# Translating the Group Lifestyle Balance Program™ for Use Among Obese and Overweight Adults with Arthritis: Effects on Measures of Balance

By

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# ABSTRACT

Obesity and arthritis are risk factors for falls. Little is known about the effects of weight loss on balance in people with arthritis. The Group Lifestyle Balance (GLB) Program™ is an evidence-based, lifestyle change program for weight loss in individuals with prediabetes but it hasn't been evaluated in people with arthritis. The purpose of this pilot study was to evaluate the effectiveness of an adapted version of the GLB on balance outcomes among overweight (Body Mass Index (BMI) $\geq$27) individuals with arthritis. A single-group, quasi- experimental design was used to examine the effects of the adapted GLB program on measures of balance and function. All participants (N=17) received the GLB program and completed the following assessments at baseline, 12 weeks and six months: the Timed-Up-and-Go (TUG), 10 Meter gait speed, Fullerton Advanced Balance Scale (FAB) and the Activity Based Confidence survey (ABC). Repeated measures analysis of variance (ANOVAs) were used to examine changes over time in SPSS Version 24. Participants (mean age = 71.7 years) were primarily female (82%), white (94%), and college educated (94%). There was a linear ($F_1$=14.82, p=.002) and quadratic ($F_1$=7.20, p=.017) effect of time for the TUG. There was a linear effect of time on the FAB ($F_1$=7.10, p=.017), and on both the customary ($F_1$=5.44, p=.033) and fast walking pace ($F_1$=7.59, p=.014) 10-meter gait speed assessments. There were no significant changes on the ABC. The Group Lifestyle Balance program may be an effective way to improve balance and function among overweight and obese individuals with arthritis.

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# CHAPTER 1

# INTRODUCTION

## *Arthritis and Osteoarthritis*

Arthritis is an umbrella term used to refer to a group of joint related diseases. The Arthritis Foundation currently recognizes more than 100 joint or musculoskeletal conditions that fall under the umbrella of arthritis or arthritic conditions (Arthritis Foundation n.d.) Women are more likely to be diagnosed with arthritis and its prevalence increases with age (Arthritis Foundation, n.d.). Symptoms that typically accompany arthritis include: pain, stiffness, and disability and these symptoms can range in severity (Hootman, Brady & Helmick, 2012 & Arthritis Foundation, n.d.). Osteoarthritis (OA) is the most common form of arthritis (Felson, 1988). OA is associated with narrowing of the joint space (Guccione, Felson & Anderson, 1990). OA is progressive and, over time, the cartilage that exists between the heads of two bones wears away leaving the two bones of a joint rubbing together, bone to bone, resulting in a variety of symptoms including compromised joint strength (Arthritis Foundation, n.d.). Additionally, OA is typically accompanied by symptoms of pain and disability (Guccione, Felson & Anderson, 1990).

## *Impact and Consequences of Arthritis/ Osteoarthritis*

Arthritis and osteoarthritis in particular (OA) have a substantial impact on public health. Currently, more than 54 million American adults (1 in 5 adults) are affected by arthritis (Barbour, Helmick, Boring & Brady, 2017). OA is the most common form of arthritis, with more than 30.8 million adults reporting an OA diagnosis (Cisternas, Murphy, Sacks, et al., 2015). Due primarily to the aging of the United States population, the prevalence of arthritis is projected to increase to 78.4 million cases (1 in 4 adults) by 2040 (Hootman, Helmick, Barbour, Theis & Boring, 2016). The prevalence of arthritis is highest in adults over the age of 65, with nearly one in two individuals over the age of 65 reporting a diagnosis of arthritis (Barbour, Helmick, Boring & Brady, 2017). However, the prevalence of arthritis is also increasing among middle-aged adults. Rates of arthritis increase most noticeably at age 45 (Helmick et al., 2008). This means the number of years an individual is living with arthritis is also increasing.

Arthritis significantly affects health-related quality of life (HRQOL; Murphy et al., 2004). Individuals with arthritis report elevated levels of pain (Hootman, Helmick & Brady, 2012), impaired mobility (CDC, 2006), and higher rates of depression and anxiety compared to individuals without arthritis (Politis, Johnson, Hansen, Sullivan & Zhang, 2016). Approximately 44% of individuals with doctor- diagnosed arthritis report arthritis-attributable activity limitations (Barbour, Helmick, Boring & Brady, 2017). Currently, 1 in 25 adults between the ages of 18- 64 report arthritis attributable limitations and among those, 1 in 4 adults report work limitations (CDC, 2017). Moreover, arthritis is the leading cause of disability among older adults (Brault., Hootman, Helmick, Theis & Armour, 2009).

Arthritis- related symptoms, such as pain and mobility impairment, contribute to the negative effects arthritis has on HRQOL (Stahl & Briley, 2004). Arthritis is a source of chronic pain, which results in worsening joint symptoms (Mili et al., 2003). Nearly 70 million adults in the US report chronic and often debilitating aches and pain in their joints (CDC, 2002). Additionally, individuals with arthritis report higher rates of depression and anxiety compared to individuals without arthritis (Politis et al., 2015). Furthermore, depression and anxiety are known to negatively impact HRQOL (Stahl & Briley, 2004). Individuals with arthritis also have high rates of co-morbid conditions. Individuals with arthritis have a greater risk of developing obesity, diabetes and heart disease (Barbour, Helmick, Boring & Brady, 2017) all of which can have a negative impact on HRQOL. About half of all individuals with diabetes or heart disease also have arthritis. Similarly, nearly 1/3 of individuals who are obese have arthritis and there is a higher prevalence of arthritis among obese individuals (CDC, 2006 & Hootman & Helmick, 2006).

Pain is an important consideration for individuals with arthritis. Data from the National Health Interview Survey (NHIS) indicated 43.2% of individuals with arthritis report having pain that limits their daily activities (Kennedy, Roll, Schraudner, Murphy & McPherson, 2014). Furthermore, in 2014, 27% of individuals with arthritis reported experiencing severe joint pain, defined as a rating of 7 or higher on a 10-point scale (Neogi, 2013). Until recently this percentage had remained stable; however, from 2002 to 2014 the number of people reporting severe joint pain went from 10.5 million to 14.6 million and one in four adults with arthritis report having severe joint pain (Barbour, Boring, Helmick, Murphy & Qin, 2016). Recent studies have shown an association between pain and the risk of experiencing a fall (Leveille et al., 2009). Individuals who report experiencing musculoskeletal pain, severe joint pain or pain that results in interference with daily activities are significantly more likely to experience a fall when compared to individuals who experience lower levels of pain or no pain (Leveille et al., 2009).

Arthritis results in high healthcare utilization and financial burden due to its effects on function, disability and pain. Healthcare utilization among individuals with osteoarthritis (OA) is notable. Individuals with knee OA have significantly more physician visits when compared to individuals without OA (Wright et al., 2010). Individuals with knee OA had an average of 18.4 physician visits annually compared to an average of 10.0 visits annually among OA- free individuals (Wright et al., 2010). Additionally, individuals with comorbidities had hospitalization rates 50% higher than individuals with no comorbidity (Yelin & Felts, 1990). Healthcare costs in individuals with OA are 1.5- 2.6 higher than healthcare costs in individuals without OA (Kotlarz et al., 2009). Healthcare expenditures, for pain specifically, are costly because pain typically requires medical attention and treatment. It is estimated that total healthcare costs for pain ranged between $261 and $300 billion in 2010. This is greater than reported healthcare costs for heart disease, cancer, and diabetes.  In 2013 it was reported that arthritis costs were $340 billion with $140 billion accounted for in medical costs and another $164 billion accounted for in lost wages (Murphy, Cisternas, Pasta, Helmisk & Yelin, 2017). Furthermore, OA was the mostly costly, hospital treated, condition in the United States in 2013 with over $16 billion in medical costs (Torio & Moore, 2016).

*Balance, Falls and Arthritis*

Falls are highly prevalent among older adults with 1 in 3 adults, aged 65 and older, experiencing a fall, each year. Falls are also highly common among individuals with arthritis. OA is recognized as an independent risk factor for falling among older adults older (Foley et al., 2006, Leveille et al., 2002 & Preito- Alhambra et al., 2013). Falls commonly result in impaired function, which can lead to disability, loss of independence and the development and exacerbation of depression (Sterling, O'Conner & Bonadies, 2001, Tromp et al., 2001, Rubenstein & Josephson, 2002). While the mechanism through which lower extremity knee OA impacts the risk of falling is unclear, it is becoming more widely believed that gait and balance disorders might be secondary to knee OA resulting in an increased risk of falling. Individuals with OA, who have arthritis-related symptoms including pain and stiffness, typically experience alterations to their gait patterns and speed, which commonly go unnoticed until a fall incident occurs (Ng & Tan, 2013).

Falls are another source of financial burden on the healthcare system and for older adults. An estimated 20% of all fall incidents result in medical care (Alexander, Rivara & Wolf, 1992). Sixty-three percent of medical costs attributed to falls were for hospitalization and 16% for rehabilitation services (Stevens et al., 2006). In 2012, healthcare costs from non-fatal falls totaled $30.3 billion. An uneven distribution of falls and treatment costs related to falls exists between men and women. In a year, women experienced 2.13 million falls requiring medical care whereas men experienced 1.07 million falls requiring medical care. As a result, women accounted for $21.5 billion of the total $31.3 billion in medical costs associated with falls (Burns, Stevens & Lee, 2016). On average, the total cost of a medically treated, non- fatal fall was $9,780 in 2015 (Burns, Stevens & Lee, 2016). Because arthritis increases the risk of having a fall, costs for falls are an important consideration when describing arthritis-related health care costs.

*Obesity, Balance and Arthritis*

Bodyweight is an important consideration in the management of arthritis. Excess body weight has negative implications for the development and progression of arthritis, arthritis-related symptoms and mobility limitations (Hootman, Helmick, Hannan & Pan, 2011). Overweight/ obesity has been identified as an independent risk factor for the development and progression of OA, and more specifically, knee OA (Anandacoomarasamy, Caterson, Sambrook, Fransen & March, 2008). Nearly 23% of individuals who are overweight and 31% of individuals who are obese have a diagnosis of arthritis (Barbour et al., 2013). Likewise, individuals with OA are at a greater risk of being overweight or obese (Strauss & McCarthy, 2017). Roughly 66% of individuals, with doctor- diagnosed arthritis, are overweight or obese (Shih, Hootman, Strine, Chapman & Brady, 2006).

According to the John Hopkins Arthritis Center, "Being 10 pounds overweight increases the force on the knee joint by 30- 60 pounds with each step." (2012) This excessive load placed on the knee joint contributes to joint or cartilage degeneration over time (Creamer & Hochberg, 1997 & Bucknort et al., 2014). The National Health and Nutrition Examination Survey (NHANES) reported that obese individuals' risk of developing OA is four to five times higher than the risk of non-obese individuals (Anderson & Felson, 1988). Furthermore, obesity has been identified, in multiple studies, (Coggon et al., 2001, Felson & Zhang, 1998 & Blagojevic, Jinks, Jeffery & Jordan, 2010), as the single most important risk factor for the development of severe knee OA and a risk factor for developing OA.

Being overweight or obese increases the risk for disability (Felson et al., 2000). Moreover, excess weight has a clear association with increased pain in the lower limb joints. Anderson and colleagues examined the effects of body mass index (BMI) in adults over the age of 60 and demonstrated that as BMI increases, the prevalence of self-reported, significant pain levels increases (Anderson et al., 2003). Furthermore, overweight individuals with arthritis have an increased risk of developing an arthritis-related mobility limitation which may be attributable to lower levels of physical activity (Strauss & McCarthy, 2017).

*Weight loss, Balance and Arthritis*

Weight management is recommended in treatment guidelines for arthritis (Melanson, 2007) yet there are relatively few studies examining the benefits of weight loss in people with arthritis or the best ways to accomplish and sustain weight loss in people with arthritis. The Framingham study examined the BMI of 800 women and their risk of developing symptomatic OA in a 10 year follow up. They found a 2 point or higher decrease in BMI decreased the risk of developing symptomatic arthritis by more than 50% (Felson, Zhang, Anthony, Naimark & Anderson, 1999). Additionally, The American College of Rheumatology recommends a combination of exercise and diet be utilized for the management of OA in obese and overweight patients (Hochberg et al., 2012). Recent weight loss intervention studies suggest weight loss can be achieved in people with arthritis; however, these interventions used intensive approaches including meal replacements, very low calorie diets, and one-on-one approaches (Hunter et al., 2015 & Messier, 2009). This may limit the translatability of the findings.

Weight not only plays a role in the development and progression of OA, but it also plays a critical role in developing the risk for a fall. One study found that obese older adults, those who reported a BMI of 30 or greater and an average age of 50 years, had an increased risk of falling (Fjeldstad, Fjeldstad, Acree, Nickel & Gardner 2008). Furthermore, a longitudinal study found that obesity is associated with an increased risk of experiencing a fall among older adults. Obesity is a growing concern in older adults. Between the years of 2007 and 2010, 1 in 3 older adults were classified as obese, (Fakhouri, 2012). Furthermore, the prevalence of obesity is expected to grow from 40 million to 88.5 million older adults by the year 2050 (Vincernt & Velkoff, 2010).

Recent data suggest that excess bodyweight is associated with balance impairments in people with arthritis (Affiuletti et al., 2005) but evidence-based solutions to this problem are lacking. To the best of our knowledge, there are not any published studies examining the effect of weight loss on balance outcomes in people with arthritis. Balance is crucial to older adults' independence, risk of falls and for delaying disability (Hess & Woollacott, 2005). Therefore, this is a key area for research and study.

*Physical Activity, Balance and Arthritis*

Regular physical activity is recommended as a crucial component in the management of arthritis (Wing & Peterson, 2012, Messier et al., 2004, Batterham, Heywood & Keating, 2011, Pedersen & Saltin, 2015 & Shih, Hootman, Kruger & Helmick, 2002). It is well established that regular participation in exercise improves arthritis-related outcomes including pain, depression, physical function and may delay the onset of disability (Messier, et al., 2004, Callahan et al., 2008 & Penninx et al., 2002, & Bischoff, 2003). Although it is widely known that exercise is essential for individuals with arthritis, individuals with arthritis tend to exercise less than those without arthritis (Batterham, Heywood & Keating, 2011, Pedersen & Saltin, 2015 & Shih, Hootman, Kruger & Helmick, 2002). This lack of exercise, due to discomfort from initial exercise, encourages symptoms of pain and results in reduced muscular strength and reduced range of motion (Ambrose & Golightly, 2015).

Exercise is also critical for weight management in people with arthritis. According to Semanik, Chang & Dunlop, one of the most important factors to consider when caring for individuals with OA is to include exercise in their care plan to help prevent weight gain and obesity. Physical activity is a crucial component for any weight loss effort among adults and especially, older adults to avoid the loss of lean muscle mass (Ambrose & Golightly, 2015). Strength training is necessary for older adults, especially with OA, to promote muscular strength and improvements in arthritis-related outcomes including function and pain (Fransen & McConnel, 2008, Fransen, McConnely & Bell, 2003 & Lange, Vanwanseele & Fiatarone, 2008).

It is well-established that exercise promotes balance and may reduce the risk of falling in older adults (Buchner et al., 1997 & Robertson, Devlin, Gardner & Campbell, 2001). The effects of exercise on balance, in people with arthritis, are not as well studied. Gait and balance impairments are two of the most commonly identified risk factors for a fall and improving and maintaining proper gait patterns are recommended as the focus of fall intervention programs (Lundebjerg et al., 2001). Furthermore, a recent study looked at objective measurements of physical activity and balance, among adults age 40 and older, and found higher accelerometer activity is associated with better functional balance outcomes. (Loprinzi & Brosky, 2014).

*Purpose of the Study*

The objective of this study was to assess whether a group-based, lifestyle intervention can elicit improvements in balance among overweight individuals with arthritis. Specifically, this study examined the effects of a modified version of the Group Lifestyle Balance™ (GLB) program on balance outcomes among overweight and obese individuals with arthritis. The Group Lifestyle Program ™ (GLB) is an evidence-based program based on the Diabetes Prevention Program (Kramer, Kriska, Orchard, Semler &

Venditti, 2011). The GLB program was developed to improve diet and physical activity behaviors in individuals with pre-diabetes and promote a 5-7% reduction in bodyweight. It has been thoroughly evaluated in people with pre-diabetes and metabolic syndrome and older adults (Kramer, Kriska, Orchard, Semler & Venditti, 2011). The GLB has proven effectiveness for weight loss in these populations. It has not been previously tested in people with arthritis specifically nor has its effects on balance been studied. In the present study, we examined the effects of the GLB program on balance outcomes and gait speed in overweight and obese individuals with arthritis. The Fullerton Advance Balance scale (FAB), the timed up and go (TUG), the Activity Specific Balance Confidence scale (ABC) and the 10- meter gait speed test were administered three times over a six-month period to examine changes in balance over time among Group Lifestyle Balance participants.

*Specific Aims*

The following were the aims of this study.

Aim 1: To examine the effects of an adapted GLB program on objective measures of balance (the Fullerton Advanced Balance Scale and Timed Up and Go) and gait speed in overweight and obese individuals with arthritis.

Aim 2: To examine the effects of an adapted GLB program on subjective measures of balance (the ABC scale) in overweight and obese individuals with arthritis.

Aim 3:To examine the association between weight loss and changes in objective and subjective measures of balance.

*Hypotheses*

The primary hypothesis was participants in the GLB program would have significant improvements over time in objective measures of balance and gait speed. The secondary hypothesis was participants in the GLB program would have significant improvements over time in their perceived confidence to perform activities requiring some balance. Our final hypothesis was, in post-hoc analyses, individuals who achieved at least a 5% weight loss would show greater improvements in objective and subjective measures of balance and gait speed compared to individuals who did not achieve the 5% weight loss goal of the GLB program.

*Limitations and Delimitations*

This study, while well thought out and conceived, had some possible limitations. Time commitment was a limitation in this study. The participants were expected to remain in the study for a total of 6 months. Due to life events, vacations and illness participants missed sessions and dropped out. To minimize the time commitment, a phased approach was used in the intervention. The initial requirement for the intervention was to meet once per week for 4 weeks. The following 12 weeks the participants met twice per week. After the initial 16 weeks, the core sessions were completed and the participants met bi-weekly for the remaining 2 months. We also allowed the participants to allot themselves to the most convenient location, Tempe or downtown Phoenix. Also, to encourage motivation and participation in the program we included motivational check- in calls, group based activities where participants interact with each other and accountability components.

Pain from exercise was also a possible limitation. The adapted GLB program includes a strong focus on physical activity in the form of cardiovascular exercise and strength-based training. Individuals with arthritis, particularly OA, report experiencing pain when exercising. To help eliminate this potential limitation we updated the manual to include modifications applicable for all fitness levels and tailored the strength-training exercises to individuals with arthritis. We used resistance bands that come in 5 levels of difficulty allowing each participant to work at their appropriate intensity. We included stretches to help aide in reduced injury and stiffness from exercise. By incorporating exercise at a slow and progressive rate, the participants had enough time to become accustomed to the exercises without experiencing adverse side effects. The benefits of exercise for arthritic individuals outweighs the possible limitations or dangers of exercising.

Delimitations of the study include the sample population. Individuals who had a joint replacement in the past 12 months were not able to participate in the study. This was a boundary set due to the nature of recovery and risk for injury, post joint replacement. Another parameter placed on the sample population was a minimum body mass index (BMI) of 27 kg/m2. When working with individuals who are middle –aged or older there are increased health risks associated with weight loss. Also, since this was a weight loss intervention for individuals who are over weight or obese it was important to set a boundary that made sure we were working with individuals who were not only over weight but wouldn’t fall into the underweight category as a result of the intervention. For safety reasons any individual who had contraindications to exercise and could not obtain physician approval to participate in the study was not invited to partake in the intervention. This is for the researchers’ protection and liability and more importantly, the individuals' health and safety.

Considerations were also made with the measurement tools. Since the participants of the study were diagnosed with arthritis test number 8 was eliminated from the Fullerton Advanced Balance Scale (FAB), the 2-foot jump. This decision was made because of the impact placed on the lower extremity joints during the landing of this exercise. Additionally, the FAB scale was chosen over the Berg Balance scale due to ceiling effects seen with the BBS. When working with individuals who are community dwellers and of higher functioning capability, the FAB is a more accurate tool for assessment of fall risk.

Lastly, a single group, quasi – experimental design was selected for analysis of the data. This was a pilot study examining the feasibility and effectiveness of the GLB program. While this approach allows the researcher to examine changes over time, the main limitation is ruling out threats to internal validity. There is no way to be 100% certain the GLB program caused the changes in the outcomes.

# CHAPTER 2

# BACKGROUND LITERATURE

*Arthritis and Osteoarthritis*

Arthritis is one of the most commonly occurring, chronic conditions in the US population (Cleveland Clinic, 2016). Arthritis is a term that refers to more than 100 rheumatic diseases that involves inflammation at and around a specific joint. Inflammation is a response to injury or disease and is often accompanied by pain, stiffness and swelling. The medical community does not completely understand the precise causes of arthritis but there are three factors that have been identified as playing a role in the development if arthritis: genetics, lifetime history and current lifestyle (Cleveland Clinic, 2016). Additional risk factors include age, gender, weight, and work related-factors.

