense of belonging and enjoyed contributing to research. Lastly, residents seemed to enjoy having the opportunity to interact and talk with younger generations. All these positives findings should be studied in the future using qualitative research. As well as taking into account the data and information gathered from this study to plan future randomized control trials.

3.7 Limitations

There were several limitations noted in this study. The first being the variability observed in outcomes related to the small sample size, as well as the lack of control group. Another limitation is the inclusion of many LTC residents who are considered independent. Staff at the LTC suggested participants that they believed could do the intervention, not based on who would benefit the most from the intervention.

There were also limitations for using the ActivPAL, even if considered the gold standard. The device was small, which was an asset for comfort, but also made it easy to misplace. This has also resulted in residents throwing out devices due to size and forgetting to use it. This resulted in only 13 of the 24 participants having ActivPAL data.

Illness and aging showed to be a limitation as some participants had to leave the study due to illness or the progression of their disease. Holidays as well as unexpected closures were also a limitation as participants could not attend. Another limitation was the lack of acceptance from some staff. Some staff and family members were non-supportive or fearful of residents standing. This could be resolved with proper education of the purpose of the project, as well as the safety procedures in place.

Additionally, residents seemingly enjoyed having the research staff present, which may have developed a bias encouraging participation and increased standing time in an attempt to spend more time with them.

3.8 Impacts/Conclusion

Even if attendance was lower than expected, it could be improved with the feedback that was received. Functional benefits are possible and would be worth testing with the appropriate sample size and study design. There is very limited research on reducing sedentary time in aging adults living in LTC settings. Until now, there had been no reports of attempting to reduce sitting time with aging adults living in LTC. The present study acts as a foundation to intervene in LTC to reduce sedentary behaviour using a standing intervention. Because of the considerable amount of time that aging adults in LTC facilities spend sitting, it is important to continue research in this area and to build on the proposed strategy in the future.

4.0 References-Article

A User Guide to the MicroFET 2 Hand Held Dynamometer. (2018). Retrieved March 8, 2019, from https://www.prohealthcareproducts.com/blog/a-user-guide-to-the-microfet-2-hand-held-dynamometer/

Aguilar-Farías, N., Brown, W. J., & Peeters, G. M. E. E. (Geeske). (2014). ActiGraph GT3X+ cut-points for identifying sedentary behaviour in older adults in free-living environments. *Journal of Science and Medicine in Sport*, *17*(3), 293–299. https://doi.org/10.1016/j.jsams.2013.07.002

Bohannon, R. W., & Glenney, S. S. (2014). Minimal clinically important difference for change in comfortable gait speed of adults with pathology: a systematic review. *Journal of Evaluation in Clinical Practice*, *20*(4), 295–300. https://doi.org/10.1111/jep.12158

Brach, J. S., Perera, S., Gilmore, S., VanSwearingen, J. M., Brodine, D., Nadkarni, N. K., & Ricci, E. (2017). Effectiveness of a timing and coordination group exercise program to improve mobility in community-dwelling older adults: a randomized clinical trial. *Journal of the American Medical Association Internal Medicine*, *177*(10), 1437–1444. https://doi.org/10.1001/jamainternmed.2017.3609

BXL International Sales Inc (2015). Steadymate walker. Retrieved March 31, 2019, from https://plus.google.com/102487901964309929198

Cadmus-Bertram, L., Irwin, M., Alfano, C., Campbell, K., Duggan, C., Foster-Schubert, K., McTiernan, A. (2014). Predicting adherence of adults to a 12-month exercise intervention. *Journal of Physical Activity and Health*, *11*(7), 1304–1312. https://doi.org/10.1123/jpah.2012-0258

Calum F Leask, Marlene Sandlund, Dawn A Skelton, & Sebastien FM Chastin. (2017). Co-creating a tailored public health intervention to reduce older adults' sedentary behaviour. *Health Education Journal*, *76*(5), 595–608. https://doi.org/10.1177/0017896917707785

Chastin, S. F. M., Fitzpatrick, N., Andrews, M., & DiCroce, N. (2014). Determinants of sedentary behavior, motivation, barriers and strategies to reduce sitting time in older women: a qualitative investigation. *International Journal of Environmental Research and Public Health*, *11*(1), 773–791. https://doi.org/10.3390/ijerph110100773

Copeland, J. L., Ashe, M. C., Biddle, S. J., Brown, W. J., Buman, M. P., Chastin, S., Dogra, S. (2017). Sedentary time in older adults: a critical review of measurement, associations with health, and interventions. *British Journal of Sports Medicine*, *51*(21), 1539–1539. https://doi.org/10.1136/bjsports-2016-097210

DiPietro, L. (2001). Physical activity in aging changes in patterns and their relationship to health and function. *The Journals of Gerontology: Series A*, *56*(suppl_2), 13–22. https://doi.org/10.1093/gerona/56.suppl_2.13

Ellard, D. R., Thorogood, M., Underwood, M., Seale, C., & Taylor, S. J. (2014). Whole home exercise intervention for depression in older care home residents (the OPERA study): a process evaluation. *BMC Medicine*, *12*(1), 1. https://doi.org/10.1186/1741-7015-12-1

Falck, R. S., Davis, J. C., Milosevic, E., & Liu-Ambrose, T. (2017). How much will older adults exercise? A feasibility study of aerobic training combined with resistance training. *Pilot and Feasibility Studies*, *3*(1), 2. https://doi.org/10.1186/s40814-016-0116-5

Finnegan, S., Bruce, J., Lamb, S. E., & Griffiths, F. (2015). Predictors of attendance to group exercise: a cohort study of older adults in long-term care facilities. *BMC Geriatrics*, *15*(1), 37. https://doi.org/10.1186/s12877-015-0043-y

Fitzsimons, C. F., Kirk, A., Baker, G., Michie, F., Kane, C., & Mutrie, N. (2013). Using an individualised consultation and activPAL™ feedback to reduce sedentary time in older Scottish adults: Results of a feasibility and pilot study. *Preventive Medicine*, *57*(5), 718–720. https://doi.org/10.1016/j.ypmed.2013.07.017

Lee, A. M., Sénéchal, M., Hrubeniuk, T. J., & Bouchard, D. R. (2019). Is sitting time leading to mobility decline in long-term care residents? *Aging Clinical and Experimental Research*. https://doi.org/10.1007/s40520-019-01148-z

Harvey, J. A., Chastin, S. F. M., & Skelton, D. A. (2015). How sedentary are older people? A systematic review of the amount of sedentary behavior. *Journal of Aging & Physical Activity*, *23*(3), 471–487.

Jing Song, Lindquist, L. A., Chang, R. W., Semanik, P. A., Ehrlich-Jones, L. S., Jungwha Lee, Dunlop, D. D. (2015). Sedentary behavior as a risk factor for physical frailty independent of moderate activity: results from the osteoarthritis initiative. *American Journal of Public Health*, *105*(7), 1439–1445.

Kallings, L. V., Johnson, J. S., Fisher, R. M., Faire, U. de, Ståhle, A., Hemmingsson, E., & Hellénius, M.-L. (2009). Beneficial effects of individualized physical activity on prescription on body composition and cardiometabolic risk factors: results from a randomized controlled trial. *European Journal of Cardiovascular*

Prevention & Rehabilitation, *16*(1), 80–84. https://doi.org/10.1097/HJR.0b013e32831e953a

Kempen, J. C. E., de Groot, V., Knol, D. L., Polman, C. H., Lankhorst, G. J., & Beckerman, H. (2011). Community walking can be assessed using a 10-metre timed walk test. *Multiple Sclerosis Journal*, *17*(8), 980–990. https://doi.org/10.1177/1352458511403641

Lee, A., Sénéchal, M., Hrubeniuk, T., & Bouchard, D. R. (2019). Is sitting time leading to mobility decline in long-term care residents? *Aging Clinical and Experimental Research.* February Ahead of Print doi: 10.1007/s40520-019-01148-z.