Inflammation has been identified as the primary cause of arthritis-related pain. Inflammation of the synovial membrane, tendons and/ or ligaments have a strong influence on the severity of pain. A clinical diagnosis of arthritis is determined through a variety of methods including a physical examination, X-rays, CT scan or a MRI. Arthritis is not curable.  Most treatment and management efforts aim to address arthritis-related pain by increasing joint mobility or range of motion, strengthening the muscles surrounding the joint and educating the individual on methods of pain management such as pharmaceuticals, exercise, hot and cold therapies and joint replacement surgery (Cleveland Clinic, 2016).

Osteoarthritis (OA) is the most common form of arthritis, particularly among individuals aged 65 and older (Barbour, Helmick, Boring & Brady, 2017). OA is a degenerative joint disease. More specifically, OA is a synovial joint disease. Deterioration of the articulating cartilage found between the joints ball and socket is a progressive process that commonly leads to bone- on- bone joints, which results in pain. Unlike RA, where the immune system of an individual starts to attack its own healthy tissues, OA is largely recognized as a joint disease that develops from lifestyle factors. Factors such as age, obesity status and injury play a critical role in the development and progression of OA (Felson, Anderson, Naimark, Walker & Meenan, 1988). The development and progression of arthritis-related conditions vary based on the form of arthritis. However, in all cases, arthritis compromises the joints of the individual resulting in varying degrees of alteration and deterioration.

*Impact and Consequences of Arthritis/ Osteoarthritis*

Arthritis currently affects more than 54 million adults in the United States (Barbour, Helmick, Boring & Brady, 2017). Arthritis, along with other rheumatic disorders, is the leading cause of disability in the US (Brault, Hootman, Helmick, Theis & Armour, 2009). Arthritis prevalence is highest among older adults age 65 and older (Cisternas, Murphy, Sacks, et al., 2015). Nearly 1 in 2 older adults have doctor-diagnosed arthritis (Barbour, Helmick, Boring & Brady, 2017). This specific age demographic is also experiencing exponential growth (Colby & Ortman, 2014). In 2014, 14.5% of the US population was 65 and older, totaling more than 46 million individuals (Colby & Ortman, 2014). This number is expected to grow to more than 90 million by the year 2060, accounting for nearly one-fourth of the US population (Colby & Ortman, 2014). The rapid growth in the number of individuals aged 65 and older combined with 49.6% of this age group reporting a diagnosis of arthritis (Barbour, Helmick, Boring & Brady, 2017) creates a significant public health concern for the individual as well as the healthcare system and the economy.

As the older adult demographic continues to grow, we are going to see a continued growth in the number of individuals with arthritis (Hootman, Helmick, Barbour, Theis & Boring, 2016). Lawrence and colleagues reported an estimated 15% or 40 million individuals had some form of arthritis in 1995 (1998). Furthermore, they estimated by 2020 more than 18% of the population would be affected by arthritis or musculoskeletal disease, accounting for 59.4 million individuals (Lawrence et al., 1998). Recent prevalence data support the predictions by Lawrence and colleagues (1998). Prevalence data from 2010- 2012, indicated 52.5 million people had arthritis and by the year 2020, it is estimated there will be 63 million cases of doctor diagnosed arthritis (Barbuor & Helmick, 2013). Moreover, the most recent prevalence data suggest the prevalence has increased. Using data from 2013-2015, nearly 54.4 million individuals had arthritis (Barbour, Helmick, Boring & Brady, 2017), an increase of nearly 2 million cases of arthritis, over a one- to- three year period. This increase is due to both the increased number of adults over the age of 65 and the increased prevalence of overweight and obesity. Nearly 50% of individuals age 65 and older have been diagnosed with arthritis (Barbour, Helmick, Boring & Brady, 2017). Osteoarthritis, specifically, is the most common form of arthritis and joint disease among US adults (Barbour, Helmick, Boring & Brady, 2017). It is estimated that OA impacts more than 30 million adults (Cisternas, 2015).

Another important consideration to make when looking at the prevalence of arthritis is the noticeable disparities in prevalence rates between men and women.

Osteoarthritis is more prevalent among women than men. (Woolf & Pfleger, 2003). The most recent statistics on the prevalence of doctor -diagnosed arthritis show that women experience arthritis at a significantly higher rate (26%) compared to men (19.1%) (Barbour, Helmick, Boring & Brady, 2017). There are also noticeable differences in prevalence among race and ethnicity. The prevalence of arthritis among Non- Hispanic whites is noticeably higher (41.3 million cases) compared to Hispanic adults (4.4 million cases), Non- Hispanic blacks (6.1 million cases) and Non- Hispanic Asians (1.5 million cases) (Barbour, Helmick, Boring & Brady, 2017).

These overall projections and prevalence rates are important to consider for several reasons. Arthritis impacts the individual and creates a burden for the nation's economy and healthcare resources (Lawrence et al., 1989 & Britton, 2009). OA is considered the costliest disease in terms of healthcare expenditure due to its high rates of prevalence rate (Britton, 2009). Arthritis comes with multiple consequences for the individual, their family members, care givers, policy makers, hospitals, health care providers and physicians. The effects are vast and wide reaching. From an individual standpoint, arthritis is a major concern because of its impact on overall quality of life. The consequences of arthritis vary from one individual to another. Common consequences of arthritis for individuals include: disability, mobility disability, limitations in daily activities, pain, anxiety, depression, an increased risk of falling, loss of independence and mortality (Hootman, Helmick, Barbour & Theis & Boring, 2016). Of all the above-mentioned consequences, disability is the most widely experienced consequence. Arthritis is the leading cause of disability among individuals 65 and older (Brault, Hootman, Helmick, Theis & Armour, 2009).

Because of the debilitating nature of the disease, arthritis compromises quality of life and independence among older adults (Song, Chang & Dunlop, 2006). An estimated 37.6% of adults indicate they have some level of arthritis-related disability (CDC, 2006). More specifically, arthritis is the leading cause of "work- related disability" among individuals between the ages of 16 – 72 years of age (Lawrence et al., 1998). The impact of arthritis on disability occurs across all age groups, including the youngest members of society and the oldest (Lawrence et al., 1998). Individuals as young as 16 report "work related disability" that is attributable to arthritis. However, it is well-established arthritis and arthritis-related symptoms increase as we age (Lawrence et al., 1998).

Early research from the 1980's and 1990's demonstrated and brought awareness to the disabling and debilitating nature of arthritis (LaPlante, 1988 & Cunningham & Kelsey, 1984). Arthritis was the most frequently reported cause of disability. Moreover, arthritis was reported nearly twice as often as the second most frequently reported cause of physical disability, which is circulatory disorders (LaPlante, 1988 & Cunningham & Kelsey, 1984). Population level data showing arthritis as a leading cause of disability in the US began to emerge more than 15 years ago (CDC, 2002). Currently, of the 54 million US adults diagnosed with arthritis, 23.7 million or 44% report having arthritis-attributable activity limitation (AAAL) (Barbour, 2017). Moreover, the number of individuals who experience arthritis attributable activity limitations (AAALs) is projected to increase by 52%, resulting in 34.6 million individuals suffering from AAALs by the year 2040. This equates to about 11.4% of all US adults (Hootman, Helmick, Barbour & Theis & Boring, 2016). These numbers are alarming and call for interventions that can reduce the impact arthritis has on disability. One study hypothesized that if arthritis were eliminated, 1 in every 4 new cases of disability, impacting ADL, would be prevented (Song, 2006). This would currently improve the lives of roughly 13.5 million individuals or 25% of the current 54.4 million cases of arthritis.

Arthritis significantly increases the likelihood of developing ADL disability (Song, 2006). Song reported that individuals with a diagnosis of arthritis are twice as likely to develop disabilities within two years (2006). This is both a challenge and an opportunity for medical and healthcare professionals. With advancing research on ways to better manage and delay the progression of arthritis, this two-year timeframe can be seen as an opportunity to aggressively intervene and potentially delay or prevent disability. If we know that ADL disability typically develops within the first two years of diagnoses, prevention programs can be developed to target those individuals who are newly diagnosed with arthritis. The only caveat to this proposed intervention plan is whether the diagnosis is made at the onset of arthritis or if the individual has been living with arthritis for several years before being diagnosed. Regardless, attempting to target those individuals who are newly diagnosed might be an area of further research and development.

Furthermore, gender differences exist in the risk for developing OA with women reported to have a one point five to four times greater risk of developing knee OA (Tsai & Liu, 1992). One study looked at cartilage development and total cartilage present at the joint site to explain the gender differences in OA prevalence rates (Jones, Glisson, Hynes & Cicuttini, 2000). The researchers concluded that knee cartilage developed earlier in life might create a greater risk for development of OA later in life. When looking at sex differences in cartilage volume among female and male children. They found that there was a difference of 16-31% in cartilage volume between males and females with females experiencing a lower cartilage volume compared to males. It was stated that while this is largely unexplained, physical activity, bone size, hormones and diet might be to explain for the differences. The above reported difference in cartilage volume was after adjusting for physical activity and bone size differences between male and female children (Jones, Glisson, Hynes & Cicuttini, 2000). This data suggests it is plausible that the development of OA may begin in childhood, similar to other diseases such as heart disease, type 2 diabetes and osteoporosis, the development of these diseases begin in childhood.

Another major concern among individuals with arthritis is pain. Pain is a significant contributor to disability among older adults (Leveille et al., 2009). Data from the National Health Interview Survey indicate that one fourth of individuals living with arthritis experience severe joint pain (Barbour, Boring, Helmick, Murphy & Qin, 2016). Pain caused by arthritis-related conditions is chronic and often requires a lifelong treatment and management plan (van Laar et al., 2012). Furthermore, pain and joint stiffness are common symptoms of OA (Escalante, Saavedra, Garcia- Hermoso, Silva & Barbosa, 2010). Pain is recognized as the most notable contributor to joint mobility reduction and loss of function (McDougall, 2006). Currently, there are no effective and satisfactory means of pain treatment or management (McDougall, 2006). With nearly 50% of individuals with arthritis reporting severe pain, it is critical that we explore means of effective and beneficial pain management.

Treatment options for pain management must explore options aside from pharmacological therapies (van Laar et al., 2012), which typically result in negative side effects when relied on to manage pain, long term (Peppin, 2009). Hence, there is a need for alternative options that won't negatively impact other areas of an individual's health. Pain caused by arthritis-related conditions is, for a large portion of the population, incurable. Since we are unable to reverse the symptoms of arthritis-related pain, it is essential that we develop methods of management to protect the integrity of life, into the latest years of our existence (Fitzcharles, Lussier & Shir, 2010). When considering the pain and disability associated with arthritis, it is important to move beyond management methods such as drug therapies and explore preventative options that require lifestyle focused treatment plans.

Pain further complicates and compromises the health status of older adults by creating an increased risk of falling (Leville et al., 2009) Falls are of great concern for older adults and individuals diagnosed with arthritis (Dore et al., 2015). In fact, osteoarthritis (OA) is considered an independent risk factor for falling among adults (Foley et al., 2006, Leveille et al., 2002 & Preito- Alhambra et al., 2013). Falls have grave consequences for older adults and individuals with arthritis. Falls are the leading cause of "injury- related mobility and mortality" among adults 65 years of age and older (Stevens, Corso, Finkelstein & Miller, 2006). Individuals with arthritis are 2.5 times more likely to experience two or more falls in a 12-month time period and experience fall-related injuries (Barbour et al., 2012). Pain is thought to impact the risk of falling in multiple areas of physical and mental health. Three general areas that have been examined as possible underlying mechanisms contributing to the pain- fall relationship include: local joint pathology, neuromuscular effects and cognitive activity (Leveille, 2009). With multiple areas of concern, it is easy to see how complex and intricate the relationship is between pain and falls.

Another component of health and quality of life that is negatively impacted by arthritis is mental well- being. Arthritis is associated with depression (Sterling, O'Conner & Bonadies, 2001). Additionally, anxiety is another form of mental illness that is more prevalent in individuals with arthritis than in individuals without diagnosed arthritis (Shih, Hootman, Strinr, Chapman & Brady, 2006). Until recently, anxiety was thought to exist in conjunction with depression however, recent studies have shed light on that exclusiveness of the two illnesses, as well as, the potential risk anxiety might play in the development of depression (Kessler, Keller, Wittchen, 2001). Anxiety and depression are both common illnesses that effect outcomes common to individuals with arthritis including pain and disability (Dominick, Blyth & Nicholas, 2012).

Currently, one-third of individuals with arthritis, aged 45 and older, report having anxiety or depression or both (Murphy et al., 2012). Furthermore, anxiety is experienced at higher rates than depression with 31% of individuals experiencing anxiety and 18% of individuals reporting depression (Murphy et al., 2012). While these statistics are high and show an obvious concern not only for physical well- being of individuals with arthritis, even more alarming, of the individuals surveyed, only half reported receiving help (Murphy et al., 2012). Knowing the impact that anxiety and depression have on mental health and physical health, impacting disability and pain, it is essential to find a way to incorporate treatment and care for anxiety and depression into arthritis treatment plans.

Due to the high prevalence rates and wide-reaching effects of arthritis, the individual, the healthcare system and economy are impacted by arthritis. Healthcare costs are high among individuals with arthritis because arthritis typically requires frequent and consistent healthcare utilization. Individuals with OA reportedly have healthcare costs that surpass individuals without arthritis by 1.5.- 2.6-fold (Kotlarz et al., 2009). Additionally, according to Wright and colleagues (2010), individuals with arthritis have more frequent physician visits (mean of 18.4 visits) compared to those individuals without arthritis (mean of 10.0 annual visits). It is estimated that if medical expenditures ($140 billion) were combined with economic loss through missed days of work and reduced productivity ($164 billion) a total of nearly $304 billion is contributable specifically, to arthritis-related conditions (Murphy, Cisternas, Pasta, Helmick & Yelin, 2018). This is an astronomical number and one that can be potentially reduced though better prevention and management options.

Another major contributor to annual healthcare costs and economic burden is pain. Healthcare expenditure, for pain specifically, is costly because pain typically requires medical attention and treatment. It is estimated that total healthcare costs for pain ranged between $261 and $300 billion in 2010. This is greater than reported healthcare costs for heart disease, cancer, and diabetes. The mean healthcare cost, per individual, was $4,475 with prevalence estimates of 25% attributable to arthritis, 33% joint pain and 12% functional disability. (Gaskin & Richard, 2011). When the total cost of lost productivity in the workplace is included, which is estimated to be between $299 billion and $355 billion, the total cost of pain adds up to $560 billion to $636 billion, annually (Gaskin & Richard, 2011). Furthermore, it was reported that nearly $43 billion were lost indirectly through reduced productivity while at work and absenteeism (Ricci & Chee, 2005).

Joint replacements are another source of financial costs for individuals and the healthcare system. Total knee replacements are among the most common and expensive medical procedures in the United States totaling between $15 and $18 billion, annually. Furthermore, on average, the hospital charges for a total knee replacement are nearly $40,000 (Ilfeld, et al., 2007). It is estimated that about 675,000, lower extremity joint replacements are performed annually. This number is expected to increase significantly with a projected rise of 673% for knee replacements and 174% for hip replacements by 2030 (Kutz, et al., 2007).

Research on the future prevalence of arthritic conditions doesn't look very promising in the way of decreasing rates of arthritis-related conditions among older adults. It appears that we will continue to see an increase in the number of individuals with arthritis and at a steady rate. The most currently predicted prevalence of arthritis is 78.4 million by the year 2040 (Hootman, Helmick, Barbour, Theis & Boring, 2016). With rates expected to continue to climb it is crucial that health care providers identify ways to prevent and manage the symptoms of arthritis-related diseases.

*Balance, Falls and Arthritis*

Falls are a great concern not only for older adults but also among individuals diagnosed with arthritis (Dore et al., 2015). Osteoarthritis (OA) is recognized as an independent risk factor for experiencing a fall, among adults 65 years of age and older (Foley et al., 2006, Leveille et al., 2002 & Preito- Alhambra et al., 2013). Research has shown that OA has a major impact on the risk of falling. Individuals with OA have 25% greater likelihood of falling compared to those without a self- reported case of OA. Furthermore, 50% of individuals with OA report experiencing a fall each year (Preito-Alhambra et al., 2013). The relationship between OA and falls remains unclear. However, a recent review of the literature found that self- reported pain, of the lower extremities, is associated with a risk of falling among older women, specifically (Ng & Tan, 2013). This is of importance to healthcare providers because lower extremity, knee OA is the most common form of OA (Ng & Tan, 2013). Knowing that OA is typically accompanied by pain at the joint site and that women who experience lower extremity joint pain do have an increased risk of falling, there is a possible relationship between OA and balance impairments which can lead to falls. This relationship is one worth studying and further investigating for the benefit of the general population.

Furthermore, Dore et al. reported that the likelihood of experiencing a fall increases with the number of lower extremity joints that are affected by arthritis. The same study reported that the odds of falling increase by 53% in those with a single lower extremity joint effected by OA (2015). There is a positive relationship between OA and falls in that, as the number of arthritic joints increases, chances for experiencing a fall, increases. 2 joints result in 74% higher risk and those with 3-4 effected joints had an 85% increased probability of experiencing a fall (Dore et al., 2015). It is becoming increasingly clear that arthritic conditions impact the likelihood of experiencing a fall and the number on influence on falling, is balance.

One major contributor thought to influence the risk of falling, in the context of pain, is joint specific pain. Knee pain, specifically, has been identified as a mediating factor that increases the risk of falling among older adults (Arden et al., 2006). Furthermore, one study attempted to look at the physiological risk factors for falls, among older adults with arthritis. This study included a sample of 684 men and women between the ages of 75- 98, with self- reported lower extremity arthritis. Those individuals with self- reported arthritis performed significantly worse in knee and ankle muscular strength, lower limb proprioception, vision, reaction time and pain assessments. Additionally, the researchers reported that these individuals also experienced significantly more falls over a 12- month time period than those without self- reported arthritis (Sturnieks et al., 2004). The study also found physical function indicators that played the greatest role in predicting a fall. Knee extension strength and sway, conducted by using standing balance assessments, were identified as areas of importance when targeting individuals at the greatest risk of falling (Sturnieks et al., 2004). One possible explanation for decreased muscular strength, due to pain, is lower levels of physical activity. Furthermore, gait alterations are also considered a possible change resulting from pain that impairs balance subsequently, increasing the risk of a fall (Leveille, 2009).

The last but equally important factor to take into consideration, when examining the relationship between falls and pain, is cognitive activity. Leveille and colleagues proposed that chronic pain might interfere with an individual's cognitive abilities and presents itself as a distraction resulting in reduced cognitive reasoning capabilities (2009). When individuals are in a compromised position where they experience balance interruptions and need to avoid a fall, "cognitively– mediated physical maneuvers" are a necessity (Leveille, 2009). Possessing the ability to think and react quickly appears to play a significant role in reducing and preventing fall risk. Individuals who experience chronic pain exhibit changes to their brain structure, as well as, brain function. This has been witnessed in imaging studies that used neuropsychological testing (Apkarian, Baliki & Geha, 2009).

Furthermore, individuals who experience chronic pain demonstrate poorer executive function coupled with a decreased capability of attention when compared to healthy counter parts (Eccleston & Crombez, 1999). With a decreased attention to your surroundings paired with reduced ability to think quickly and proactively an individual might find themselves in a compromised state conducive to a greater risk of falling. While these factors seem to play a role in preventing a fall, mobility limitations and an individual's fall history have been identified as the greatest predictors of experiencing a fall (Rubenstein, 2006).

Balance related incidents, such as falls, are highly prevalent among older adults and individuals with arthritic conditions. Barbour and colleagues reported 1 in 3 older adults experience a fall, each year (2014). Furthermore, arthritis is recognized as an independent risk factor for experiencing a fall with nearly 50% of individuals, with arthritis, reporting at least one fall incident (Levinger, Wallman & Hill, 2011). With this multidimensional crisis it is imperative to explore interventions that address physical function improvements to both the arthritic joint and balance.

Balance related accidents, such as falls, have wide reaching effects on an individual's overall quality of life. For example, falls are reported to impact an individual's functionality both physically and mentally; This includes limitations to physical activity and mobility, fractures to the hip, possible brain injury and reduced time spent doing activities that are considered physical activities (Rubenstein & Josephson, 2006). Balance impairments are related to several physical function factors such as, gait speed, gait patterns and healthy joints. All of these factors are also related to arthritic conditions and are commonly experienced side effects of living with arthritis, specifically OA.

Since balance and balance related factors greatly impact the likelihood of a fall, it is imperative to explore possible avenues for improving balance. Falls are a major threat among the aging population also, because they have been identified as the leading cause of mortality and morbidity within this population (Dore et al., 2015). In 2003, the annual mortality rate was 36.76% and in 2007, the annual mortality rate, from falls, jumped to 44.89%. This resulted in an increased mortality rate of 22.14% (Alamgir, Muazzam & Nasrullah, 2012). Given this noticeable increase in mortality resulting from falls, there is an apparent need to advance areas of research that examine possible means of reducing the risk of a fall.

Lastly, fall incidents are also an indicator of independence. They have been identified as a good predictor of whether an individual will likely be able to maintain independence in their latest years of life (Chang et al., 2004). Balance impairment and consequential falls, have grave impacts on the individual but they also have wide reaching effects that dramatically effect health care spending each year. It is estimated that in 2005, falls cost the health care system 24 billion dollars (Dore et al., 2015). This statistic is alarming because the number of individuals who experience a fall, each year, continues to grow as the aging population grows in volume. This has become so apparent that research shows the number of falls from 2001 to 2008 rose 50% (Tinetti, 2003 & Hartholt, Stevens, Polinder, Van der Cammen & Patka, 2011). Knowing that arthritis has negative consequences to the individual and the health care system it is wise from a financial and health related stand point to explore interventions that will aid in the reduction of balance and physical function decline.

Falls not only effect the individual but they also result in an additional economic and healthcare burden. Sixty-three percent of medical costs attributed to falls were for hospitalization and 16% for rehabilitation services (Stevens et al., 2006). In 2012, healthcare costs for non-fatal injuries from falls totaled $30.3 billion. An uneven distribution of treatment costs and fall incidents existed between men and women. Women accounted for $21.5 billion of the total $31.3 billion in medical costs with 2.13 million falls compared to men who reportedly experienced 1.07 million falls, accounting for $8.8 billion in medical costs (Burns, Stevens & Lee, 2016). The total cost of medically treated, non- fatal falls was on average, $9,780 in 2015 (Burns, Stevens & Lee, 2016). Because arthritis increases the risk of experiencing a fall, costs related to falls are an important consideration when evaluating costs related to arthritis.

*Obesity, Balance and Arthritis*

Obesity is another disease that is occurring at alarming rates. Obesity is defined as a body mass index (BMI) of 30 kg/m2 or greater. One of the greatest changes seen among the baby boomers, versus cohorts of previous decades, is the prevalence of obesity. Currently, more than 1 in 3 adults are classified as overweight and more than 2 in 3 adults are classified as being either overweight or obese according to the National Health and Nutrition Examination Survey (NHANES). Another changing factor, among current generations, is the onset of obesity, at a younger age. Obesity rates among adults in their 30's and 40's are nearly twice that of what they were in previous generations (Leveille, Wee & Iezzoni, 2005). While obesity has been on the rise in recent decades, there was a plateau in prevalence rates seen among the NHANES survey data when comparing rates from 2003- 2004 and 2011- 2012 (Ogden, Carroll, Kit & Flegal, 2014).

Currently, it is reported, based on data from 2011- 2014, that roughly 36.5% of all U.S. adults are obese (Ogden, Carroll, Kit & Flegal, 2014).

Literature has also shown that obesity and being overweight can result in adverse health effects. A 40-year follow- up of the Framingham Study stated that a loss of 6-7 years of life resulted from being obese (Peeters et al., 2003). Additionally, Reynolds & McIlvane reported that adults, 70 years of age and older, whom are overweight or obese and are diagnosed with arthritis experienced significant increases in the years lived with disability. They reported that men have nearly a three-fold increase in the number of years lived with disability. Woman experience a two- fold increase in the years lived with disability when compared to individuals who were neither overweight or obese or diagnosed with arthritis. The authors reported an increase in years lived with disability when only accounting for one factor, either obesity or arthritis, also. The years of disability reported were less when experiencing only one factor versus comorbidities (Reynolds & McIlvane, 2009).

Furthermore, approximately 71% of the older adult population is considered overweight or obese (Cheng et al., 2016). While there is some disagreement in regards to whether being classified as obese, in terms of BMI or weight alone, causes deterioration of health in all individuals, the majority of research shows that being overweight or obese is a health risk. Obesity has been identified as a clear indicator for increased risk of developing OA (NHANES 1). Excess weight is also associated with an increased risk of mortality and prevalence of chronic disease among aging adults (Mokdad et al., 2001). The main, modifiable risk factor for OA is overweight or obesity status (Kulkarni, Karssiens, Kumar & Pandit, 2016).

Being overweight or obese plays an important role in the onset, management and progression of arthritis (Shih, Hootman, Strine, Chapman & Brady, 2006). The First National Health and Nutrition Examination Survey (NHANES), which is a survey that is conducted periodically to collect health information on the U.S. population, among all age groups, reported on trends seen among obesity rates and arthritis prevalence. This survey is acknowledged as a "nationally representative sample of the U.S. residents" and is used to produce national prevalence projections (Leville, Wee & Iezzoni, 2005). The most notable findings in obesity trends were among the baby boomer cohort, those born between 1956- 1965. This cohort not only experienced a substantially higher rate of obesity but they also developed obesity much earlier compared to those individuals in proceeding generations (Leville, Wee & Iezzoni, 2005).

Along with the witnessed increases in obesity, researchers examined the NHANES data from 1971- 2002 and found that the percentage of individuals with arthritis, who are also obese, has also seen an increase. In the initial NHANES data set it was reported that those individuals who were obese were 20% more likely to report a doctor diagnoses of arthritis when compared to those individuals who were not obese. In the data from 1999- 2002 it was reported that obese individuals were 60% more likely to report a diagnoses of arthritis when compared to their non- overweight counterparts. The authors made a prediction that 18% of arthritis cases could have potentially been prevented if none of the members were in the obese weight category (Leville, Wee & Iezzoni, 2005). The authors also reported in the most recent wave of data there was a significant association between obesity and the development of arthritis. In fact, it was reported that obese female subjects were 4 times more likely to develop OA compared to females who were not obese. Obese males reported a five-fold increased risk of developing OA compared to non-obese males (Anderson & Felson, 1988). The authors also stated that the overall findings of the 1999- 2002 NHANES survey data suggest that obesity, among the baby boomers, is and will continue to be an "important risk factor for arthritis." (Leville, Wee & Iezzoni, 2005)

Furthermore, when we examine diagnosis criteria of osteoarthritis, one of the main criteria is a decrease in joint spacing or joint space narrowing which is determined through radiographic imaging and is largely affected by loss of cartilage (Ding, Cicuttini, Scott, Cooley & Jones, 2005). Knee OA diagnosis, determined by radiographic criteria, increases nearly 4-fold among woman who are obese compared to woman who are not obese (Manek, Hart, Spector & MacGregor, 2003). These findings further support the idea that being overweight or obese plays in a role in the development of arthritis and suggest that being overweight is a contributor to disease progression.

Another landmark study, the Framingham Heart study, looked at an adult population and risk factors associated with the onset of cardiovascular disease. Unlike the NHANES survey, this sample was representative of a specific region, Framingham, Massachusetts. One study conducted by Felson, Anderson, Naimark, Walker & Meenan looked at associations between knee OA and obesity (1988). The authors looked at baseline weight measured at the start of the Framingham Study and data from 1983- 1985 on knee OA among the participants. All subjects were asked to participate in a knee radiograph and a total of 79% of subjects completed the knee radiograph as part of their $18^{th}$ biennial examination. They found that overweight individuals were at an increased risk of developing knee OA later in life. Roughly thirty-five years after the initial examination, those individuals who were in the heaviest weight quintile experienced the greatest risk of developing knee OA. Risk was only increased among men in the heaviest quintile compared. Women experienced an increased incidence rate in each increasing weight category. As weight increased among females, the cumulative incidence rate of radiographic knee increased. The researchers concluded that while the factors are unknown, obesity, measured at examination one, created a risk among both men and women for the development of knee OA nearly 36 years later (Felson, Anderson, Naimark, Walker & Meenan, 1988).

Obesity not only increases the risk of development of arthritis, but it also appears to play a role in exacerbation of arthritis symptoms, specifically pain (Messier et al., 2018). Pain is a well-known symptom of arthritis and research suggests that it is also a well-known symptom of being overweight or obese (Kennedy, Roll, Schraudner, Murphy & McPherson, 2014 & Barbour, Boring, Helmick, Murphy & Qin, 2016). The presence of pain appears to have a compounding effect on obesity. Individuals who experience pain are also less active and more sedentary which appears to exacerbate pain and obesity (Okifuji & Hare, 2015).

Obesity not only plays a negative role in the development and progression of arthritis, but it also appears to play a role in the risk for experiencing a fall. Obese individuals are at an increased risk of falling with nearly twice the prevalence: 15% in non-obese individuals and 27% in obese individuals (Wu, Nussbaum & Madigan, 2016). Several factors seem to influence balance performance among individuals who are overweight or obese.

Fjeldstad and colleagues looked at over 200 females and males who had an average age of 50 years to see if obese individuals experienced higher rates of falling when compared to individuals who were "normal weight." (2008) Furthermore, the researchers looked at whether there was a higher prevalence of impaired balance among the obese individuals compared to those who were in the normal weight category. They found that obese older adults had a higher prevalence of falling (27%) than the normal weight individuals (15%). The obese group also reported ambulatory stumbling at a higher rate than their normal weight counterparts, 32% and 14% respectively (Fjeldstad, Fjeldstad, Acree, Nickel & Gardner, 2008).

Furthermore, Himes and Reynolds looked at data collected from the Health and Retirement Study (HRS), which was a longitudinal survey that was conducted every 2 years and included factors on health, economics and family transitions among older adults (2012). Himes and Reynolds looked at self- reported data on whether the participants had experienced a fall, whether the participants had experienced a fall that resulted in a serious injury and a third variable that that represented ADL disability. All of the data was collected between the years 1998 and 2006. Based on the previously collected data from the HRS it was found that a linear relationship existed between obesity and risk of falling with the greater the obesity status, the greater the risk of experiencing a fall (Himes & Reynolds, 2012). The study also found compelling evidence that obesity offered a protective means to fall related injuries. Individuals who were class 3 obesity were significantly less likely to experience a serious, fall- related injury when compared to the normal weight individuals. The authors proposed that the excess of soft tissue around the bones and joints might offer protection from breakage (Himes & Reynolds, 2012).

Postural sway and control is an important factor among older adults. Poor postural control is recognized as a risk factor for experiencing a fall (Maki, Holliday & Topper, 1994). More recently, research has further shown a strong relationship among higher weight status and postural instability (Hue et al., 2007). It has also been demonstrated that weight loss among overweight and obese individuals has a strong relationship with improved balance control (Hue et al., 2007).

A study of obese, older woman that examined whether obesity was associated with decreased balance control through examination of postural sway found that obesity appears to play a negative role in proprioceptive feedback for postural control. A force plate was used to measure balance control or postural sway and revealed that overweight and obese woman had increased postural sway which was interpreted as decreased postural stability when compared to a group of normal weight woman (Dutil et al., 2013). Deficits in sensorimotor systems have clearly been recognized as risk factors for increased risk of falling (Muir et al., 2010). Recent studies have shown that maintaining upright balance depends primarily on sensory input and sensory systems such as: visual vestibular and proprioception. Ankle stiffness combined with the above-mentioned mechanisms results in decreased balance control (Loram & Lakie, 2002). These decreases in functional ability and mechanical constraints play a negative role in balance among older adults who are overweight or obese.

Postural sway, while a good indicator of balance disorders and risk of fall, is not the only reliable predictor of balance impairments. Gait speed is an important and perhaps more reliable predictor of falls (Rubenstein, Powers & McLean, 2001). Gait disorders are prevalent among older adults and identified as one of the most common causes of falls among older adults. Furthermore, gait disorders are commonly caused by arthritis (Salzman, 2010). Additionally, obesity has been identified as a cause of balance disorders (Salzman, 2010) and known to negatively impact walking ability (Houston et al., 2009 & Stenholm, 2007).

Wu and colleagues found that obese individuals undergo alterations to their gait patterns that adversely affect function such as balance and falling, which are associated with a higher risk of experiencing a slip (2016). Furthermore, changes in gait are expected during dual task scenarios, especially among obese individuals because of changes to their executive function (Wu et al., 2016). While the exact relationship between obesity and balance disorders is unclear it is thought that excess body weight results in biomechanical alterations among lower extremity joints (Ling et al., 2003) that can be burdensome and lead to impaired walking and balance disorders (Ko, Stenholm & Ferrucci, 2011).

*Weight loss, Balance and Arthritis*

Obesity and arthritis have a clear but not completely understood relationship. Knowing that weight status plays a role in the development, management and progression of arthritis, it is imperative to consider the impact of weight loss and understand its ability to negate these negative effects. The literature overwhelmingly states that the single most important modifiable risk factor for the onset and progression of OA is obesity (Felson, 1988, Davis, Ettinger & Neuhaus, 1990 & Sturmer, Gunther & Brenner, 2000). Obesity is also a contributing factor for the origin of arthritis symptoms and weight loss has demonstrated itself as being a viable option to reduce arthritic symptoms such as pain, inflammation and disability which are commonly associated with knee OA (Messier et al., 2018).

There appears to be a cyclical relationship between obesity and OA. Overweight and obesity increase the risk of developing OA and worsen disease progression (Anderson & Felson, 1988, Leville, Wee & Iezzoni, 2005 & Shih, Hootman, Strine, Chapman & Brady, 2006). Little is known about the benefits of weight loss for individuals with arthritis. Historically, weight loss was not encouraged for older adults due to concerns about loss of lean muscle mass and bone (Bales & Buhr, 2008). However, recent studies have demonstrated that intentional weight loss may be safe for older adults when the weight loss approach includes exercise to preserve lean muscle mass.

With rising obesity rates, it is increasingly important to determine whether intentional weight loss is beneficial to older overall adult's health and can help with the management of OA. One consistent problem mentioned in the weight loss literature is that weight loss is not the same for older adults as it is for younger populations especially when the older adult population is experiencing co-morbidities, reduced muscle mass, reduced bone mineral density or frailty (Villareal et al., 2004). Weight loss plans have been cautioned due to losses seen in muscle mass and bone mineral density despite their successes in improving important measures such as physical function and cardiovascular health (Cheung & Giangregorio, 2012). A better understanding of what a successful weight loss intervention needs to include, and appropriate modes of weight loss are necessary in order to utilize this lifestyle modification as a means to prevent and manage OA.

A recent study of 240 overweight and obese adults with knee Osteoarthritis found that intensive weight loss versus moderate weight loss is better for eliciting improvements in arthritic symptoms. This randomized controlled study found that weight loss of 20%, achieved through diet and exercise, was helpful for reducing pain among overweight and obese individuals with knee osteoarthritis (Messier et al., 2018). The presence of Osteoarthritis is known to breakdown the cartilage and tissue that cushions joints where bones meet. One known cause of this deterioration of cartilage and tissue is the mechanical stress on the joint that results from bearing excess weight on the joint (Messier et al., 2018 & Ding, Cicuttini, Scott, Cooley & Jones, 2005). Excess load on joints is thought to exacerbate the deterioration of the joint tissues, narrowing the joint space and resulting in more bone-on-bone friction which can cause pain and swelling (Messier et al., 2018). These findings suggest that weight loss can potentially help manage symptoms of arthritis, such as pain, by reducing the excess force load placed on the joints.

One meta- analysis that reviewed 10 trials, all of which were randomized control trials, among older adults who were 65 years of age and older found that a weight loss of 10% of body mass is achievable through the utilization of dietary means and exercise. The authors did note that a reduction in lean body mass was witnessed and while exercise can help decline the lean body mass reduction; it could not be stopped, completely, during the weight loss period (Water et al., 2013). This is a primary concern for recommending weight loss among older adults (Bales & Buhr, 2008). The authors also provided important, relevant information on the critical importance of prescribing adequate resistance training-based exercises, which is inadequately addressed among this population in the current literature (Water et al., 2013). It appears that this is a critical component to attenuating lean muscle loss during the weight loss period. Another suggestion made by the authors, to help preserve calcium and Vitamin D, is including a calcium and Vitamin D supplement (Waters et al., 2013). While this last suggestion might be a good suggestion for preserving bone mineral density, there is still the concern about preserving lean muscle mass.

A loss of lean muscle mass can be particularly problematic for old adults. Recent literature is showing that when resistance training is performed at moderate intensity, improvements in physical function and decreases in fat mass can be elicited while maintaining skeletal muscle mass (Frimel, Sinacore & Villareal, 2008). Frimel and colleagues looked at the benefits of incorporating high intensity strength-based exercises, in combination with a dietary intervention that included a caloric deficit, among frail older adults. They found that this combination elicited increases in lean mass, as well as, increased muscular strength during weight loss (2008). This provides meaningful and important information for health care providers working with obese older adults. Improvements in physical function are important but maintaining muscular strength and not compromising overall body composition is also important. We don’t want to improve one area of wellness while compromising another.

Another study looked at the benefits and the ability of a weight loss intervention to improve lower extremity, thigh muscle, composition among obese adults. Two groups were designated, one was a dietary intervention only group and the other was a dietary and resistance training group. They found that measures of physical function were improved in the dietary and resistance training weight loss group but the diet only group failed at eliciting meaningful improvements in both weight status and thigh composition.

However, the group that partook in the dietary weight loss and resistance training intervention experienced improvements in fat mass, as well as, thigh composition (Avila, Gutierres, Sheehy, Lofgren & Delmonico, 2010). This study found that during a weight loss intervention, that includes dietary alterations and resistance training, thigh muscle composition can be improved while achieving an 11% body fat decrease (Avila, Gutierres, Sheehy, Lofgren & Delmonico, 2010). The muscle cross- sectional area experienced only a slight increase, which is still meaningful because it shows that weight loss can be achieved without eliciting lean muscle mass loss.

The American College of Rheumatology recommend a combination of exercise and diet be utilized for the management of OA in obese and overweight patients (Hochberg et al., 2012). Past research has shown a strong association between obesity and knee OA and exercise programs, along with weight loss, are showing promising results in improving mobility and managing the disease progression of OA (Davis, Ettinger & Neuhaus, 1990 & Felson, Zhang, Anthony, Naimark & Anderson, 1992).

One landmark study that observed an association between obesity, weight loss and OA is the Framingham study. The Framingham study provided meaningful information in regard to obesity and the development of OA and it also provided important insight on weight loss and the role it plays in the development and management of OA. The Framingham study examined the BMI of 800 women and their risk of developing symptomatic OA in a 10 year follow up. They found that a decrease in BMI, greater than or equal to 2, decreased the risk of developing symptomatic arthritis by more than 50% (Felson, Zhang, Anthony, Naimark & Anderson, 1992). This shows that a modest reduction in BMI, of 2 units, which is equivalent to roughly 11 pounds, which doesn't require extreme lifestyle modification or changes can still provide a 50% reduction in risk of developing symptomatic arthritis (Felson, Zhang, Anthony, Naimark & Anderson, 1992).

Furthermore, weight loss is a potentially beneficial means for improving balance among older adults with arthritis. As established earlier, obesity and increased pain levels are well recognized symptom of being overweight or obese (Kennedy, Roll, Schraudner, Murphy & McPherson, 2014, Neogi, 2013 & Barbour, Boring, Helmick, Murphy & Qin, 2016). Pain, especially pain at multiple sites, is also recognized as a risk factor for experiencing a fall (Welsh, Clarson, Mallen & McBeth, 2019). Previous research has demonstrated that weight loss is effective for reducing pain among overweight adults with OA (Messier et al., 2018). Knowing that weight loss improves pain levels and that pain is associated with an increased risk of falling it is possible that improvements in pain levels, elicited through weight loss, could potentially improve balance.

Excess weight it also identified as a cause of balance disorders (Salzman, 2010). As established previously, excess weight negatively impacts postural sway (Dutil et al., 2013) and gait speed (Salzman, 2010). One study conducted by Teasdale and colleagues examined the effects of weight loss on postural sway among obese and morbidly obese individuals (2007). The authors conducted a longitudinal study looking at postural control before and after a weight loss intervention. The authors found that weight loss did elicit improvements in postural control and improved balance and there was a "near linear relationship" where the greater amount of weight loss resulted in greater improvements in balance control (Tesdale et al., 2007). This is one of very few studies that provide insight on the potential benefits of weight loss on balance.

It is also thought that excess weight plays a role in knee- joint forces which impacts walking patterns. It is thought that by attenuating the effects of excessive knee- joint force, through weight loss, management and development of knee OA can be improved (Messier, Gutekunst, Davis & DeVita, 2005). The authors found that minimal weight loss can have very beneficial effects on knee- joint loads and results in force reduction. For every pound lost, a load reduction of 4 pounds was reported, per step. Furthermore, the researchers found a direct relationship between internal knee abduction and body mass. Internal knee abduction is considered a "knee- joint moment" and is reported to increase the stress on the knee joint while walking. It was found that as body mass decreases are associated with decreased knee- joint moments of internal knee abduction resulting in an attenuated impact on knee- joint loads (Messier, Gutekunst, Davis & DeVita, 2005).