Lewis, L. K., Rowlands, A. V., Gardiner, P. A., Standage, M., English, C., & Olds, T. (2016). Small Steps: Preliminary effectiveness and feasibility of an incremental goal-setting intervention to reduce sitting time in older adults. *Maturitas*, *85*(1), 64–70. https://doi.org/10.1016/j.maturitas.2015.12.014

Millor, N., Lecumberri, P., Gómez, M., Martínez-Ramírez, A., & Izquierdo, M. (2013). An evaluation of the 30-s chair stand test in older adults: frailty detection based on kinematic parameters from a single inertial unit. *Journal of NeuroEngineering and Rehabilitation*, *10*(86). https://doi.org/10.1186/1743-0003-10-86

Pate, R. R., O'Neill, J. R., & Lobelo, F. (2008). The evolving definition of "sedentary." *Exercise and Sport Sciences Reviews*, *36*(4), 173. https://doi.org/10.1097/JES.0b013e3181877d1a

Perera, S., Mody, S. H., Woodman, R. C., & Studenski, S. A. (2006). Meaningful change and responsiveness in common physical performance measures in older adults. *Journal of the American Geriatrics Society*, *54*(5), 743–749. https://doi.org/10.1111/j.1532-5415.2006.00701.x

Reid, K. F., & Fielding, R. A. (2012). Skeletal muscle power: a critical determinant of physical functioning in older adults. *Exercise and Sport Sciences Reviews*, *40*(1), 4–12. https://doi.org/10.1097/JES.0b013e31823b5f13

Rikli, R. E., & Jones, C. J. (2013). *Senior Fitness Test Manual*. Human Kinetics.

Rosenberg, D. E., Bellettiere, J., Gardiner, P. A., Villarreal, V. N., Crist, K., & Kerr, J. (2016). Independent associations between sedentary behaviors and mental, cognitive, physical, and functional health among older adults in retirement communities. *The Journals of Gerontology: Series A*, *71*(1), 78–83. https://doi.org/10.1093/gerona/glv103

Taraldsen, K., Askim, T., Sletvold, O., Einarsen, E. K., Bjåstad, K. G., Indredavik, B., & Helbostad, J. L. (2011). Evaluation of a body-worn sensor system to measure physical activity in older people with impaired function. *Physical Therapy; Washington*, *91*(2), 277–285.

Wang, C.-Y., Olson, S. L., & Protas, E. J. (2002). Test-retest strength reliability: Hand-held dynamometry in community-dwelling elderly fallers. *Archives of Physical Medicine and Rehabilitation*, *83*(6), 811–815. https://doi.org/10.1053/apmr.2002.32743

WorkSafeNB. (2012). Nursing Homes. Retrieved September 26, 2018, from https://www.worksafenb.ca/safety-topics/nursing-homes/

Wright, A. A., Cook, C. E., Baxter, G. D., Dockerty, J. D., & Abbott, J. H. (2011). A comparison of 3 methodological approaches to defining major clinically important improvement of 4 performance measures in patients with hip osteoarthritis. *Journal of Orthopaedic & Sports Physical Therapy*, *41*(5), 319–327. https://doi.org/10.2519/jospt.2011.3515

Yanagawa, N., Shimomitsu, T., Kawanishi, M., Fukunaga, T., & Kanehisa, H. (2016). Relationship between performances of 10-time-repeated sit-to-stand and maximal walking tests in non-disabled older women. *Journal of Physiological Anthropology*, *36*(2). https://doi.org/10.1186/s40101-016-0100-z

Table 1.