Lastly, while weight loss is acknowledged as an effective means to improve health status. A moderate weight loss of 5%- 10% is suggested to be adequate to elicit health related improvements. However, simply losing weight isn't sufficient. In order to sustain these health benefits, the individual must maintain the weight loss (Ferland & Eckel, 2011). Sustaining meaningful weight loss over a life span is critical for those individuals wishing to gain health related benefits and improved quality of life. While it is widely acknowledged that obesity is a risk factor for OA, as well as, the progression and weight loss is shown to result in significant improvements, exercise adherence and exercise prescription for the disease is still being researched (Bliddal, Leeds & Christensen, 2014). Just as obesity and weight status appear to play a role in the development of OA, weight loss appears to play a meaningful role in prevention, management and delayed decline from OA.

When combining the appropriate variables, to elicit weight loss, we see meaningful results in OA management including improved function, attenuated decreases in skeletal muscle and improved joint load. Strength based exercises appear to be crucial when implementing a weight loss intervention with older adults. Strength training appears to be essential during the weight loss period to attenuate lean muscle mass loss. Weight loss also has potentially meaningful benefits for improving balance outcomes in overweight and obese individuals. Weight loss has been shown to improve pain levels which are known to negatively impact balance. Weight loss is also a potentially beneficial means for reducing excess load on lower extremity joints which can protect joints from being compromised structurally. Weight loss offers many benefits for individuals with OA and should be explored as a means of intervention among this population.

*Physical Activity, Exercise, Balance & Arthritis*

Historically, exercise has been discouraged among individuals with arthritis and recommendations for physical activity were largely confined to pool based activity (Wing & Peterson, 2012). However, these recommendations are no longer considered accurate and physical activity is recognized as a beneficial means to manage arthritis symptoms (Fransen & McConnell, 2009). The 2008 Physical Activity Guidelines Advisory Committee Report recommended physical activity as part of a treatment and care plan for individuals with arthritis (2008). The report also included recommendations that physicians should include counseling on physical activity with their patients. The suggested exercise prescription included 30 minutes of physical activity, 5 days per week at a low- to- moderate intensity, to not exacerbate pain and prevent any major risk for joint injury (Physical Activity Guidelines Advisory Committee, 2008).

Physical activity is recommended for individuals with arthritis for a multitude of reasons, including: pain management, decreased disability, improved function, disease progression management, improved HRQOL and weight loss (Fransen & McConnell, 2009). One study that looked at long- term effects of physical activity among individuals with OA is the Fit and Strong study (Hughes et al., 2004). The Fit and Strong study was designed to address the growing rate of disability among individuals with OA. Fit and Strong is an eight-week intervention that combines strength-based exercises with aerobic exercise and an educational component. Individuals meet for ninety minutes, on three days of the week, for two months. Follow up phone calls were conducted to examine long-term efficacy of the intervention. The study addressed the need for attenuating strength and aerobic declines witnessed among individuals with OA (Hughes et al., 2004). Data from the initial 215 participants showed a significant decrease in lower extremity stiffness at months two and six, as well as, reduced levels of pain at month six. Overall, the authors of this study found physical activity to be beneficial for individuals with OA by improving stiffness, pain and disability (Hughes et al., 2004). This study provided meaningful and convincing evidence that physical activity provides benefits among an osteoarthritic population.

Additional research has been conducted to examine the efficacy of physical activity to reduce the risk of disability among older adults. Disability increases the risk for mortality and loss of independence and arthritis is the leading cause of disability (Guralnik, Fried & Salive, 1996). Due to the negative effects associated with arthritis and disability, The LIFE study looked at the benefits of a structured physical activity on reducing the risk of mobility disability among older adults (Pahor et al., 2014). Subjects were randomly assigned to one of two groups: a moderate- intensity exercise intervention or an educational group. The following findings come from the study's pilot data, which was conducted and collected from 2010 to 2013.  The primary variable examined was the subject's ability to walk, which was used to determine mobility disability. Over a 2.6 year follow up, the study found the physical activity intervention group experienced significant reductions in mobility disability compared the education group. The physical activity group experienced mobility disability in approximately 30% of participants compared to the education only group where nearly 36% of participants experienced mobility disability. This study was conducted among a sedentary group of adults between the ages of 70- 85 years old (Pahor et al., 2014).  These results, while conducted among an older population, still have translatability due to the increased functional limitations that typically accompany an arthritic population.

Another value of physical activity and exercise is its benefits on muscular strength. Research supports the notion that muscular atrophy or muscle loss and weakening is a contributing factor to the progression of osteoarthritis (Ikeda, Tsumura & Torisu, 2005). Several benefits have been identified in relation to muscular strength and muscle mass. Among them include producing movement, absorbing joint loads and providing stability and support for joints (Brandt, 1997 & Hortobagyi, Garry, Holbert & Devita, 2004). Decreased muscular strength and muscular atrophy compromises joint function and structure (Valderrabano & Steiger, 2010). Since there is no cure for OA current research focuses on management of pain and improved joint function and stability as means of treatment and disease management (Valderrabano & Steiger, 2010). It is known that pain and function are improved through exercise among an OA population (Fransen & McConnell, 2009). OA is a complex disease that is linked to muscle function (Valderrabano & Steiger, 2010) but the direct benefits and pathogenesis of muscular atrophy and strength are not completely understood in context to disease management and development. While not completely understood, there is a link to muscular health and OA.

Cartilage plays a crucial role in pain management and mobility when dealing with arthritis. The deterioration of cartilage at the joints cause great pain for individuals because it leaves the ends of the articulating bones left exposed and they begin to grind into each other causing further joint damage. One study, conducted using hamsters, examined whether sedentary or active hamsters experienced the greatest cartilage loss at the femoral joint. After a 3-month intervention, of either daily exercise or sedentary living, the hamsters who exercised had a smooth, articulating surface compared to the sedentary hamsters. The sedentary hamsters also showed decreased synovial fluid volume (Otterness et al., 1998). This study showed that, in hamsters, exercise has a protective effect against cartilage breakdown, not a negative effect. To examine whether exercise favors human cartilage in the same way that Otterness and colleagues found in hamsters, a study was conducted to look at the effects of moderate exercise on human cartilage of the knee. The examined population had all undergone a partial medial meniscectomy. The participants were asked to complete a 4 month exercise regimen or where instructed to maintain their current physical activity level. At the conclusion of the 4 month program it was found that exercise positively impacts cartilage structure among humans, also (Roos & Dahlberg, 2005). This research is promising to those looking to help manage and delay the onset and progression of OA. It amplifies the need for implementing more treatment plans that involve lifestyle changes such as exercise and promote living a more active lifestyle, overall.

Impaired balance and risk for falling can be attributed to multiple factors. Among these factors, lower extremity muscular strength is considered a factor for impaired balance and increased risk of falling among older adults (Tinetti, Williams & Mayewski, 1986). Some of the earliest studies conducted to examine the benefits of strength based exercise intervention among individuals with OA found improvements in lower extremity musculature of the knee flexors and knee extensors (Chamberlain, Care & Harfield, 1982). Know the relationship between muscular strength and balance, as well as, protecting joint integrity it is important to further examine witnessed benefits of strength training on balance and falls. Robertson, Devlin, Scuffham, Gardner, Buchner and Campbell conducted a study, out of New Zealand, to examine the ability of a strength training and balance-based exercise program, among octogenarian women, to positively impact healthcare cost and fall reduction (2001). The authors found an at home exercise program to be effective in reducing the number of falls among older women. The authors failed to find any reductions in healthcare costs. After further examination, the researchers found that the exercise program was effective at preventing falls but moderate injury still resulted accounting for the maintained healthcare costs (Robertson, Devlin, Scuffham, Gardner, Buchner & Campbell, 2001).

Gait speed has also even been identified as an independent risk factor for falling (Van Kan et al., 2009). Gait speed has also been recognized as a reliable performance measure of functional capability that provides consistently reliable values that predict the risk of falling. Gait speed, which is also referred to as walking speed, has been identified as a marker of overall health among aging adults. Walking is an activity and thus requires energy. A decline in gait speed is thought to echo other health related problems that might not be apparent (Studenski et al., 2011). Furthermore, with decreased gait speeds we also see a trend in poorer health related outcomes including: falls, poor quality of life and mortality (Peel, Kuys, & Klein, 2013). Gait speed is an important predictor of physical function, balance and overall mortality and thus is a reliable and important variable among older adults.

*Weight loss and the Group Lifestyle Balance Program (GLB)*

The GLB program is a modified version of the Diabetes Prevention Program's (DPP), which is a lifestyle behavior change intervention designed for individuals who were at high risk of developing Type 2 diabetes. The DPP program was developed to help promote a 5-7% weight loss through dietary behavior modification and participation in physical activity. The DPP program was originally developed and tested as an individually-based program, which limits its delivery capabilities when working in the community. The GLB program modified the DPP, formatting it to cater to a group setting.

The DPP is a proven, evidence-based program with demonstrated effectiveness for achieving a 5-7% weight loss goal, increasing physical activity and reducing the likelihood of becoming diabetic by 58% compared to a control group (Kramer et al., 2011). This is important because the program was able to help individuals achieve a healthy weight loss goal and increase their activity levels both of which are important among older adults who are obese and arthritic. Furthermore, The DPP was administered over a wide audience including 27 different health centers across the United States with more than 3,000 adult participants.

The GLB is based on the DPP program and was developed in collaboration with Diabetes Prevention Support Center faculty (Kramer et al., 2011). A previous study implemented the GLB program among individuals who were pre- diabetic, diabetic or neither and found that at 12 weeks all of the participants had experienced significant weight loss and increased physical activity levels (Greenwood et al., 2014). They also found that the program was effective among all groups, regardless of whether they had diabetes or not. This is positive because it shows that the program has potential among other diseased populations that could benefit from weight loss and exercise. The GLB program has been implemented in in a variety of community based center, over the past several years, and has been shown to reproduce the same effect of weight loss (Greenwood et al., 2014). Additionally, a study by Villareal et al. found that an intervention of diet and exercise was able to reduce fat mass while maintaining and gaining lean mass through the combination of diet and exercise (2011). This would show that exercise and diet together create a positive effect on weight loss among obese individuals.

Another crucial component to consider when working in the healthcare setting is always, cost. Being able to administer the intervention in a group setting versus one- on-one helps assist with cost and the financial burden of delivering a lifestyle change program. Greenwood and colleagues report that the delivery of the GLB program, in a community setting, is not a costly burden and helps reduce overall financial need. Additionally, the researchers stated that the GLB program is an efficient use of resources among overweight and obese individuals, diabetes status aside (Greenwood et al., 2014). It was reported in 2012 that the cost of delivering the DPP, on a one- on- one basis, cost roughly $1,400 per person in the initial year of participation (Diabetes Prevention Program Research Group, 2012). Both efficacy and cost are important to consider and the GLB program is conscious of both factors. By focusing on diet and physical activity to elicit positive effects to weight and physical function it is hoped to achieve ample changes that will result in improved balance.

The GLB program has a core focus on exercise, as well as, nutrition. There have been numerous studies over the years in regard to nutrition and trying to decipher what type of dietary changes promote the greatest weight loss. Also, there is discussion about achieving weight loss through a combined effort of diet and exercise changes. Weight loss and nutrition is a very important topic among older adults. As we age, we experience changes and alterations to our homeostatic reserve. There is typically a decrease in the amount of energy requirements and thus a reduction in caloric needs (Bales & Ritche, 2002). However, simply reducing caloric intake doesn't appear to be the solution to meaningful and lasting weight loss.

The GLB program has a weight loss goal of 7% of their initial body weight with a long-term goal of maintaining this this weight loss. Several nutritional goals were set to help the participants reach these goals including fat and calorie reduction goals. Dieting or calorie suppression is an energy expenditure reducer which results in difficulty maintain long term weight loss (Wu et al., 2009) One way to increase the amount of energy expended is to exercise. By including exercise as a part of healthy weight loss, you can counteract the energy suppression and increase energy expenditure which increases metabolic rate. This end result of an increased metabolic rate helps aid in long term weight loss.

Likewise, additional studies that utilized a lifestyle intervention utilizing diet and exercise as their mode of intervention have found promising results (Messier et al., 2013). The Intensive Diet and Exercise for Arthritis study (IDEA) looked specifically at an arthritic population and the benefits of an exercise and diet based lifestyle intervention. The IDEA study was an 18 month intervention that included three groups: diet only, diet plus exercise and exercise only that was looking for weight loss among arthritic participants. The study looked at the benefits of a diet based, with or without exercise, versus an exercise based group achieving a minimum of 10% weight loss on functional and self- reported measures of pain and mobility (Messier et al., 2013). After 18 weeks, the authors concluded that the diet and exercise group saw the greatest improvements overall. This group saw improvements in inflammation, pain, function, walking speed and self- reported data on physical HRQOL. Some of the most promising results from this study were the improvements in gait speed and decreased levels of compressive force at the knee joint. Both variables have been identified as important for improving balance and reducing arthritic symptoms, respectively.

Additionally, one meta-analysis study found that weight loss interventions that consisted of both physical activity and diet efforts promoted long term weight loss, greater than diet alone efforts (Wu et al., 2009). Another important finding from this study was that the greatest weight loss was seen among interventions that lasted longer than 1 year in duration opposed to those that were shorter than 1 year. They also found that time spent interacting with the subjects is important. They suggested that group meetings, clinical visits, email and telephone calls are important to achieving long term weight loss (Wu et al., 2009). The GLB balance program is 1 year in duration which according to this meta-analysis could be a limitation of the study. On the other hand, the first 3 months of the program involves bi weekly interaction with the subjects. This interaction continues and presents itself in multiple forms over the course of 12 months in the form of the above suggested, telephone calls and emails. This could be a possible benefit of the GLB program over other interventions that involve less interaction with the subjects.

Additionally, when working with older adults it is critical that you manage a healthy weight loss plan that doesn't lead to the loss of lean muscle mass. The importance of lean muscle mass was established previously with it's greatest importance, in reference to arthritis and obesity, being improved joint stability and mobility, increased energy expenditure, increased and greater muscular strength. By combining strength training with diet changes you are more likely to preserve muscle mass and elicit muscular atrophy. This is especially beneficial for joints affected by arthritis, it increases joint stability and acts as a protective mechanism against falls.

# CHAPTER 3

# METHODOLOY

This study was a secondary data analysis of data collected as part of a funded-project examining the effects of an adapted Group Lifestyle Balance Program$^{TM}$ on weight loss, cardiovascular risk factors and physical function in overweight individuals with arthritis. The parent study was a year-long study examining the effects of the Group Lifestyle Balance Program$^{TM}$ on weight loss in people with arthritis. This ancillary study examined the effects of the Group Lifestyle Balance Program on balance and physical function outcomes at 12 weeks and 6 months.

*Study Design*

A single-group, quasi- experimental design with a pre-test and two post-tests was used. Data was collected at baseline, which was defined as 1 week prior to the study initiation to allow for the collection of baseline physical activity data, and again at 12 and 24 weeks. All study participants received an adapted version of the Group Lifestyle Program Balance program. Changes, over time, in the dependent variables will be examined.

*Participants*

*Recruitment*

Participants were primarily recruited through Osher Lifelong Learning Institute (OLLI) in Tempe, Arizona and the Arizona State University (ASU) Retirement Association. The respective organizations sent their members an email via the organizations' list server. The email included information about the study and contact information for the research team (*see Appendix C*). Interested individuals were asked to contact the study team to learn more about the study and to be pre-screened for eligibility. Interested individuals could either call the study, send an email or complete an initial screening via an online survey administered via Qualtrix. Individuals who were eligible, based on the pre-screening criteria, were invited to an in-person, baseline evaluation for additional screening to determine final eligibility status (*See Table 1*).

Table 1. Recruitment Criteria

| **Primary Inclusion Criteria** | |
|---|---|
| **Variable** | **Pre-screening Inclusion Criteria** |
| Age | ≥ 45 years of age |
| Arthritis Diagnoses | Doctor diagnosed |
| BMI | ≥ 27 |
| Joint Replacement | No joint replacement in past 12 months |
| Walk 1/4 mile | With or without an assistive device |
| **Additional Inclusion Criteria assessed at baseline** | |
| PAR Q+ | No contraindication to exercise.<br>Physician approval if known contraindication exists. |
| CESD - 10 | Score < 10 |

*Inclusion Criteria*

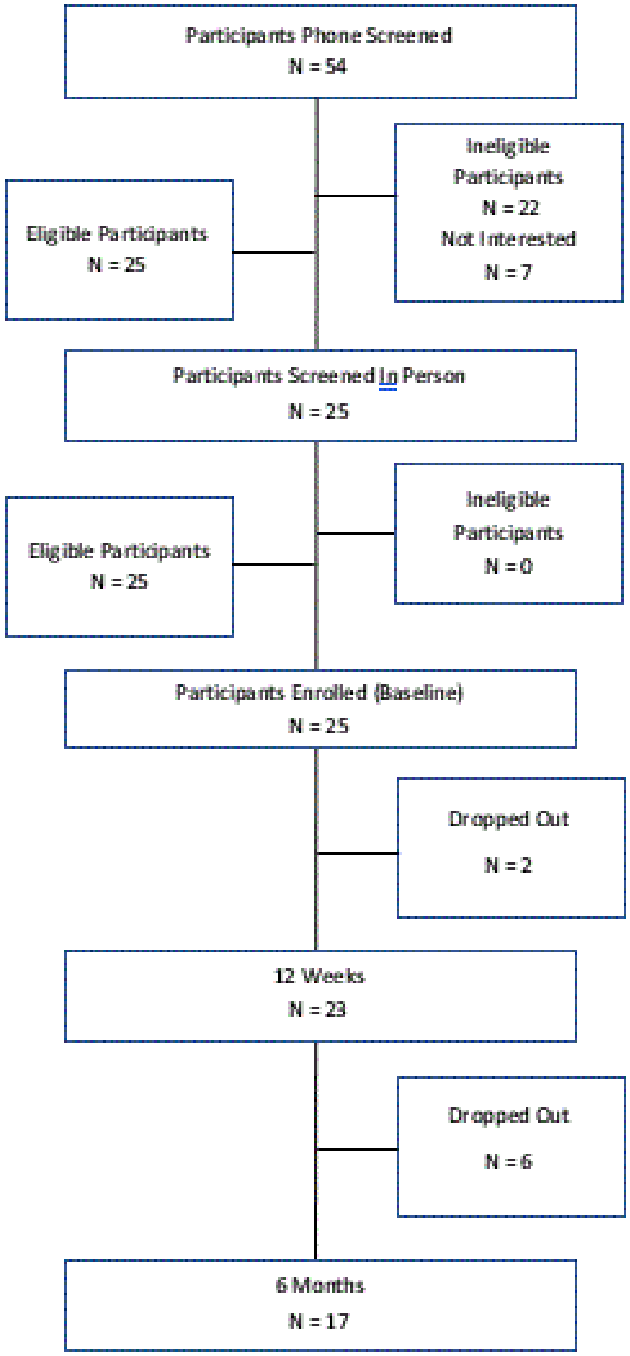
Inclusion criteria for the study were as follows: at least 45 years of age, self-reported, healthcare provider diagnosis of arthritis, body mass index (BMI) of at least 27 kg/m2 based on self-reported height and weight, no history of a total joint replacement within the past 12 months and self-reported ability to walk one-quarter of a mile, with or without an assistive device. Interested participants were screened over the phone or via a Qualtrics survey for these criteria and, if these inclusion criteria were met, participants were invited to attend an in-person meeting for additional screening and baseline data collection. After providing informed consent *(see Appendix B)* participants were screened for the following inclusion criteria: no known contraindications to exercise as assessed by the Physical Activity Readiness Questionnaire Plus (Bredin, Gledhill, Jamnik & Warburton, 2013) *(see Appendix D)* or physician permission *(see Appendix D)* to participate in the GLB program. The PARQ+ is an evidence based screening tool that helps prevent barriers and false positives for exercise participation (Jamnik, Warburton, Makarski, et al., 2011). The self- guided screening tool used medical history and symptomology to provide exercise recommendations that are better tailored to the individual. Any participant who had a health condition that could preclude safe participation in an exercise program was asked to obtain permission to participate in the program from his/her healthcare provider.

*Exclusion Criteria*

Exclusion criteria for the study were as follows: less than 45 years of age, no diagnosis of arthritis, BMI less than 27 kg/m2, unable to walk ¼ of a mile, history of total joint replacement within the past 12 months, has known contraindications to exercise as assessed by the PARQ + and was unable to obtain healthcare provider permission to participate in the study.

Thirty-two participants expressed interest in the study and, of the thirty - two individuals, 25 were eligible to participate. Participant flow through the study is presented in Chart 1. Participants were predominantly female (n=22; 88%) and ranged in age from 55 to 78 years with a mean age of 66.5 years. Eighty- eight percent of the participants classified themselves as white and twelve percent identified as Hispanic.

Chart 1. Participant Flow Chart



*Human Subjects*

The study was approved by the Institutional Review Board at Arizona State University. All participants provided informed consent prior to participation in the study *(see Appendix B).*

*Variables*

*Dependent variables*

The primary dependent variables in this secondary study included measures of balance, physical function, gait speed and perceived balance confidence. Balance was assessed with the Timed- Up- and – Go (TUG) *(see Appendix E)* performed in three variations: alone, dual task cognitive and dual task manual, the 10-meter gait speed assessment (Figure 10) and the Fullerton Advanced Balance scale (FAB) *(see Appendix E).* The TUG is an assessment of dynamic mobility and balance. More specifically, the TUG is a measure of multiple factors of mobility that effect an individual's level of independence. Balance and walking abilities were assessed to determine the individual's risk of falling based on their time and overall performance on the test. The FAB is an assessment of static and dynamic balance (Hernandez & Rose, 2008) and is intended for higher functioning, community dwelling older adults *(see Appendix E).*

Gait speed was assessed with a 10- meter test of gait speed performed in two variations: self- selected velocity and fast velocity *(see Appendix E)*. The 10-meter gait speed walking test was used to assess functional mobility and gait patterns, as well as, speed (Perera et al., 2006). The time it takes to walk a total of 10M with the intermediate 6M used for scoring is measured. Two variations are administered with three trials, each resulting in a total of 6 trials to be used for scoring. Perceived balance confidence was assessed with the Activities- Specific Balance Confidence scale (ABC). The ABC scale is a subjective measure of the participant's perceived confidence to perform specified activities. A total of 16 items were presented and rated on a scale from 0- 100. Each question was initiated by asking, "How confident are you that you will not lose your balance or become unsteady when you…" The assessment can be self- administered or facilitated in a one- on- one manner. The participants were asked to take the questionnaire home and return it during their first class session.

*Independent Variables*

A modified version of the Group Lifestyle Balance program was the primary independent variable in the study. The Group Lifestyle Balance program is an evidence-based program designed to promote weight loss through diet modifications and physical activity (Kramer, Kriska, Orchard, Semler & Venditti, 2011 ). The Group Lifestyle Balance program was developed at the University of Pittsburg as an adaptation of the Diabetes Prevention Program (Kramer, Kriska, Orchard, Semler & Venditti, 2011 ). The Diabetes Prevention Program (DPP) was designed as an individually-based program and was primarily delivered in one-on-one sessions by a health professional. The goal of the program was to promote seven percent weight loss through increased physical activity and dietary modifications. In the DPP, participants were encouraged to engage in at least 150 minutes of moderate-intensity physical activity, to decrease their caloric intake based on the participant's starting weight and to improve the quality of their diet based on US Dietary Guidelines (Kramer, Kriska, Orchard, Semler & Venditti, 2011). The program emphasized behavior-change strategies for long-term success. The Group Lifestyle Balance program was adapted from the DPP program so that it could be delivered in a small group setting while maintaining the same weight loss, diet and physical activity goals and behavior change strategies. The Group Lifestyle Balance Program is a 12-month program. The dose of the program was tapered over the 12-month period as the group meetings became less frequent, over time.

The present study examined results from participation during the first six-months of a modified, Group Lifestyle Balance program. In this study, the GLB program was adapted to promote the importance of physical activity, dietary change and weight loss for people with arthritis, specifically. The original program focused on diabetes prevention; we kept this information but added additional information about the benefits of exercise and weight loss for arthritis. We also added information about safely exercising with arthritis and a section on emotional eating. In addition, a group-based strength-training program was added to the Group Lifestyle Balance program. While the Group Lifestyle Balance Program recommends including strengthening exercises and provides information to promote strength-training including a strength-training exercise packet, we decided to include an in-person, strength-training program for the participants during the first 16 weeks of the program. Strength-training is a critical component of exercise programs for arthritis management (Fransen & McConnel, 2009 & Fransen & McConnell, 2003). Also, because we focused the intervention on a predominantly older population, a strength-training program was critical to prevent muscle loss with weight-loss and improve balance (Ambrose & Golightly, 2015 & Buchner et al., 1997).

Consistent with the GLB program, participants met weekly during the first 16 weeks of the program and then bi-weekly during the last two-months of the program. The initial 16 sessions of the program served as the core of the program and focused on the behavior change skills necessary to promote long-term dietary and physical activity behavior change *(see Appendix F).*

The modified GLB program consisted of two components during the initial 16 weeks of the study, the GLB lifestyle behavior change program and a group-based exercise program focused primarily on strengthening exercises. During weeks one to three, participants were asked to attend class once per week for 60 minutes. During this time, they received the GLB behavior change program. Starting in week four and continuing through week 16, participants were asked to attend class twice per week to participate in the strength-training class on the second day. During weeks 4 – 16, participants received the 60-minute GLB behavior change education program, as well as, 30 - 45 minutes of strength-training exercise on one day and 60 minutes of an exercise program, only, on the second day. In addition to the group-based exercise program and educational portion, participants were encouraged to accumulate 150 minutes of moderate intensity, aerobic exercise, each week. The individuals were allowed to select the type of exercise they performed outside of the group-based sessions. They were provided with numerous ideas and suggestions for exercises that are beneficial for arthritis but were not limited to these only. Examples of recommended exercises included: upper body exercises (chest, shoulders, back & arms), lower body exercises (quadriceps, hamstrings, hips and claves) abdominal exercises, wrist and hand exercises and balance exercises*(see Appendix F).* Flexibility exercises were also included. Some examples of included stretches: hamstring stretch, quadriceps stretch, iliotibial band stretches, chest stretches, bicep stretches etc. *(see Appendix F).*

As part of the intervention participants were provided with a FitBit and physical activity log to self-monitor their participation in physical activity. Participants were encouraged to reach a goal of 10,00 steps each day for health-related benefits (Tudor-Locke et al., 2011). Similarly, participants were provided with weekly food logs to monitor food intake and weight. Participants were asked to record the food they ate each day, including the number of calories and fat grams consumed and at least one measure of body weight per week. These monitoring techniques were used to promote self-regulation of physical activity and dietary behaviors.

Weight loss was the second independent variable in this study. The present study examined results in weight loss over the course of six months in relation to balance measures. Weight was measured at baseline, 3 months and 6 months data collection. Percent change in body weight over the 6-month time period was calculated.

*Covariates*

Sociodemographic characteristics, comorbid conditions, physical activity and weight loss were collected as covariates. Socio-demographic characteristics collected included: age in years, sex (male or female), race (white, black, Hispanic, Native American, Asian, Pacific Islander or other), education level (Never attended school or only attended kindergarten, grades 1-8, grades 9- 11, grade 12 or GED, college 1-3 years, college 4 years or more, refuse) and income level ($0 - $9,999, $10,000 - $14,999, $15,000 - $19,999 ,$20,000 - $24,999, $25,000 - $34, 999, $35,000 - $49, 999, $50,000 - $74,999, $75,000 + or refuse). Sociodemographic characteristics are known to influence health outcomes and there for will be controlled for in analyses to avoid manipulation of the results by an outside variable. Participants were asked to report if they had any of the

18 listed, different illnesses and the impact of these illnesses on their health. The survey looked at disease- specific measurements of physical, social and emotional health (Meenan, Gertman & Mason, 1980).

*Measurement Tools*

Data was collected at baseline (1 week prior to the intervention), at 12 weeks and at 6 months. All data were collected by individuals (n=4) with experience assessing physical function and balance in older adults. All individuals collecting the data were trained by the principal investigator of the research study and each individual had to demonstrate proficiency on the measures. During the training, inter-rater reliability was established. The same four administrators were used to collect the measurements at each of the three time periods.

Body weight: Participants' weights were assessed using a Tanita Body Composition Analyzer (TBF- 300A). Participants were asked to remove their shoes, jackets and all belongings from their pockets prior to stepping on the scale. Weight was recorded to the nearest 1/10$^{th}$ of a kilogram.

Timed Up and Go (TUG): The TUG is an assessment of functional performance in relation to balance (Rose, Jones & Lucchese, 2002). The TUG measures, in seconds, the time it takes an individual to stand up from a standard arm chair (approximate seat height of 46 cm [18in], arm height 65 cm [25.6 in]) walk a distance of 3 meters (118 inches, approximately 10 feet), turn around a cone, and complete the test by walking back to the chair and sitting down *(see Appendix E)*. The subject wears their regular footwear and uses their customary walking aid, if applicable (cane or walker). No physical assistance is given to the participant; if the participant cannot perform the test safely on their own, the test is terminated. The protocol for performing the TUG was as follows: the participants started in a seated position with their back against the chair their arms resting on the armrests, and their walking aid at hand (if applicable). They were instructed that, on the word "go" they were to rise from the chair and walk at a comfortable and safe pace around the cone and back to the chair, completing the course by returning to a seated position in the chair. The course was demonstrated by the test administrator once before the participant attempted it on his or her own. After the course was demonstrated to the participant, the subject was asked to walk through the test once and this was considered the "test" try. Two total attempts were made, and both were timed using a stopwatch. In addition to the standard TUG protocol, participants were also asked to complete the TUG cognitive and a dual tasking TUG protocol. The protocol for TUG cognitive protocol was the same was the same as the standard TUG protocol except participants were asked to count backwards from a randomly selected number between 20 and 100 while completing the walking course. Two total attempts were timed and recorded. Finally, the participants completed a dual tasking TUG in which the participants were asked to complete the standard TUG protocol while holding a coffee mug with water. Participants were asked to complete this assessment twice.

The TUG is a clinical assessment tool used to assess dynamic balance and mobility performance (Donoghue, Horgan & Savva et al., 2012). This assessment has been used at a high rate due to its ability to reliably measure functional balance (Podsiadlo & Richardson, 1991). A substantive body of research has been conducted utilizing the TUG and overall, as a clinical assessment of balance among community dwelling older adults, it is ideal for this studies purposes (Podsiadlo & Richardson, 1991).

The reliability and validity of the TUG is adequate to excellent. The TUG has an excellent test- retest reliability among community dwelling older adults along with a good between rater reliability (Podsiadlo & Richardson, 1991). Furthermore, criterion validity is excellent among older adults (Podsiadlo & Richardson, 1991) and it has an adequate construct validity (Podsiadlo & Richardson, 1991). The reliability and validity of the TUG combined with its easy set up and administration made it an ideal assessment of balance for this study.

To score the TUG, the second score was used. Normal, healthy individuals between the ages of 65 and 79 should complete the test in ten seconds or less. Normative ranges for individuals, by age are as follows: 60- 69 years of age = 8.1 seconds, 70-79 years of age = 9.2 seconds. These normative values do not change with gender until 80 years of age and older (Steffen at al, 2002). The cut off value on the standard TUG, that is predictive of falls among community dwelling older adults who have an increased risk of falling, is 13.5 seconds (Shumway-Cook, Brauer & Woollacott, 2000). Additionally, the TUG was chosen because it is a test of gait performance which is correlated with functional balance and motor impairment (Manaf, Justine & Omar, 2014), both of which can impact the risk of falling.

Fullerton Advanced Balance test (FAB): The FAB is a multi- test assessment of static and dynamic balance. The FAB is a 10- item, assessment of balance. The battery of tests is progressive in nature and includes items such as: standing with feet together and eyes closed, reaching forward to retrieve a pencil from an outstretched arm, turning 360 degrees in the right and left directions and stepping up and over a bench *(see Appendix E)*. For this study, the two-footed jump, item #8, was omitted from the battery of tests.

The two-footed 8 is not recommended for individuals with joint impairment or arthritis in the lower extremities. All of the participants in the present study had arthritis and joint impairment so this test was omitted from the assessment. The FAB is scored based on a total of 40 possible points. Higher scores are considered better with higher scores being indicative of a lower risk of falling. Each test item is scored on a scale from 0- 4. For this study, the maximum score was a 36. The assessment took, on average, 10- 15 minutes to administer.

Each participant was asked to perform the FAB on three separate occasions: at baseline, 3 months and 6 month. For each of the 9 tests, the instructions were read to participate and then demonstrated, when appropriate. The participant was then asked if they had any questions, if they felt they could safely perform each test and then the test was administered.

The FAB is a reliable test of both dynamic balance and a variety of sensory conditions. It is designed to measure balance among high-functioning older adults. According to Hernandez and Rose, a cut off score of 25, or lower is indicative of fall risk (2008). The FAB's test- retest reliability is excellent among for the entire battery of 10 tests and adequate to excellent when examining test- retest among individual tests that make up the entire assessment (Rose, Lucchese & Wiersma, 2006). Additionally, inter-rater reliability, when tested on older adults, is excellent (Rose, Lucchese & Wiersma, 2006). Construct validity is also excellent (Rose, Lucchese & Wiersma, 2006) meaning that we can trust that the FAB is indeed measuring what we intend it to measure, balance.

10M Gait Speed Assessment: Ten-meter gait speed (10M) was assessed on three separate occasions: baseline, 3 months and 6 months *(see Appendix E)*. The 10M gait speed assessment is a walking test where the individual is instructed to walk, on command of the administrator, until told to stop. The distance walked is a total of 10 meters with 2 meters allowed for acceleration and 2 meters allowed for deceleration. The middle 6 meters is timed for scoring. The 10M gait speed was performed a total of six times. The subjects were asked to walk at their normal, comfortable walking pace three time and then they were instructed to walk as fast but as safely, as possible, three times. The subjects were given specific instructions for each test. For the customary walking speed, the test administrator stated: “I will say ready, set, go. When I say go, walk at your normal comfortable speed until I say stop.” For the fast pace trials, the test administrator stated, “I will say ready, set, go. When I say go, walk as fast as you safely can until I say stop”. These instructions were repeated before each trial. A brief moment for recovery and a drink of water were allowed between trials. The test took an average of 5- 10 minutes to administer. The times, for each category test administration were recorded in seconds. The times, for each of the respective categories, will then be divided by seconds to determine m/s and then added and divided by 3 determine the average time in meters per second.

Normative data for the 10 meter gait speed assessment (Bohannon, 1997) indicates females between the age of 50 and 79 years of age were able to walk 1.40 meters/ second ,or faster, on average, when walking at their self- selected, normal, comfortable walking pace. Males of the same age category were able to walk at a speed of 1.39 meters/ second or faster. The test has demonstrated clinical relevance in older adults. According to Perera and colleagues (2006), a small, meaningful change in scores is 0.05 m/s and 0.10 m/s is a substantial meaningful change.  Furthermore, when using this test among healthy adults, test- retest reliability is excellent for self- selected, comfortable gait speed and fastest walking pace (Bohannon, 1997).

Activity-Based Confidence Scale (ABC): The ABC is a survey that subjectively assesses an individual's perceived confidence to perform a variety of activities without losing their balance. The ABC includes 16 items in which the participants are asked to rate their perceived ability to do an activity without losing balance or becoming unsteady (*see Appendix E*). Each statement is rated on a scale from 0- 100 with a score of 0 representing no confidence to perform the activity without losing balance or falling to complete confidence to perform an activity without losing balance or falling, 100. Scores are determined by adding up the total for all 16 test items and dividing it by the total number of test items, 16. The survey was administered at baseline, 3 months and 6 months just like all the objective measures of physical balance. The participants could take the survey home and return at the next session or by prepaid and addressed envelope.

Like the TUG, the ABC is a good assessment tool for falls risk. Lajoie & Gallagher reported the cut off scores for fallers versus non-fallers. A score of less than 67% was indicative of being at an increased risk for falling. Furthermore, the researchers stated that the ABC can accurately predict fallers 84% of the time (2004). Community dwelling adults with a mean age of 70 reported an average score of 79.89 of the ABC scale (Huang & Wang, 2009). The survey was administered at baseline, 3 months and 6months just like all the objective measures of physical balance. The participants were allowed to take the survey home and return at the next session or by prepaid and addressed envelope.

Reliability and validity of the ABC is well established. Test- retest reliability is excellent (Powell & Myers, 1995), as well as, internal consistency, among community dwelling older adults (Huang & Wang, 2009). The overall construct validity was determined to be adequate when correlated with the gait speed assessment (Wrisley et al., 2010). The ABC survey could experience a ceiling effect. Those participants scoring an 80 or higher are unlikely to see improvements in their perceived balance (Huang & Wang, 2009).

*Materials*

The program was offered in a public location to facilitate participation. The GLB program was offered in a conference room at both the Tempe Public Library and the Burton Barr Public Library. The conference room had sufficient chairs and tables to accommodate the number of the participants and ample room for exercise. Participants self-selected the location in which they attended the program.

The participants were provided with materials developed for the GLB program. All participants received a participant manual, which helped guide the participants through each week's session and served as a reference for achieving their behavior change and weight loss goals. Additionally, the participants were provided with a food and activity log and a FitBit to track their food intake and physical activity. The food and activity logs were passed out during their GLB sessions. Participants received a body weight scale to monitor their weight loss progress and a food scale and measuring cups to aid in their dietary endeavors. Finally, each participant received a set of resistance bands for performing the strength-based exercises at home. They were given new bands as they progressed in intensity.

There were substantial material needs for the collection of data. The ABC surveys were printed and distributed at data collection. Each participant received an envelope with their survey. Additionally, for the FAB the following materials were needed: painters tape, a measuring tape, a pencil, a 6- inch step or bench, a stopwatch, an Airex pad and a metronome at 100 BPM. To administer the TUG an arm chair was used, a tape measure to mark off eight feet, tape, a cone and a stopwatch. Finally, to administer the 10-meter gait speed test a stopwatch, painters tape and a tape measure were needed.

*Procedures*

Participants in the study were told that they would be participating in a lifestyle intervention with a focus on diet and physical activity. The goal of the intervention was to improve physical function and promote weight loss in people with arthritis. Prior to study participation, each participant had the study explained to them and was asked to provide informed consent after all of their questions were answered. Each participant was provided a signed copy of the consent document (*see Appendix B)* and the researcher kept a 2$^{nd}$, signed, copy. Participants were informed that their documents and personal information would be kept confidential and in a secure location. They were also informed that electronic copies of their personal information are kept on a private server with access limited to only the research team.

A single-group repeated measures approach was used to assess outcome measures. Baseline measures occurred one week prior to the beginning of the intervention to allow for seven days of physical activity assessment via an accelerometer. For the baseline measures, all participants were asked to come to the Arizona Biomedical Collaborative building in downtown Phoenix to complete the eligibility screening, for an assessment of body weight and body composition as well as assessments of physical function and balance. Participants were also asked to complete a survey which included questions about their socio-demographic characteristics, presence of chronic illness, impact of their arthritis, perceived balance, physical activity level and attitudes and beliefs toward diet and physical activity. This survey could be completed in-person or taken home to complete and returned prior to the first intervention visit. A time wise model was used where participant's measurements were taken on 3 separate occasions and improvements, in scores, were assessed at 3 time intervals. Differences in scores were expected to coincide with the progression of time. This was a within subjects design. There are effectively 2 groups, but they were analyzed as a single group of participants.

Balance measures were collected at 3 separate times: baseline, three months and six months. The participants were asked to attend an additional "session" the week of data collection to not interrupt with the course schedule. Participants were compensated for parking fees, if applicable, and their time. A $20 cash incentive was provided to each participant for their time at each of the three data collection sessions.

*Data Analysis*

All data was examined for normality prior to data analysis. Descriptive statistics were used to describe participant characteristics. Repeated measures analysis of variance (ANOVA) was used to examine changes over time in the dependent variables. Repeated measures ANOVA compared one or more, mean scores, with one another over time. All data analyses were conducted in SPSS version 24 (IBM). There was a minimum of one dependent variable that was observed at more than one point in time. In the present study, the null hypothesis was that the measures of balance would be the same at each time point. Ho = T1= T2= T3. The alternative hypothesis stated that the balance measures would be significantly different at, at least one-time point. To further examine the results and identify where the meaningful differences occurred, a post hoc analysis was conducted.

To address specific aim 2, percent change in body weight, from baseline to 6 months, was calculated for each participant. Then, each participant was classified as either having achieved the 5% weight loss or not achieving the 5% weight loss goal. Percent change in all four measures of balances (FAB, TUG, 10-Meter gait speed and ABC) were calculated, as well. Independent t-tests were then conducted to see if there was a difference in percent change in the outcome measures between individuals who achieved a 5% weight loss and those that did not.

*Strengths and Weaknesses of the Design and Analysis*

A single-group design examined pre-post changes in the dependent variable. With repeated measures, it compared the original or baseline status of the participants to the after-treatment status of the participant. All participants received the same treatment. A strength of this design was that you needed fewer participants compared to a study with a control group and having two post-test assessments in the present study increased the power of the study to detect a change. A post hoc analysis was used to look for correlations among balance scores and weight loss. This was also a pre- post test analysis but without repeated measures.

However, a single- group study design comes with limitations. One of the most notable limitations of a single group design is that it was difficult to disprove the null hypothesis and definitively show that the results came from the intervention. The proposed changes in weight and physical function, as well as, intended improvements in balance could have been elicited from outside or confounding variables and it can be difficult to show that any results were from the intervention. Additionally, it is important to consider the effects of attrition. Participants can drop out and this is more likely when doing an intervention over a long period of time. If too many participants dropped the study, the sample size could become too small to show meaningful results.

# CHAPTER 4

# RESULTS

*Descriptive Data*

Thirty-two participants were screened for the study and, of the thirty - two individuals, 25 were eligible to participate and enrolled in the study. Of these 25 participants, 17 completed all 6 months of the study. Participants (mean age = 71.7 years) were primarily female (82%), white (94%), and college educated (94%). Participant characteristics are presented in Table 2.