Participant characteristics

Variable	Median or N	IQR or %
Age (years)*	82.5	69.0-88.0
Women	15	62.5
Body Mass index (kg/m^2) *	26.0	22.2-29.3
Transfer status		
Independent	17	70.0
Assisted	7	30.0
Mobility aid used		
No aid used	2	8.4
Cane	1	3.2
Walker	14	58.3
Wheelchair	7	29.2
Assent (yes)	10.0	41.7
Totals (N=24)		

Note. Data shown as median Interquartile (IQR- 25-75^{th}) * or N (%)

Table 2.

Results of pre- and post-tests by completers (N= 24)

	Pre-test		Post-test		
	Median	IQR	Median	IQR	P-value
Sitting time (Hours /day) *	20.88	19.15-23.02	22.24	20.46-23.54	0.03
Steps (per day) *	1129.0	210.3-2158.0	769.1	50.2-1755.1	0.01
Upright time (Hours/day) *	2.66	0.68- 4.13	1.77	0.46-3.54	0.08
Sit to stand (#/day) *	30.00	21.63-63.30	26.28	18.27-37.29	0.05
Walking Speed (m/s)	0.60	0.42-0.97	0.63	0.48-0.84	0.69
Leg strength (kg)	23.14	17.08-37.00	25.63	18.26-37.01	0.96
30 second chair stand (#)	6.00	5.00-11.00	9.00	4.50-12.50	0.02
Totals (N=24)					

Note. * 13 participants had a valid measure of ActivPAL pre-post. Data shown as median Interquartile (IQR 25-75th)

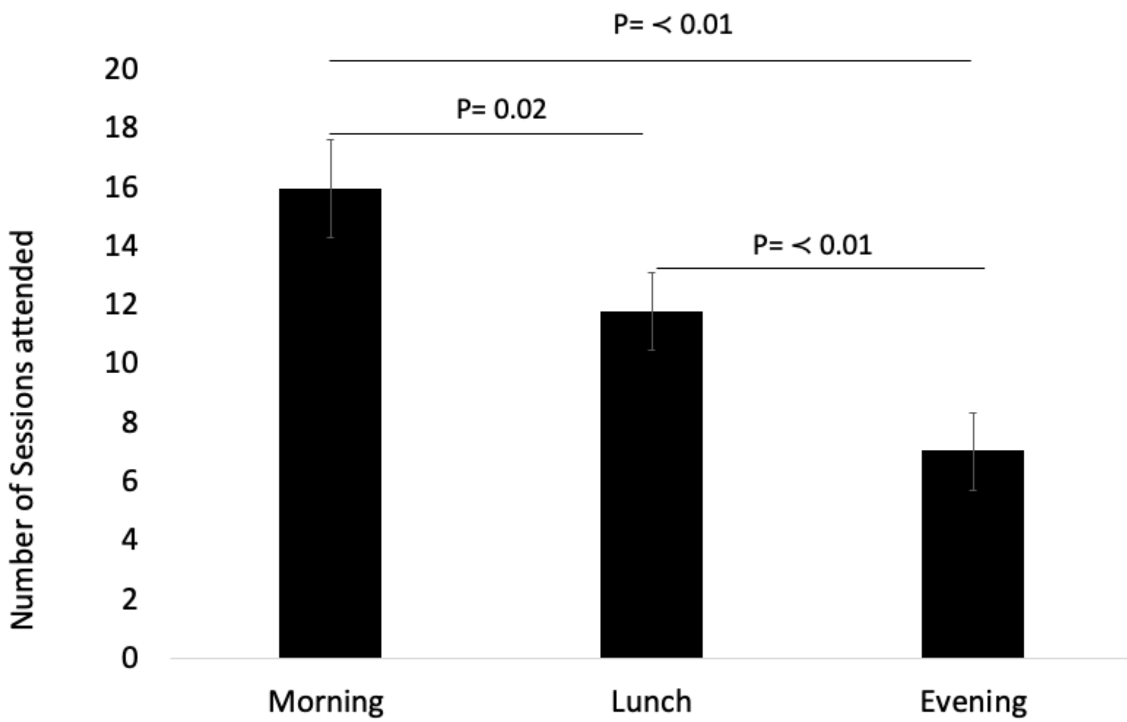

Figure 1: Average Attendance by Time of Day Offered
*Data presented as the mean and standard error