Table 2. Participant Characteristics

| Characteristic | Mean ± SD<br>n (%) |
|---|---|
| Age (years) | 71 ± 6 |
| Race | |
| White Non- Hispanic | 16 (94.1) |
| Other | 1 (5.9) |
| Sex | |
| Male | 3 (17.6) |
| Female | 14 (82.4) |
| Education | |
| High school | 1 (5.9) |
| Some College | 4 (23.5) |
| College Graduate | 12 (70.6) |
| Income | |
| $25,000 - $34,000 | 1 (5.9) |
| $35,000- $49,999 | 6 (35.3) |
| $50,000 - $74,999 | 3 (17.6) |
| $75.000 + | 4 (23.5) |
| Refused | 3 (17.7) |

*Outcomes*

Results from the repeated measures ANOVA are presented in Table 3. In the repeated measures ANOVA, there was a significant linear ($F_1$= 7.103, p= .017) effect of time from baseline to 12 weeks for FAB scores. Post-hoc analyses indicated FAB scores increased significantly from baseline to 12 weeks (p = .016).

The repeated measures ANOVA analysis showed that there was a significant linear ($F_1$=14.823, p=.002) and quadratic ($F_1$=7.204, p=.017) effect of time on the TUG alone scores. TUG alone scores decreased significantly from baseline to six months (p= 0.004), suggesting an improvement in balance. There was a linear effect of time on TUG cognitive scores ($F_1$=5.878, p=.028). However, in post-hoc analyses, there were no significant differences in TUG cognitive scores across the time points. Sphericity was violated for the TUG manual scores (p= .013). Scores were corrected using Greenhouse Geiser (p=.113). The repeated measures ANOVA showed a significant linear effect of time ($F_1$= 11.208, p= .004). In post hoc analyses, the TUG manual scores were significantly lower at six months compared to baseline (p= 0.007), suggesting an improvement in dynamic balance. There was a significant linear effect of time for the 10-meter gait speed test for both the customary ($F_1$=5.44, p=.033) and fast walking pace applications ($F_1$=7.59, p=.014). For the customary gait speed test, in post hoc analyses, there were no significant differences between any specific time points. For the fast-paced gait speed test, gait speed was significantly faster at 12 weeks than baseline (p=.037) and at 6 months compared to baseline. There were no significant changes over time on the ABC.

Table 3. Repeated Measure ANOVA Results

| | Baseline | 12 Weeks | 6 Months | Linear Effect | | Quadratic Effect | | Effect Size | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (SE) | Mean (SE) | Mean (SE) | F Value | P Value | F Value | P Value | F Value | P Value | Partial Eta Squared |
| FAB [1] (0-36) | 24.24 (1.96) [a] | 27.65 (1.48) [b] | 29.18 (1.39) [ab] | 7.103 | 0.017 | 0.908 | 0.355 | 5.504 | 0.016 | 0.423 |
| TUG Alone (sec) | 10.33 (0.366) [a] | 8.884 (0.404) [b] | 9.041 (0.378) [bc] | 14.823 | 0.002 | 7.204 | 0.017 | 8.228 | 0.004 | 0.545 |
| TUG Cognitive (sec) | 10.648 (0.504) | 9.608 (0.553) | 9.776 (0.447) | 5.878 | 0.028 | 1.386 | 0.257 | 3.275 | 0.068 | 0.319 |
| TUG Manual (sec) | 10.746 (0.371) [a] | 10.308 (0.558) [ac] | 9.796 (0.341) [bc] | 11.208 | 0.004 | 0.007 | 0.934 | 7.161 | 0.007 | 0.506 |
| 10 Meter Normal (sec) | 5.555 (0.239) | 5.186 (0.153) | 5.071 (0.126) | 5.444 | 0.033 | 1.113 | 0.307 | 2.815 | 0.092 | 0.273 |
| 10 Meter Fast (sec) | 4.092 (0.172) [a] | 3.785 (0.134) [b] | 3.764 (0.141) [bc] | 7.588 | 0.014 | 3.812 | 0.069 | 4.149 | 0.037 | 0.356 |
| ABC Scale (0- 100) | 78.705 (3.780) | 80.580 (3.923) | 81.116 (3.568) | 3.926 | 0.069 | 0.106 | 0.75 | 3.449 | 0.066 | 0.365 |

1 – Participants didn't complete the standing long jump (0-4 pts.) due to presence of arthritis

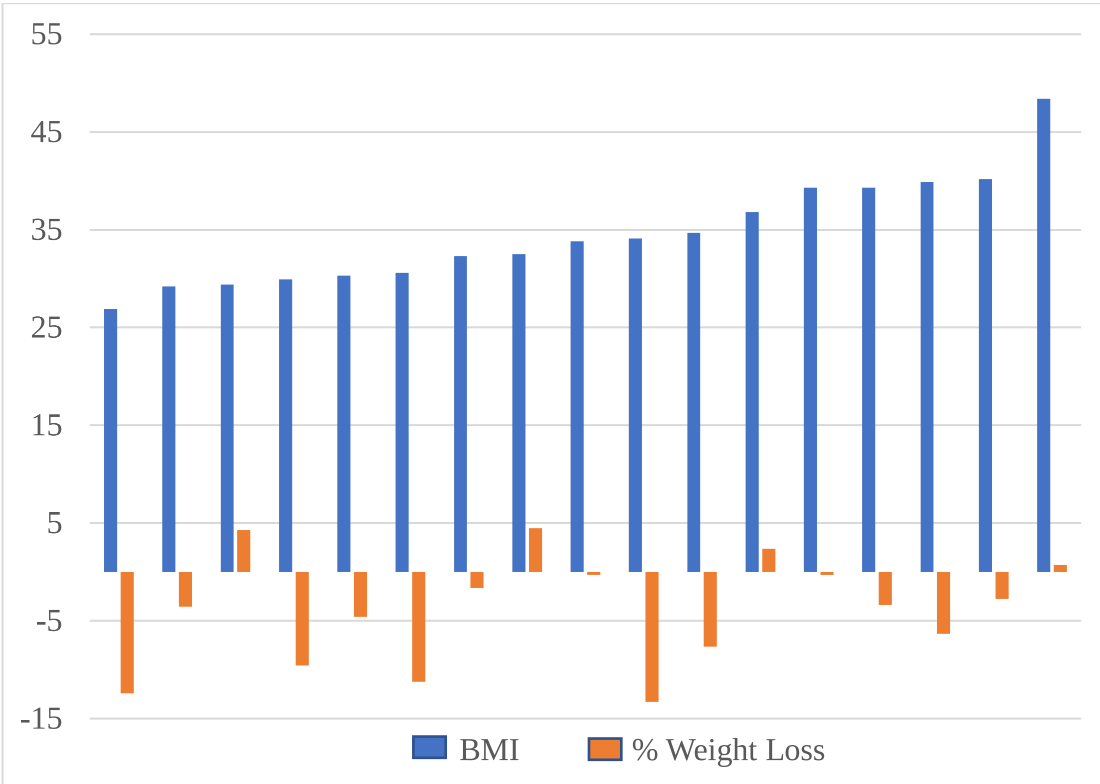
a,b,c values where the superscript differs indicates significant difference ($p<.05$)

33% of the participants in this study achieved the weight loss goal of at least 5%. There was no association between initial start weight or BMI and weight loss over time *(See Chart 2).* The results of the independent t-tests examining percent change in balance assessments between individuals who achieved the 5% weight loss goal and those that did not are presented in Table 7. There were no significant differences in percent change between those who achieved the 5% weight loss goal and those who did not for the FAB ($t = 0.119$, $p = 0.907$), TUG alone ($t = 1.134$, $p = 0.296$), TUG cognitive ($t = 0.845$, $p = 0.431$) or TUG Manual (; $t = 1.651$, $p = 0.124$), 10-Meter Gait Speed ( $t = 1.444$, $p = 0.175$) or ABC ($t = 0.481$, $p = 0.641$) (*See Table 4).*

Table 4. Independent T - Test Results of Percent Change (n=17)

| | 5% Weight Loss | | | |
|---|---|---|---|---|
| | Mean (SE) | | | |
| | Yes (n=17) | No (n=17) | T Score | P Value |
| FAB (% change) | 35.165 (28.180) | 39.249 (20.162) | 0.119 | 0.907 |
| TUG Alone (% change) | -16.870 (2.541) | -9.182 (8.037) | 1.134 | 0.296 |
| TUG Cognitive (% change) | -11.008 (6.487) | -5.289 (1.922) | 0.845 | 0.431 |
| TUG Manual (% change) | -13.300 (3.487) | -5.440 (3.241) | 1.651 | 0.124 |
| 10 Meter Normal (% change) | -13.505 (6.031) | -3.398 (3.371) | 1.463 | 0.181 |
| 10 Meter Fast (% change) | -12.072 (4.017) | -4.436 (3.435) | 1.444 | 0.175 |
| ABC (% change) | 2.596 (2.599) | 4.171 (1.993) | 0.481 | 0.641 |

Chart 2. Percent Weight Loss by Initial BMI (n=17)



# CHAPTER 5

# DISCUSSION

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The present study assessed whether a group-based lifestyle intervention could elicit improvements in balance among overweight individuals with arthritis by utilizing a modified version of the GLB Program. Findings from the present study suggest participating in a modified version of the Group Lifestyle Balance program can improve measures of balance among overweight and obese, older adults with arthritis. Moreover, the present study suggests improvements in balance can occur in the absence of weight loss. There were no differences in changes in balance scores from baseline to 6 months between those who lost at least 5% of their body weight and those who did not achieve this goal. All objective measures of balance including the: TUG alone, TUG cognitive and TUG manual assessments, the 10- meter gait speed, fast pace and customary walking speed and the FAB showed significant linear effects of time. Participants did not achieve statistically significant differences on the subjective measure of balance, the ABC survey.

Participants achieved a significant difference, over time, on all three variations of the TUG. At baseline, none of the participants were at an increased risk of falling: TUG alone (10.33sec.), TUG cognitive (10.64sec.) and TUG cognitive (10.64sec.). The cut off scores for assessing risk of fall, with a 90% correct predication rate, are: (TUG alone (≥ 13.5 secs.), TUG manual (≥ 14.5 secs.) and TUG cognitive (≥ 15 secs.) (Shumway-Cook, Brauer & Woollacott, 2000). Although the participants did achieve a significant linear effect over time on the TUG cognitive (p = .028), the effect size (p=.068) while approaching significance was too small to be clinically significant. Meaningful clinical differences have been reported to be highly variable, but one study reported that a change of 3.4 sec. is considered a meaningful clinically important difference (MCID) (Gautschi, et al., 2016). According to this recommendation, the participants did not achieve a clinically meaningful improvement on any of the three variations of the TUG. However, it is important to note that none of the participants were deemed as a fall risk, based on the three variations of the TUG, at any time point and the failure to obtain a clinically significant finding may be due to a ceiling effect, i.e., the scores had less room for improvement. A meta-analysis of 21 studies found that TUG scores for healthy older adults were a mean of 8.1 seconds for adults 60- 69 years of age and 9.2 seconds for adults 70- 79 years of age (Bohannon, 2006). The present study's average age was 71 and at 6 months the average speed in seconds was 9.04 for the TUG alone which is consistent with Bohannon's findings (2006).

Participants achieved significant increases in FAB scores ($p = .016$) from baseline to 12 weeks. When all items are included on the FAB instrument, a score of between 25 and 40 is considered a moderate risk of falling. At baseline, our participants had a baseline score of 24.24 suggesting they had a moderate risk of falling. However, this finding needs to be interpreted with caution because one item (long jump) was not included when the test was administered due to safety precautions. It is possible they would have been classified as not at-risk of falling had they completed this test. At post-test, the participants had a mean score of 29.18 suggesting they were no longer at an increased risk of falling. The participants improved by 4.94 points from baseline to post-test which is not likely to be of clinical significance.

Participants achieved significant difference on the 10 – meter gait speed assessment, fast walking speed (p = .014) and significance for the customary walking speed (p = .033). While there was a statistically significant change over time for customary walking speed the effect size was too small to be clinically significant (p=.092). An improvement of .05 m/s is considered a clinically small meaningful change and .13m/s is considered a clinically substantial change (Perera, Mody & Woodman, 2006). Participants achieved substantially meaningful improvements on the 10- meter gait speed, customary walking pace assessment from T1 – T2 (.37 m/s) and T1- T3 (.48 m/s) and small meaningful improvements from T2- T3 (.12). Similarly, participants achieved substantially meaningful improvements on the 10- meter gait speed, fast paced assessment from T1- T2 (.31) and T1 – T3 (.33) but did not achieve a clinically meaningful improvement from T2 – T3.

Participants did not achieve statistically significant differences on the ABC survey (p=.069) but the improvements were approaching significance (p=.066). The scores improved across all three time points (T1 = 78.705, T2 = 80.580, T3= 81.116), but not significantly. Participants had a near high-level of confidence at baseline (80%) (Myers, Fletcher, Myers & Sherk, 1998) which could potentially explain the minimal improvements in scores across time. Previous research has demonstrated that among a less- frail population of community- dwelling adults, 60 and older, which is representative of the present study's population, a score greater than 80, at initiation of an intervention, will likely not improve perceived balance confidence at completion of a physical activity-based intervention (Huang & Wang, 2009). This is similar to what we witnessed, and our results support this finding.

The results of this study are similar to results observed in other studies examining the effects of a lifestyle intervention on objective balance and functional outcomes (Hughes et al., 2004 & Messier et al., 2013). The Intensive Diet and Exercise for Arthritis study (IDEA) study examined the potential benefits of a lifestyle intervention on physical function and arthritis related outcomes among adults with arthritis (Messier et al., 2013). The IDEA study included three intervention groups: diet alone, exercise alone and a combination of diet and exercise. They found the greatest improvements in walking speed on the six-minute walk test, reduced pain on the WOMAC and lower levels of pain reported, over time an eighteen-month trial period, among the diet and exercise intervention group (Messier et al., 2013).  Similarly, Fit and Strong, an eight-week program that combines strength based and aerobic exercise with self- managed, health education for arthritis, is designed to help those with arthritis make lifestyle changes that are beneficial for improving stiffness, pain levels and disability (Hughes et al., 2004). Improvements in pain and stiffness, physical activity and physical function were outcomes of Fit and Strong (Hughes, et al., 2004).

Additionally, The Fitness and Arthritis in Seniors Trial (FAST) study examined the effects of an exercise program on measures of disability, physical performance and pain among older adults with osteoarthritis. This study found strength- based and aerobic training significantly improve static balance among community dwelling adults with arthritis (Buchner et al., 1997). Similarly, the Balance- Enhanced Exercise Program (BEEP) study of self- administered exercise training for 6 weeks found improvements in TUG scores and walking speeds (Hafstrom et al., 2016). The current study’s results provide further evidence that exercise potentially provides a protective benefit, improving dynamic balance.

The present study demonstrates the potential benefits of a lifestyle intervention on improvements in balance and physical function outcomes among older adults with OA. Furthermore, our results suggest that these improvements do not require weight loss to occur. There was a lot of variability in achieving weight loss goals, with only 33% of participants who completed the program successfully achieving the 5% weight loss goal. There was no difference in the percent change in balance for any outcome measure between the individuals who achieved the weight loss goal and those who did not. This finding suggests that weight loss is not required for improvements in balance to occur.

Previous research, such as the Framingham Study, which examined women over a 10-year time period and looked at the role weight plays in development of OA found that women who decreased their BMI by 2 or more decreased their risk of developing symptomatic OA by more than half (Felson, Zhang, Anthony, Naimark & Anderson, 1998). These results speak to the role that weight loss can have on developing OA. Research is very limited on balance outcomes and lifestyle interventions among an overweight population with OA. Fall risk increases with obesity and arthritis but the mechanisms explaining the associations between excess body weight, arthritis and falls risk are not well understood. Our findings suggest exercise alone may be enough to improve balance. With limited research available to either support or refute the present findings we might be able to conclude that we have made a novel discovery among a small sample size that needs to be researched further before concluding that meaningful balance improvements are attainable in the absence of weight loss.

The non-significant improvement in ABC scores was a surprising finding. Much of the existing research has demonstrated that perceived confidence is typically a good indicator of and correlates with balance performance (Hafstrom et al., 2015). We did not see a statistically significant improvement over time in perceived balance. While the mean scores improved from time one (M= 78.705) to time two (M=80.580) and from time two to time three (M=81.116), they were not significantly different but were approaching statistical significance (p=.069).

The Balance Enhancing Exercise Program (BEEP) study which implemented a 6-week, self- administered exercise intervention among community dwelling older adults found that participants experienced a significant increase (p=.013) on the ABC scale, post intervention (Hafstrom et al., 2015). However, another study conducted by Barnett and colleagues utilized a community, group exercise intervention among an at-risk, older adult population and while they witnessed improvements in several objective measures of balance, they did not experience a significant difference between the exercise group and a control group on fear of falling scores (2003). It is plausible that attrition impacted our ability to detect a significant change over time. However, the results of the study are promising for improvements in both perceived and objective measures of balance.

This study, while well thought out and conceived, had some possible limitations. Time commitment was a limitation in this study. The participants were expected to remain in the study for a total of 6 months. Due to life events, vacations and illness participants missed sessions and dropped out. To minimize the time commitment, a phased approach was used in the intervention. The initial requirement for the intervention was to meet once per week for 4 weeks. The following 12 weeks the participants met twice per week. After the initial 16 weeks, the core sessions were completed and the participants met bi-weekly for the remaining 2 months. We also allowed the participants to allot themselves to the most convenient location, Tempe or downtown Phoenix. Also, to encourage motivation and participation in the program we included motivational check- in calls, group-based activities where participants interacted with each other and accountability components.

While the present study was well conceived both strengths and limitations exist. Since we were working with an arthritic population, exercise was both a strength and limitation. While exercise is a known benefit for arthritis management, pain from exercise was a possible limitation. Modifications were made to the intervention manual to help eliminate this potential limitation. Time was also both a strength and limitation. The intervention was 6 months and while this allowed for more guidance and support there was also a risk of a higher dropout rate. To help avoid drop out among the participants, they were given the option to attend the intervention at two locations to help with convenience.

Parameters were established for participation in the present study. Individuals who had a joint replacement in the past 12 months were not eligible to participate in the study. This potentially limited the number of participants that we could enroll in the study thus decreasing the potential sample size. Another parameter placed on the sample population was a minimum body mass index (BMI) of 27 kg/m2. Since increased health risks are associated with weight loss among older adults and to avoid weight loss that would put participants in the underweight category this parameter was necessary for safety reasons. Furthermore, individuals with contraindications to participate in exercise and those that could not obtain physician approval to participate in the study were not invited to partake in the intervention. These parameters were potential limitations to the present study.

In summary, the present study provides meaningful insight into the potential benefits of participating in a group based, lifestyle intervention focused on diet and exercise among older adults who are overweight and have arthritis. Improvements in all measures of balance, both subjective and objective, were witnessed over the 6-month time period with all achieving statistical significance with the exception of the ABC survey. All physical function measures of balance witnessed statistically significant improvements of time. This is a promising finding and potentially suggests that utilization of lifestyle interventions for this population is beneficial and should be explored as a viable option when attempting to improve balance. Furthermore, the present study suggests that a translated version of the GLB program for use among overweight adults with arthritis is effective at improving balance outcomes.

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# APPENDIX A

## IRB APPROVAL

APPROVAL: EXPEDITED REVIEW

Cheryl Der Ananian

SNHP: Exercise Science and Health Promotion

602/827-2290

Cheryl.Derananian@asu.edu

Dear Cheryl Der Ananian:

On 6/5/2016 the ASU IRB reviewed the following protocol:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title: | Evaluating the Effectiveness of the Group Lifestyle Balance Program in People with Arthritis. |
| Investigator: | Cheryl Der Ananian |
| IRB ID: | STUDY00004445 |
| Category of review: | (2)(a) Blood samples from healthy, non-pregnant adults, (4) Noninvasive procedures, (7)(a) Behavioral research |
| Funding: | Name: SNHP: Administration; Name: SNHP: Administration |
| Grant Title: | |
| Grant ID: | |
| Documents Reviewed: | • COLOR Piper Flyer without TABs V2 06062016.pdf, Category: Recruitment Materials;<br>• Online Screening Survey.pdf, Category: Screening forms;<br>• COLOR Piper Flyer with TABs V2 06062016.pdf, Category: Recruitment Materials;<br>• BLACK  WHITE Piper Flyer without TABs V2 06062016.pdf, Category: Recruitment Materials;<br>• Press Release Intervention V2 06062016.pdf, Category: Recruitment Materials; |

| | |
|---|---|
| | • Data Collection Sheet Objective Measures, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br><br>• PARQPlusJan2014.pdf, Category: Screening forms;<br><br>• Arthritis Study Exercise Packet.pdf, Category: Participant materials (specific directions for them);<br><br>• GroupLifestyleBalanceMiscHandouts.pdf, Category: Participant materials (specific directions for them);<br><br>• pedometerPacket.pdf, Category: Participant materials (specific directions for them);<br><br>• IRB Application Protocol, Category: IRB Protocol;<br><br>• BLACK  WHITE Piper Flyer with TABs V2 06062106.pdf, Category: Recruitment Materials;<br><br>• Study Questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br><br>• Letter to IRB, Category: Other (to reflect anything not captured above);<br><br>• Der Ananian Piper Initiative, Category: Sponsor Attachment;<br><br>• Telephone Screener V2.pdf, Category: Screening forms;<br><br>• Informed Consent_Piper Grant, Category: Consent Form;<br><br>• GroupLifestyleBalanceManualOperations.pdf, Category: Participant materials (specific directions for them); |

The IRB approved the protocol from 6/5/2016 to 6/4/2017 inclusive. Three weeks before 6/4/2017 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 6/4/2017 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the “Documents” tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc:

Sonia Vega-Lopez

Brianna Scott

Aubry Merkel

Natasha Birchfield

# APPENDIX B

## INFORMED CONSENT

***Title of research study:*** Evaluating the Effectiveness of the Group Lifestyle Balance Program in People with Arthritis.

***Investigator:*** Cheryl Der Ananian, PhD, Associate Professor, Exercise Science and Health Promotion Program and Sonia Vega-Lopez, Associate Professor, Nutrition Program, Arizona State University.

***Why am I being invited to take part in a research study?***

We invite you to take part in a research study because you have arthritis and may benefit from a lifestyle behavior change program focused on improving nutrition and physical activity (PA) behaviors. You must be at least 40 years old and not pregnant or trying to become pregnant to participate in this study. Participation is voluntary.

***Why is this research being done?***

This research will evaluate the effectiveness of the Group Lifestyle Balance Program™ on physical function, balance, arthritis-related symptoms, cardiovascular risk factors, and weight-loss in people with arthritis. We will also examine the intervention's impact on physical activity and nutrition behaviors.

***How long will the research last?***

We expect you will spend 12.5 months enrolled in the proposed study. You will attend a 1 ½- 2 hour visit 1-2 weeks prior to the start of the Group Lifestyle Balance Program™, at 12 weeks, 6 months and 12 months for a series of assessments of your physical function, balance and body composition and to complete a survey about your personal characteristics, health, arthritis-symptoms, and physical activity and dietary behaviors. During each of these visits you will receive an accelerometer to wear the following week and return. Prior to the start of the study, you will be asked to participate in a second 30-minute meeting to complete baseline assessments of physical function, blood pressure, and have blood drawn (venipuncture). The Group Lifestyle Balance Program™ will last for 12-months. You will meet twice a week (day one 90-min, day two 60-min) during the first 12 weeks, weekly during month 4, every other week (60-min) during months 5 - 6, followed by monthly meetings (60-min) during months 6-12.

***How many people will be studied?***

We expect about 64 people to participate in this research study.

***What happens if I say yes, I want to be in this research?***

You will attend 38 group sessions of the Group Lifestyle Balance Program ™ and receive booster phone calls during months 7-12. The Group Lifestyle Balance Program™ focuses on diet and physical activity and includes a supervised resistance training program during the first 12-weeks. You will be encouraged to engage in moderate and strength-training exercise for the study duration.

During the intervention, you will wear a pedometer and record your daily steps on a log using a provided FitBit Zip. You also will complete food logs and submit them weekly to the research team.

You will complete a questionnaire to evaluate your readiness for physical activity. You will be asked questions about your health history. If the findings suggest the need for physician clearance, you will need to obtain clearance from a healthcare provider prior to participation in the study.

If you enroll in the study, we will assess your physical function, mobility, balance, arthritis-related symptoms, body composition and cardiovascular risk factors. We will also collect information about your health history, diet and physical activity, and factors-related to PA and diet, (e.g., self-efficacy, social support, and barriers to healthy eating, etc.). We will obtain these measures (described below) **four times**: **prior to starting the program,** and at **12-weeks, 6-months, and 12-months**.

**Assessments of Physical Function, Mobility Strength and Balance:** You will complete a series of tests of increasing difficulty to examine your physical function, mobility, balance, and strength. Physical function will be assessed using standing, walking, and balance assessments such as the Short Performance Physical Battery, the Timed Up-and-Go test, and the Fullerton Advanced Balance Scale. To assess mobility and strength, you will walk, complete 30-second chair stands (i.e., rising from a chair and returning to a seated position), and perform a grip strength assessment.

**Body composition, blood pressure and cardiovascular risk factors:** We will measure your height, weight, hip and waist circumferences, and your lean body and fat mass. We will assess cardiovascular risk factors by measuring blood pressure and collecting a small (~40 ml or 3 tbsp.) fasting blood sample (by a certified phlebotomist at ASU) via venipuncture, to measure blood lipids, glucose, insulin, and hsCRP. **Blood will only be collected at baseline and 12-weeks.**

**Questionnaire Data**: You will complete a comprehensive survey at baseline, 12-weeks, 6-months, and 12-months. The survey will ask questions about your personal characteristics, health history, arthritis-related symptoms, balance, dietary and PA behaviors, and factors related to PA and dietary behaviors.

**Assessment of Physical Activity**: You will wear an accelerometer, a device that measures movement, for a 1-week at baseline, 12-weeks, 6-months, and 12-months. You will keep a log of when you wear and remove the device as well as activities the accelerometer cannot track (e.g., bicycling, swimming or water aerobics). Additionally, all participants will receive a FitBit Zip to wear and log daily step-counts. Logs will be turned-in to the research team and device data will be downloaded during sessions.
You will receive a FitBit Zip, food scale, body-weight scale, and basic exercise equipment (resistance bands and yoga mat). You will also receive $20 for completing the baseline, 12-week and 6-month assessments (up-to $60 total).

***What happens if I say yes, but I change my mind later?***

You can withdraw from the research study at any time and there will be no adverse consequences. If you no longer wish to participate and decide to withdraw, we ask you to report the reason to Cheryl Der Ananian (Cheryld@asu.edu). If you no longer want to participate in the Group Lifestyle Balance Program™ but are willing to complete the remaining assessments, you may choose to do so. We may not remove the data collected prior to withdrawal from the study database.

***Is there any way being in this study could be bad for me?***

This study involves a relatively safe form of PA; however, with any type of PA, minor injury or muscle soreness is possible. We do not anticipate injury or discomfort beyond minor soreness. The instructors of the program can work with you to alter your program and manage any discomfort should it occur. Bruising or swelling may occur at the site of the blood draw. You may experience lightheadedness, dizziness, or fainting during or immediately after the blood draw. Those with a history of fainting during blood draws will be discouraged from participating in the blood draw. You may experience hunger or headache due to fasting and food will be available for you after completing the blood draw. Reducing your food intake to lose weight may also cause hunger or headaches. If this occurs, the instructors will work with you to adjust your food intake and alleviate symptoms.

***Will being in this study help me in any way?***

We cannot promise benefits to you or others from your participation in this study. However, benefits may include improved balance, physical function, strength, endurance, arthritis-related symptoms, and modest weight loss.

***What happens to the information collected for the research?***

The use and disclosure of your personal information will be limited to people who have a need to review it. We cannot promise complete confidentiality. We will link your data to a participant ID number and only the key investigators will have access to the master list linking the ID number with your name. Data will be stored in a password-protected file on a password-protected computer only accessible by key team members.. Publications will only report aggregated data.

***What else do I need to know?***

This research is funded by a grant from the School of Nutrition and Health Promotion and the Virginia G. Piper Trust Foundation. If you agree to participate in the study, consent does not waive any of your legal rights. However, no funds have been set aside to compensate you in the event of injury.

***Who can I talk to?***

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at Cheryld@asu.edu ***or 602-827-2290***

This research has been reviewed and approved by the Bioscience IRB ("IRB"). You may talk to them at (480) 965-6788 or research.integrity@asu.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research participant.
- You want to get information or provide input about this research.

**Signature Block for Capable Adult**

Your signature documents your permission to take part in this research.

______________________________ ______________

Signature of participant Date

______________________________

Printed name of participant

______________________________ ______________

Signature of person obtaining consent Date

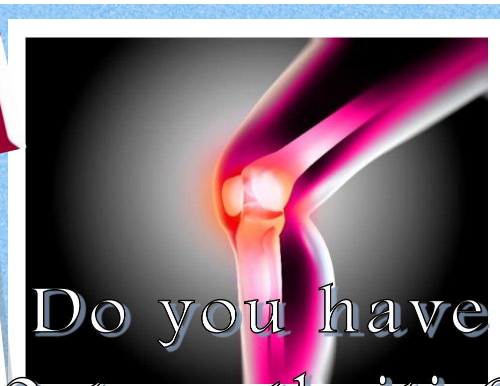
______________________________

Printed name of person obtaining consent

# APPENDIX C

# RECRUITMENT MATERIALS

ASU IRB IRB #
STUDY00004445 | Approval
Period 6/5/2016 – 6/4/2017



# Do you have Osteoarthritis?

- ❖ Are you currently overweight or obese (Body Mass Index of 27 or higher)?
- ❖ Are you at least 40 years old?
- ❖ Are you interested in changing your diet and physical activity behavior?
- ❖ Would you be willing to come to a lifestyle change program, Group Lifestyle Balance™ ?

**If you answered yes to the questions above, please call us to learn more about a research study we are conducting and to find out if you are eligible.**

We are currently conducting a study to evaluate the effectiveness of the lifestyle change program, Group Lifestyle Balance, for improving diet, physical activity and function in overweight or obese individuals with osteoarthritis.

- You will be asked to participate in a free, 12-month lifestyle change program focusing on improving dietary and physical activity behaviors.
- Classes will meet twice per week for the first 4 months, once every other week for the next 2 months and then once per month for the remaining 6 months.
- All participants will receive a FitBit Zip, a food scale, a body weight scale, and basic exercise equipment (resistance bands and a yoga mat) for participating.
- Participants will receive $20 for completion of baseline, 12-week and 6-month outcomes assessments (up to $60 total).
- Your participation is completely voluntary.

For more information or to sign up: Call (520) 314-9517 OR Go to the following link:
https://asuhealthpromotion.co1.qualtrics.com/SE/?SID=SV_9M3POSADaGOfsnb

Funded by Arizona State University School of Nutrition and Health Promotion and the Virginia G. Piper Trust Foundation

**Email Blurb**

Researchers in the School of Nutrition and Health Promotion at Arizona State University are currently conducting a research study to evaluate the effectiveness of a lifestyle behavior change program, Group Lifestyle Balance™ on improving diet, physical activity and function in overweight or obese individuals with osteoarthritis. We are looking for individuals who: are at least 40 years of age, have osteoarthritis, and are either overweight or obese (Body Mass Index of at least 27) to participate in our study*. You will be asked to participate in a* ***free****, 12-month, lifestyle change program focusing on improving your dietary and physical activity behaviors.* Classes will meet twice per week for the first 4 months, once every other week for the next 2 months and then once per month for the remaining 6 months. All participants will receive a FitBit Zip, a food scale, a bodyweight scale, and basic exercise equipment (resistance bands and a yoga mat) for participating in the program. Additionally, participants will receive $20 for completion of baseline, 12-week and 6-month outcome assessments (up to $60 total). If interested, please contact Cheryl Der Ananian at Arizona State University to learn more about the study and to be screened for eligibility. Phone (520) 314-9517 or cheryld@asu. Your participation in this study is voluntary. Thank you!

To learn more about this study, please click on this link: https://asuhealthpromotion.co1.qualtrics.com/SE/?SID=SV_eM5j0auXK2N3mFT

Funded by the School of Nutrition and Health Promotion and the

Virginia G. Piper Trust Foundation

# APPENDIX D

# SCREENING MATERIALS

CSEP approved Sept 12 2011 version

# PAR-Q+

## The Physical Activity Readiness Questionnaire for Everyone

Regular physical activity is fun and healthy, and more people should become more physically active every day of the week. Being more physically active is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

## SECTION 1 - GENERAL HEALTH

| | Please read the 7 questions below carefully and answer each one honestly: check YES or NO. | YES | NO |
|---|---|---|---|
| 1. | Has your doctor ever said that you have a heart condition OR high blood pressure? | ☐ | ☐ |
| 2. | Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity? | ☐ | ☐ |
| 3. | Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise). | ☐ | ☐ |
| 4. | Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? | ☐ | ☐ |
| 5. | Are you currently taking prescribed medications for a chronic medical condition? | ☐ | ☐ |
| 6. | Do you have a bone or joint problem that could be made worse by becoming more physically active? Please answer NO if you had a joint problem in the past, but it does not limit your current ability to be physically active. For example, knee, ankle, shoulder or other. | ☐ | ☐ |
| 7. | Has your doctor ever said that you should only do medically supervised physical activity? | ☐ | ☐ |

If you answered NO to all of the questions above, you are cleared for physical activity.

Go to Section 3 to sign the form. You do not need to complete Section 2.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow the Canadian Physical Activity Guidelines for your age (www.csep.ca/guidelines).
- You may take part in a health and fitness appraisal.
- If you have any further questions, contact a qualified exercise professional such as a CSEP Certified Exercise Physiologist® (CSEP-CEP) or CSEP Certified Personal Trainer® (CSEP-CPT).
- If you are over the age of 45 yrs. and NOT accustomed to regular vigorous physical activity, please consult a qualified exercise professional (CSEP-CEP) before engaging in maximal effort exercise.

If you answered YES to one or more of the questions above, please GO TO SECTION 2.

Delay becoming more active if:
- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant – talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
- Your health changes – please answer the questions on Section 2 of this document and/or talk to your doctor or qualified exercise professional (CSEP-CEP or CSEP-CPT) before continuing with any physical activity programme.

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## SECTION 2 - CHRONIC MEDICAL CONDITIONS

| | | Please read the questions below carefully and answer each one honestly: check YES or NO. | YES | NO |
|---|---|---|---|---|
| 1. | Do you have Arthritis, Osteoporosis, or Back Problems? | | ☐ If yes, answer questions 1a-1c | ☐ If no, go to question 2 |
| | 1a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 1b. | Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)? | ☐ | ☐ |
| | 1c. | Have you had steroid injections or taken steroid tablets regularly for more than 3 months? | ☐ | ☐ |
| 2. | Do you have Cancer of any kind? | | ☐ If yes, answer questions 2a-2b | ☐ If no, go to question 3 |
| | 2a. | Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck? | ☐ | ☐ |
| | 2b. | Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)? | ☐ | ☐ |
| 3. | Do you have Heart Disease or Cardiovascular Disease? This includes Coronary Artery Disease, High Blood Pressure, Heart Failure, Diagnosed Abnormality of Heart Rhythm | | ☐ If yes, answer questions 3a-3e | ☐ If no, go to question 4 |
| | 3a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 3b. | Do you have an irregular heart beat that requires medical management? (e.g. atrial fibrillation, premature ventricular contraction) | ☐ | ☐ |
| | 3c. | Do you have chronic heart failure? | ☐ | ☐ |
| | 3d. | Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer YES if you do not know your resting blood pressure) | ☐ | ☐ |
| | 3e. | Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months? | ☐ | ☐ |
| 4. | Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes | | ☐ If yes, answer questions 4a-4c | ☐ If no, go to question 5 |
| | 4a. | Is your blood sugar often above 13.0 mmol/L? (Answer YES if you are not sure) | ☐ | ☐ |
| | 4b. | Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, and the sensation in your toes and feet? | ☐ | ☐ |
| | 4c. | Do you have other metabolic conditions (such as thyroid disorders, pregnancy-related diabetes, chronic kidney disease, liver problems)? | ☐ | ☐ |
| 5. | Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome) | | ☐ If yes, answer questions 5a-5b | ☐ If no, go to question 6 |
| | 5a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 5b. | Do you also have back problems affecting nerves or muscles? | ☐ | ☐ |



 
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| | | Please read the questions below carefully and answer each one honestly: check YES or NO. | YES | NO |
|---|---|---|---|---|
| 6. | | Do you have a Respiratory Disease?<br>This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure | ☐ If yes, answer questions 6a-6d | ☐ If no, go to question 7 |
| | 6a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies?<br>(Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 6b. | Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy? | ☐ | ☐ |
| | 6c. | If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week? | ☐ | ☐ |
| | 6d. | Has your doctor ever said you have high blood pressure in the blood vessels of your lungs? | ☐ | ☐ |
| 7. | | Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia | ☐ If yes, answer questions 7a-7c | ☐ If no, go to question 8 |
| | 7a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies?<br>(Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 7b. | Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting? | ☐ | ☐ |
| | 7c. | Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)? | ☐ | ☐ |
| 8. | | Have you had a Stroke?<br>This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event | ☐ If yes, answer questions 8a-c | ☐ If no, go to question 9 |
| | 8a. | Do you have difficulty controlling your condition with medications or other physician-prescribed therapies?<br>(Answer NO if you are not currently taking medications or other treatments) | ☐ | ☐ |
| | 8b. | Do you have any impairment in walking or mobility? | ☐ | ☐ |
| | 8c. | Have you experienced a stroke or impairment in nerves or muscles in the past 6 months? | ☐ | ☐ |
| 9. | | Do you have any other medical condition not listed above or do you live with two chronic conditions? | ☐ If yes, answer questions 9a-c | ☐ If no, read the advice on page 4 |
| | 9a. | Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months OR have you had a diagnosed concussion within the last 12 months? | ☐ | ☐ |
| | 9b. | Do you have a medical condition that is not listed<br>(such as epilepsy, neurological conditions, kidney problems)? | ☐ | ☐ |
| | 9c. | Do you currently live with two chronic conditions? | ☐ | ☐ |

Please proceed to Page 4 for recommendations for your current medical condition and sign this document.



 

# PAR-Q+

If you answered NO to all of the follow-up questions about your medical condition, you are ready to become more physically active:

- It is advised that you consult a qualified exercise professional (e.g., a CSEP-CEP or CSEP-CPT) to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually – 20-60 min. of low- to moderate-intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate-intensity physical activity per week.
- If you are over the age of 45 yrs. and NOT accustomed to regular vigorous physical activity, please consult a qualified exercise professional (CSEP-CEP) before engaging in maximal effort exercise.

If you answered YES to one or more of the follow-up questions about your medical condition:

- You should seek further information from a licensed health care professional before becoming more physically active or engaging in a fitness appraisal and/or visit a or qualified exercise professional (CSEP-CEP) for further information.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise profesional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
- Your health changes - please talk to your doctor or qualified exercise professional (CSEP-CEP) before continuing with any physical activity programme.

## SECTION 3 - DECLARATION

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The Canadian Society for Exercise Physiology, the PAR-Q+ Collaboration, and their agents assume no liability for persons who undertake physical activity. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.
- Please read and sign the declaration below:

*I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that they maintain the privacy of the information and do not misuse or wrongfully disclose such information.*

NAME ______________________________ DATE ______________________

SIGNATURE ____________________ WITNESS ___________________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________________

For more information, please contact:
Canadian Society for Exercise Physiology
www.csep.ca

KEY REFERENCES
1. Jamnik VJ, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the eectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
2. Warburton DER, Gledhill N, Jamnik VK, Bredin SSD, McKenzie DC, Stone J, Charlesworth S, and Shephard RJ. Evidence-based risk assessment and recommendations for physical activity clearance; Consensus Document. APNM 36(S1):S266-s298, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or BC Ministry of Health Services.

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Dear Healthcare Provider,

Your patient, ________________________________________, is interested in participating in a yearlong research study promoting weight loss through diet and physical activity at Arizona State University. As part of the study, participants will be asked to engage in moderate intensity exercise (e.g., brisk walking, swimming, water aerobics, cycling, etc.) for up to 150 minutes per week. Additionally, they will be asked to participate in strengthening exercises targeting lower body strength using resistance bands and their own body weight two to three times per week. We will be teaching your patient the behavioral skills necessary to change their eating behaviors but will not be prescribing a particular diet. The ultimate goal of the study is to promote a 5-7% weight loss through diet and physical activity. The program, Group Lifestyle Balance for Arthritis, is based on the evidence-based Diabetes Prevention Program.

Your patient, _________________________________________, completed a physical activity readiness screener (PARQ+) and was identified as needing a physician or healthcare provider clearance to participate in the study for the following reason (s) ____________________________________________

__________________________________________________________________________________
______.

Please let us know if you believe your patient is able to safely participate in this program by checking one of the following:

___ It is okay for my patient to participate in the Group Lifestyle Balance Program for Arthritis with no modifications to the physical activity program.

___ It is okay for my patient to participate in the Group Lifestyle Balance Program for Arthritis with the following modifications to the exercise program:
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
______________________

___ It is not okay for my patient to participate in the Group Lifestyle Balance Program for Arthritis.

Please sign this form and return it to your patient. If you have any questions, please contact Cheryl Der Ananian, PhD at 602-827-2290 or cheryld@asu.edu.