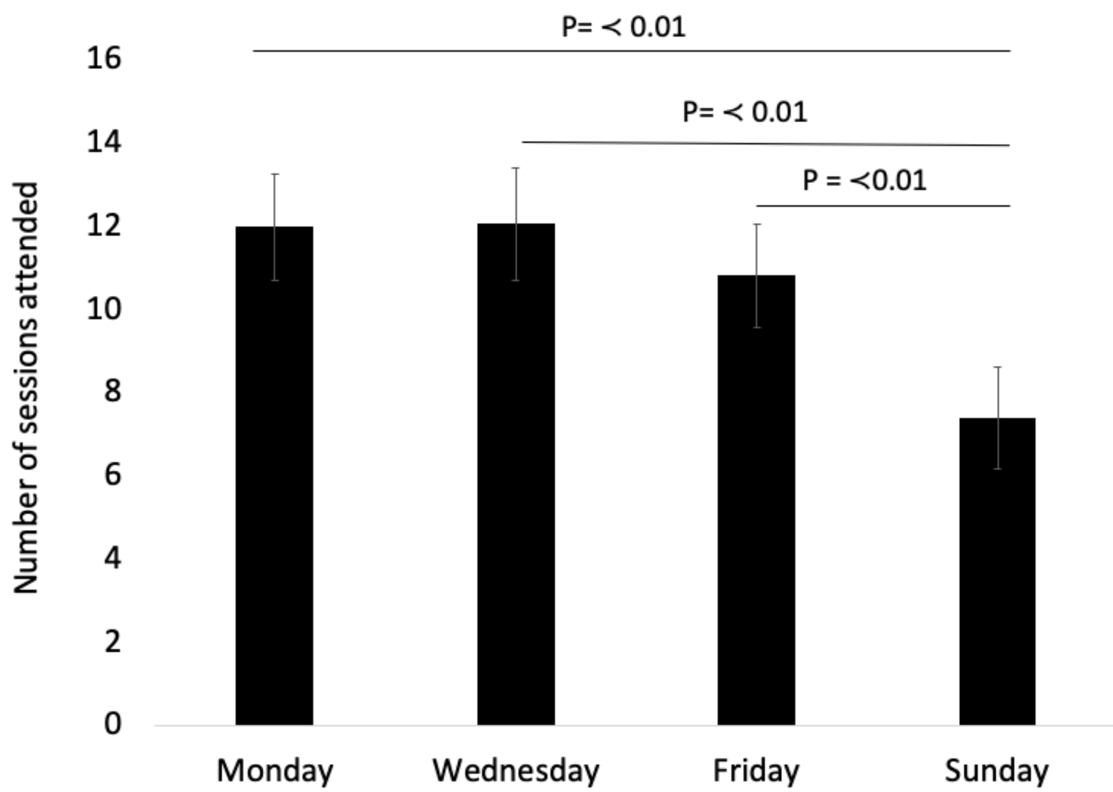

Figure 2: Average Attendance by Day Offered (4 per day,12 per week, 108 total)
*Data presented as the mean and standard error