Physician Signature:
___________________________________________________________________

Date: ________________________________________

Sincerely,
Cheryl Der Ananian, PhD
Associate Professor, Exercise Science and Health Promotion
Arizona State University

**Center for Epidemiologic Studies Short Depression Scale (CES-D 10)**
Below is a list of some of the ways you may have felt or behaved. Please indicate how often you have felt this way during the **7 days**: *(circle one number on each line)*

**During the 7 days...**

1. I felt depressed

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

2. I felt that everything I did was an effort

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

3. My sleep was restless

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

4. I was happy

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

5. I felt lonely

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

6. People were unfriendly

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or<br>none of the time | Some or a<br>little of the time | Occasionally or<br>a moderate<br>amount of time | All of the time |

7. I enjoyed life

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or none of the time | Some or a little of the time | Occasionally or a moderate amount of time | All of the time |

8. I felt sad

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or none of the time | Some or a little of the time | Occasionally or a moderate amount of time | All of the time |

9. I felt that people disliked me

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or none of the time | Some or a little of the time | Occasionally or a moderate amount of time | All of the time |

10. I could not "get going"

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| Rarely or none of the time | Some or a little of the time | Occasionally or a moderate amount of time | All of the time |

# APPENDIX E

# MEASUREMENT INSTRUMENTS

__________ Baseline
**ID#** **Visit**

## The Activities-Specific Balance Confidence (ABC) Scale*

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 9 0 100%
No Confidence ... Very Confident

"How confident are you that you will not lose your balance or become unsteady when you…

1. …walk around the house?

   0% 10 20 30 40 50 60 70 80 90 100%

   No Confidence ... Very Confident

2. …walk up or down stairs?

   0% 10 20 30 40 50 60 70 80 90 100%

   No Confidence ... Very Confident

3. …bend over and pick up a slipper from the front of a closet floor

   0% 10 20 30 40 50 60 70 80 90 100%

   No Confidence ... Very Confident

4. …reach for a small can off a shelf at eye level?

   0% 10 20 30 40 50 60 70 80 90 100%

   No Confidence ... Very Confident

5. …stand on your tiptoes and reach for something above your head?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

6. …stand on a chair and reach for something?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

7. …sweep the floor?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

8. …walk outside the house to a car parked in the driveway?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

9. …get into or out of a car?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

10. …walk across a parking lot to the mall?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

______ ID# Baseline **Visit**

11. …walk up or down a ramp?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

12. …walk in a crowded mall where people rapidly walk past you?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

13. …are bumped into by people as you walk through the mall?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

14. … step onto or off an escalator while you are holding onto a railing?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

15. … step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

16. …walk outside on icy sidewalks?

0% 10 20 30 40 50 60 70 80 90 100%

No Confidence — Very Confident

# Test Administration Instructions for the Fullerton Advanced Balance (FAB) Scale

### *1. Stand with feet together and eyes closed*

**Purpose:** Assess ability to use somatosensory (i.e., ground and body position) cues to maintain upright balance while standing in a reduced base of support and vision unavailable.

**Equipment:** Stopwatch with lanyard (for placing around neck).
**Safety Procedures:** Position person being tested n a corner (If available) or close to a wall. Stand close to participant In case of loss of balance. Hold watch at eye level so participant and time can be monitored simultaneously.

**Testing procedures:** Demonstrate the correct test position and then instruct the participants to move the feet independently until they are together. If some participants are unable to achieve the correct position due to lower extremity joint problems, encourage them to bring their heels together even though the front of the feet are not touching. Have participants adopt a position that will ensure their safety as the arms are folded across the chest and they prepare to close the eyes. Begin timing as soon as the participant closes the eyes. (Instruct participants to open the eyes if they feel so unsteady that a loss of balance is imminent.)

**Verbal instructions:** "Bring your feet together, fold your arms across your chest, close your eyes when you are ready, and remain as steady as possible until I instruct you to open your eyes."

### *2. Reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm*

**Purpose:** Assess ability to lean forward to retrieve an object without altering the base of support; measure of stability limits in a forward direction.

**Equipment:** Pencil and 12-inch ruler

**Safety Procedures:** Position person facing out from corner (If available) or close to wall. Position self to side of participant's outstretched hand. Use arm holding pencil In horizontal position to manually assist client If a loss of balance occurs.

**Testing procedures:** Provide participant with sagittal view of desired movement. Instruct the participant to raise the preferred arm to 90° and extend it with fingers outstretched. Use the ruler to measure a distance of 10 inches from the end of the fingers of the outstretched arm. Hold the object (pencil) horizontally and level with the height of the participant's shoulder. Be sure not to move the pencil once the Instructions are provided. Instruct the participant to reach forward, grasp the pencil, and return to the initial starting position without moving the feet, if possible. (It is acceptable to raise the heels as long as the feet do not move while reaching for the pencil.) If the participant is unable to reach the pencil within 2-3 seconds of initiating the forward lean, indicate to the participant that it is okay to move the feet in order to reach the pencil. Record the number of steps taken by the participant in order to retrieve the pencil.

**Verbal instructions:** "Try to lean forward to take the pencil from my hand and return to your starting position without moving your feet." After allowing 2-3 seconds of lean time: "You can move your feet in order to reach the pencil."

Revised Sept 2008 (DR)

### *3. Turn 360 degrees in right and left directions*

**Purpose:** Assess ability to turn in a full circle in both directions in the fewest number of steps without loss of balance

**Equipment:** None

**Safety Procedures:** Position person being tested about one foot In front of a wall and facing you. Stand close enough during test to provide manual assistance If a loss of balance occurs.

**Testing procedures:** Verbally explain and then demonstrate the task to be performed, making sure to complete each circle in four steps or less and pause briefly between turns. Instruct the participant (who is facing you) to turn in a complete circle in one direction, pause, and then turn in a complete circle in the opposite direction. Count the number of full steps taken to complete each circle. Stop counting steps as soon as the participant is facing you after completing each turn. Allow for a small correction in foot position before a turn in the opposite direction is initiated.

**Verbal instructions:** "In place, turn around in a full circle, pause, and then turn in a second full circle in the opposite direction. Do not begin the full circle in the opposite direction until you are facing me."

### *4. Step up onto and over a 6-inch bench*

**Purpose:** Assess ability to control body in dynamic task situations; also a measure of lower body strength and bilateral motor coordination.

**Equipment:** 6-inch-high bench (18- by 18-inch stepping surface)

**Safety Procedures:** Position bench close to a wall and self on opposite side of bench. Adopt close supervisory position and move with participant as she/he steps up and over the bench In each direction.

**Testing procedures:** Verbally explain the movement to be performed before demonstrating the step up onto and over the bench (at normal speed) in both directions. Instruct the participant to step onto the bench with the right foot, swing the left leg directly up and over the bench, and step off the other side, then repeat the movement in the opposite direction with the left leg leading the action. Encourage the participant not to touch the wall or you to maintain balance during the test. During performance of the test item, watch to see that the participant's trailing leg (a) does not make contact with the bench, or (b) swing around, as opposed to directly up and over, the bench. Verbally cue which leg should be leading the action just prior to the start of the movement In each direction.

**Verbal instructions:** "Step up onto the bench with your right leg, swing your left leg directly up and over the bench, and step off the other side. Repeat the movement in the opposite direction with your left leg as the leading leg."

### *5. Tandem walk*

**Purpose:** Assess ability to dynamically control center of mass with an altered base of support

**Equipment:** Masking tape

**Safety Procedures:** Set the tandem walk line approximately 12 Inches away from a wall. Monitor the participant closely during performance of the test Item and walk forward with the client as he/she completes the test Item. Be ready to provide manual assist If a loss of balance occurs.

**Testing procedures:** Verbally explain and demonstrate how to perform the test item correctly before the participant attempts to perform it. Instruct the participant to walk on the line in a tandem position (heel-to-toe) until you tell him/her to stop. Allow the participant to repeat the test item *one time* if unable to achieve a tandem stance position within the first two steps. The participant may elect to step forward with the opposite foot on the second attempt. Score as interruptions any instances where the participant (a) takes one or more steps away from the line when performing the tandem walk or (b) is unable to achieve correct heel-to-toe position during any step taken along the course. Do not ask the participant to stop until 10 steps have been completed.

**Verbal instructions:** "Walk forward along the line, placing one foot directly in front of the other such that the heel and toe are in contact on each step forward. I will tell you when to stop."

### *6. Stand on one leg*

**Purpose:** Assess ability to maintain upright balance with a reduced base of support.

**Equipment:** Stopwatch and lanyard.

**Safety Procedures:** Position the person being tested In a corner (If one Is available) or close to a wall. Stand In a close supervisory position and on the side of the raised leg.

**Testing procedures:** Instruct the participant to fold the arms across the chest, lift one leg off the floor, and maintain balance until instructed to return the foot to the floor. Begin timing as soon as the participant lifts the foot from the floor. Stop timing if the legs touch, the raised leg contacts the floor, or the participant lifts the arms off the chest before the 20 seconds has elapsed. Allow the participant to perform the test a second time with the other leg raised if they touch down quickly on the first attempt or are unsure as to which leg should be raised.

**Verbal instructions:** "Fold your arms across your chest, lift one leg off the floor (without touching your other leg), and stand with your eyes open until I ask you to put your foot down."

### *7. Stand on foam with eyes closed*

**Purpose:** Assess ability to maintain upright balance while standing on a compliant surface with eyes closed

**Equipment:** Stopwatch and lanyard; two Airex® pads, with a length of nonslip material placed between the two pads and an additional length of nonslip material between the floor and first pad if the test is being performed on an uncarpeted surface.

**Safety Procedures:** Position person to be tested In a corner (If one Is available) or close to a wall. After demonstrating the test Item, place the Airex® pads In front of the person If standing In a corner. Adopt a close supervisory position and hold watch at a height that allows for simultaneous monitoring of the participant's arm position and eyes as well as the time. Instruct the participant to open the eyes if she/he feels so unsteady that a loss of balance is imminent. Manually assist the client off the foam pads if he/she appears unsteady.

**Testing procedures:** Following a demonstration of the task, instruct the participant to step up onto the foam pads without assistance, position the feet shoulder width apart, fold the arms across the chest, and close the eyes when ready. Begin timing as soon as the eyes close. Stop the trial if the participant (a) opens the eyes before the timing period has elapsed, (b) lifts the arms off the chest, or (c) loses balance and requires manual assistance to prevent falling. Instruct the participant to step forward off the foam at the completion of the test item. Provide manual assistance if needed.

**Verbal instructions:** "Step up onto the foam and stand with your feet shoulder-width apart. Fold your arms over your chest, and close your eyes when you are ready. I will tell you when to open your eyes."

### *8. Two-footed jump for distance (Do not introduce this test Item if participant cannot perform test item 4 safely, has a diagnosis of osteoporosis, or complains of lower body joint pain. Score a zero on the test form and move immediately to test item #9.)*

**Purpose:** Assess upper and lower body coordination and lower body power.

**Equipment:** 36-inch ruler; masking tape.

**Safety Procedures:** Position the person close to a wall and adopt a close supervisory position during the jump. Demonstrate the jump but do not jump more than twice the length of your own feet. Stand to the side of the participant and move forward as he or she jumps. Place your hand on the participant's back to steady him/her as soon as the feet contact the ground following the jump.

**Testing procedures:** Instruct the participant to jump as far but as safely as possible while performing a two-footed jump (i.e., leave the floor with two feet and land on two feet). Demonstrate the correct movement prior to the participant performing the jump. Use the ruler to measure the length of the foot and then multiply by two to determine the ideal distance to be jumped. Observe whether the participant leaves the floor with both feet and lands with both feet. Position the ruler on the floor and on the opposite side of the participant and close to the wall so that you can glance down and see how far the participant jumped.

**Verbal instructions:** "Jump as far *but* (emphasize) as safely as you can. Try and make sure that both feet leave the floor and land at the same time."

### *9. Walk with head turns*

**Purpose:** Assess ability to maintain dynamic balance while walking and turning the head from side-to-side.

**Equipment:** Metronome set at 100 beats per minute

**Safety Procedures:** Position yourself directly behind the participant during the standing portion of the test Item so you can clearly see how far the head turns in either direction. Move to a position that Is behind and slightly to the side of the participant during the walking portion of this test Item. Stand close enough that you can provide manual assistance If the participant becomes unstable while walking.

**Testing procedures:** After first demonstrating the test item, ask the participant to practice turning the head in time with the metronome while standing in place. Watch to see that the participant Is turning the head the required distance to both sides and at the required speed. Provide verbal cueing If the participant Is not performing the head turns correctly. Once the participant appears to have the correct head turning rhythm (after no more than 4 to 6 head turns), Instruct him/her to begin walking forward. The head turns should be to the beat of the metranome. Begin counting steps as soon as the participant begins to walk forward with head turns. Observe whether the participant deviates from a straight path while walking or is unable to turn the head the required distance (In one or both directions) and/or at the required speed. If the participant Is unable to achieve the correct head turning rhythm while standing It Is highly unlikely he/she will be able to achieve It while walking (making the scoring of the test item a little easier). Also, In most cases, the steps will be synchronized with the head turns, making the counting of 10 steps easier.

**Verbal instructions:** "Begin turning your head to the beat of the metranome while standing In place. Start walking forward while turning your head from side-to-side with each beat of the metronome. I will tell you when to stop."

### *10. Reactive postural control*

**Purpose:** Assess ability to efficiently restore balance following an unexpected perturbation

**Equipment:** None

**Safety Procedures:** Position the client approximately 3-4 feet In front of a wall. Stand Immediately behind the participant and adopt a wide base of support during the leaning portion of the test. Be ready to move your feet quickly once you release your hand and the participant begins to lose balance. Flex the elbow and release your hand as soon as you determine that the participant Is exerting sufficient pressure against your hand to require that he/she must step backwards one or more times to restore balance. This release should be unexpected, so do not prepare the participant for the moment of release or allow the participant to lean too far back onto your hand before releasing it.

**Testing procedures:** Instruct the participant to stand with his or her back to you. Extend your arm with the elbow locked and place the palm of your hand In the middle of the participant's back. Instruct the participant to lean back slowly against your hand until you tell him or her to stop. Quickly flex your elbow until your hand is no longer in contact with the participant's back at the moment you estimate that a sufficient amount of force has been applied to require a movement of the feet to restore balance. Try to quickly release your hand while you are still giving the verbal instructions.

**Verbal instructions:** "Slowly lean back into my hand until I ask you to stop."

# Timed Up and Go (TUG) Test

Name:___________________________ MR: ______________________ Date:________

1. Equipment: arm chair, tape measure, tape, stop watch.
2. Begin the test with the subject sitting correctly (hips all of the way to the back of the seat) in a chair with arm rests. The chair should be stable and positioned such that it will not move when the subject moves from sit to stand. The subject is allowed to use the arm rests during the sit – stand and stand – sit movements.
3. Place a piece of tape or other marker on the floor 3 meters away from the chair so that it is easily seen by the subject.
4. Instructions: "On the word GO you will stand up, walk to the line on the floor, turn around and walk back to the chair and sit down. Walk at your regular pace.
5. Start timing on the word "GO" and stop timing when the subject is seated again correctly in the chair with their back resting on the back of the chair.
6. The subject wears their regular footwear, may use any gait aid that they normally use during ambulation, but may not be assisted by another person. There is no time limit. They may stop and rest (but not sit down) if they need to.
7. Normal healthy elderly usually complete the task in ten seconds or less. Very frail or weak elderly with poor mobility may take 2 minutes or more.
8. The subject should be given a practice trial that is not timed before testing.
9. Results correlate with gait speed, balance, functional level, the ability to go out, and can follow change over time.

**Normative Reference Values by Age**

| Age Group | Time in Seconds (95% Confidence Interval) | |
|---|---|---|
| 60 – 69 years | 8.1 | (7.1 – 9.0) |
| 70 – 79 years | 9.2 | (8.2 – 10.2) |
| 80 – 99 years | 11.3 | (10.0 – 12.7) |

**Cut-off Values Predictive of Falls by**

| Group | Time in Seconds |
|---|---|
| Community Dwelling Frail Older Adults | > 14 associated with high fall risk |
| Post-op hip fracture patients at time of discharge[3] | > 24 predictive of falls within 6 months after hip fracture |
| Frail older adults | ≥ 30 predictive of requiring assistive device for ambulation and being dependent in ADLs |

| Date | Time | Date | Time | Date | Time | Date | Time |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

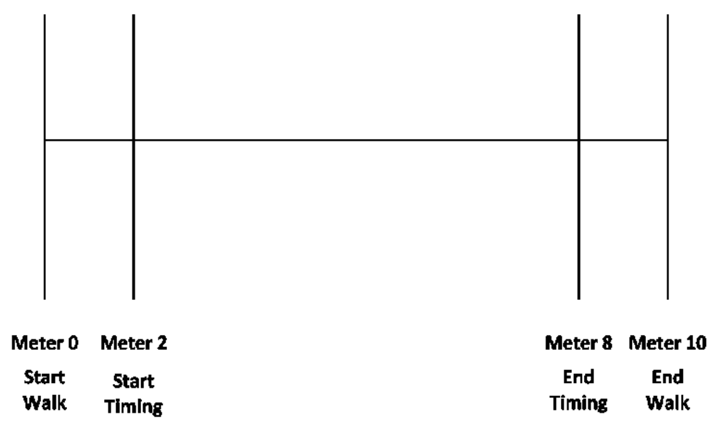
# Timed 10-Meter Walk Test

## General Information:

- individual walks without assistance 10 meters (32.8 feet) and the time is measured for the intermediate 6 meters (19.7 feet) to allow for acceleration and deceleration
  - start timing when the toes of the leading foot crosses the 2-meter mark
  - stop timing  when the toes of the leading foot crosses the 8-meter mark
  - assistive devices can be used but should be kept consistent and documented from test to test
  - if physical assistance is required to walk, this should not be performed
- can be performed at preferred walking speed or fastest speed possible
  - documentation should include the speed tested (preferred vs. fast)
- collect three trials and calculate the average of the three trials

## Set-up (derived from the reference articles):

- measure and mark a 10-meter walkway
- add a mark at 2-meters
- add a mark at 8-meters




## Patient Instructions (derived from the reference articles):

- Normal comfortable speed:  *"I will say ready, set, go.  When I say go, walk at your normal comfortable speed until I say stop"*
- Maximum speed trials: *"I will say ready, set, go.  When I say go, walk as fast as you safely can until I say stop"*

# APPENDIX F

# INTERVENTION MATERIALS

| Dates: | Week | Topic | Exercise Week | Meeting Frequency |
|---|---|---|---|---|
| 10/18/ Tuesday | 1 | Welcome to the GLB | | 1X/ week |
| 10/25/ Tuesday | 2 | Be a Fat and Calorie Detective | | 1X/ week |
| 11/1/ Tuesday | 3 | Health Eating | | 1X/ week |
| 11/8 / Tuesday<br>11/ 10 Thursday | 4 | Move those Muscles | 1 | 2X/ week |
| 11/15/ Tuesday<br>11/ 17/ Thursday | 5 | Tip the Calorie Balance | 2 | 2X/ week |
| 11/22/ Tuesday<br>No Class/Thursday | | Surviving the Holidays | | 1X/ week |
| 11/ 29/ Tuesday<br>No Class/Thursday | 6 | Take Charge of What's Around You | 3 | 2X/ week |
| 12/ 6/ Tuesday<br>12/ 8/ Thursday | 7 | Problem Solving | 4 | 2X/ week |
| 12/13/ Tuesday<br>12/15/ Thursday | 8 | Four keys to healthy Eating out | 5 | 2X/ week |
| 12/20/ Tuesday<br>12/23/ Friday | 9 | Slippery Slope of Lifestyle Plan | 6 | 2X/ week |
| 12/27/ Tuesday<br>12/29/ Thursday | 10 | Jump Start Your Activity Plan | 7 | 2X/ week |
| 1/3/ Tuesday<br>1/5/ Thursday | 11 | Make Social Cues Work for You | 8 | 2X/ week |
| 1/10/ Tuesday<br>1/ 12/ Thursday | 12 | Ways to Stay Motivated | 9 | 2X/ week |
| 1/17/ Tuesday<br>1/19/ Thursday | 13 | Long- term self- management | 10 | 2X/ week |
| 1/24/ Tuesday<br>1/26/ Thursday | 14A | More Volume, Fewer Calories | 11 | 2X/ week |
| 1/31/ Tuesday<br>2/2/ Thursday | 14B | Healthy Eating for Arthritis | 12 | 2X/ week |
| Week of February 13th | 15 | Balance Your Thoughts | N/A | Bi- weekly |
| Week of February 27th | 16A | Strengthen Your Exercise Program | N/A | Bi- weekly |
| Week of March 13th | 16B | Physical Activity and Exercise for Arthritis | N/A | Bi- weekly |

## Resistance Training GLB

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| **Chest, Arms and Shoulders** | | | | | | | |
| Chest Press (p.16) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | 3rd resistance training workout is optional. | |
| Triceps Extension (p.23) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| Bicep Curl (p.22) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| Lateral Shoulder Raise (p.25) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| Frontal Raise (p.26) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| **Back** | | | | | | | |
| Lat Pull Down (p.20) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| Seated Row (p.19) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| **Legs** | | | | | | | |
| Chair Squats (p.28) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |
| Single Leg Hamstring Curl (p.31) | 2 sets of 8-12 reps | | 3 sets of 8-12 reps | | 2 sets of 8-12 reps | | |