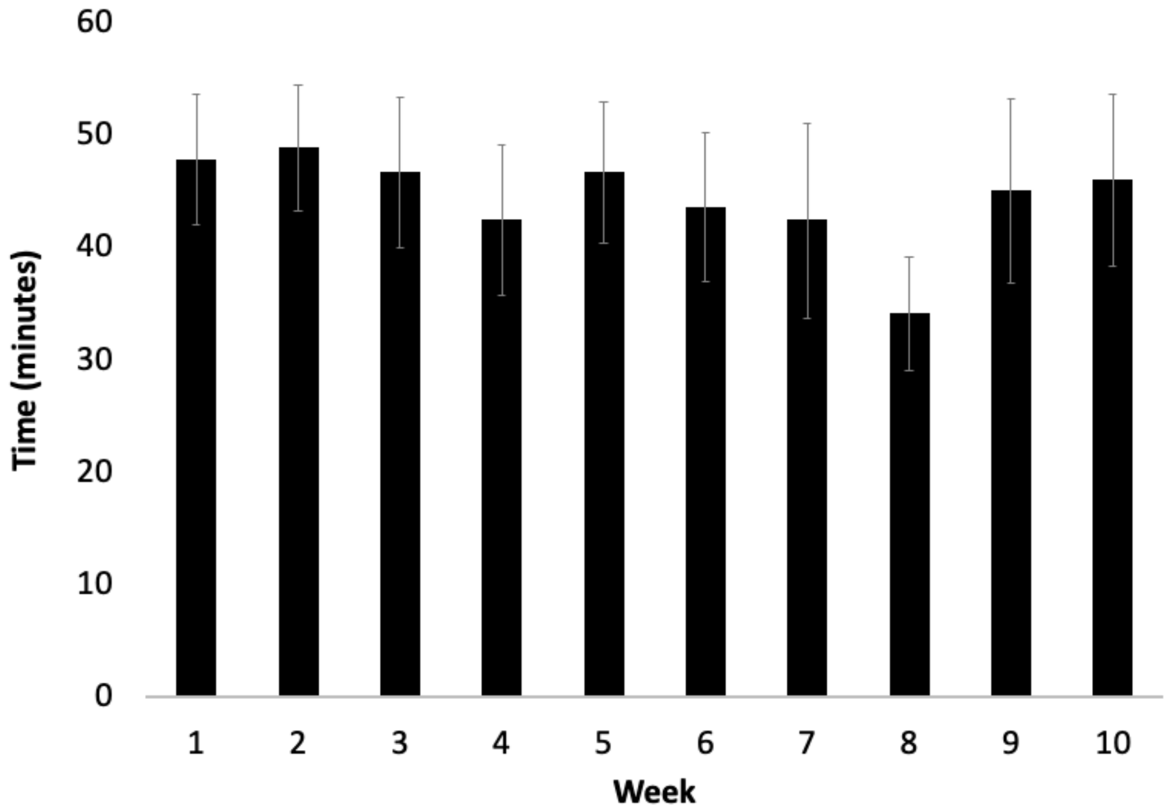

Figure 3: Average Time Standing During the Intervention Weeks (10 weeks)
*Data presented as the mean and standard error

APPENDIX I : CURRICULUM VITAE

Candidate's full name:
Amanda Lee

Universities attended (with dates and degrees obtained):
Bachelor of Science in Kinesiology, University of New Brunswick 2017

Publications:
Lee, A., Sénéchal, M., Hrubeniuk, T., & Bouchard, D. R. (2019). Is sitting time leading to mobility decline in long-term care residents? *Aging Clinical and Experimental Research.* February Ahead of Print doi: 10.1007/s40520-019-01148-z.

Conference Presentations:
Feasibility of an intervention to reduce sitting time for residents of long-term care settings Canadian Frailty Network,2018

Feasibility of an intervention to reduce sitting time for residents of long-term care settings NBHRF Research Conference,2018

Feasibility of an intervention to reduce sitting time for residents of long-term care settings Atlantic Provinces Exercise Scientists and Socioculturalists (APES+),2018

Feasibility of an intervention to reduce sitting time for residents of long-term care settings NBHRF R3 Innovations in Aging, 2018

Sedentary Behaviours in Long-Term Care Facilities York Care Center Symposium, 2017

Sedentary Behaviour in Long-Term Care Facilities 9th Annual New Brunswick Health Research Conference,2017