

Background

Osteoporosis is acknowledged as the most prevalent bone disorder in the world and is characterized by decreased bone mass, microarchitectural deterioration of bone tissue, and decreased bone strength.¹ Increased osteoclast activity and decreased osteoblast activity, predisposes the individual to an increased risk of fractures of the hip, spine, and other skeletal sites.² Osteoporosis typically only develops in older and elderly adults, with the prevalence of osteoporosis being the highest in post-menopausal women. Estimates indicate that 50% of women and 20% of men ages over 50 years will experience an osteoporosis-related fracture; hip fracture is the most devastating of these due to the consequent disability, mortality, and costs – both personal and societal.¹ In the United States the incidence of osteoporotic fractures exceeds 1.5 million, and hip fractures alone are projected to increase from 1.7 million in 1990 to 6.3 million by 2050.² 1 in 5 people die during the first year after a hip fracture, one third require nursing home placement after hospital discharge, and fewer than one third regain their pre-fracture level of physical function.² Vertebral fractures are also associated with an increased incidence of morbidity including pain, height loss, kyphosis, disability, and mortality.²

The statistics regarding osteoporosis are both startling and concerning, especially when considering the increased ageing population of the 'Baby Boomers' and as we are seeing an increase in life expectancy. As physical therapists we can play a valuable role in both the prevention and management of the disease by educating those affected and at risk of developing osteoporosis and by prescribing therapeutic activities

to prevent, treat, and manage the disease. A major determinant of bone density in an older individual is his/her peak bone mass, as low peak bone mass is associated with an increased risk of osteoporotic fracture.² Attainment of peak bone mass is typically complete by age 40 and the main contributor to this process is the amount of bone that is gained during adolescence.² This is where physical therapy interventions can initially begin. Physical therapists are experts of movement and have an extensive knowledge base regarding various health conditions and the appropriate exercise required to assist in treating and preventing the specific condition. As most of our peak bone mass is acquired during adolescence and as we are familiar with Wolff's Law, early intervention programs could be targeted towards educating those under 40 years old about the importance of physical activity including high impact exercises and resistance training. Young women are often concerned that lifting weights will make them look bulky and 'masculine' therefore a major education component of the intervention could include dispelling these such rumors.

As muscle mass and strength begin to progressively decline after the fifth decade of life, the decrease in muscle mass and strength negatively affects bone mass.³ Aged, post-menopausal women have an increased risk of both osteoporosis and sarcopenia.³ In elderly adults aged 75 years or older, it was shown that a decrease in muscle performance was related to the decline in bone microarchitecture, and that subjects with incident sarcopenia had an approximate 5-fold increased risk of concomitantly developing osteoporosis, showing a dynamic relationship between impaired muscle and bone health, with an obvious association between the concomitant incidences of osteoporosis and sarcopenia³ Frailty is a physical condition observed in elderly people

defined as a decrease in physiologic reserve leading to an increased risk of falls, cancers, cardiovascular disease, limited mobility, reduced ADL's, and increased risk of hospitalization and mortality.³ The combination of sarcopenia and osteoporosis leads to the exacerbation of negative health effects and to frailty syndrome development.³ This is where physical therapy comes into play. Although bone mass cannot be gained through physical activity in older adults >60 years, physical activity can attenuate bone loss.⁴ It is suggested that a combination or single use of resistance training and weight bearing/impact exercise can prevent bone loss after menopause.⁴ The prescription of repeated impact and resistive exercises has been proven to have positive effects on bone health for all age populations.⁴ However, if it is not appropriate for the patient to participate in such activities. They will benefit from resistive and low-impact, weight bearing exercises, because although these exercises will not directly improve bone health. Engaging in these activities will improve balance and reduce fall incidence in older adults with low BMD thereby decreasing fracture risk.⁴ It will be the physical therapist's responsibility to differentiate between patients that are appropriate for repeated impact, resistive exercises and which are not, and prescribe individualized interventions/plan of cares for the patients.

Risk factors associated with osteoporosis include osteoporotic fracture, including low peak bone mass, hormonal factors, the use of certain drugs (e.g., glucocorticoids), cigarette smoking, low physical activity, low intake of calcium and vitamin D, race, small body size, and a personal or family history of fracture.² Despite there being a laundry list of risk factors that are associated with the disease, osteoporosis is still a preventable condition. However, the majority of the population is not partaking in the necessary

steps that are needed to prevent the disease. This is why we must assess and address barriers at the intrapersonal, interpersonal, and community level in order to increase compliance with the prevention protocol. Despite the high prevalence of osteoporosis in post-menopausal women, a low percentage of women regularly engage in health-promoting behaviors associated with osteoporosis prevention.⁵ Previous studies have shown that educational interventions via telephone, text and video, email, training courses, group education, and exercise guidance could add to the patients' knowledge about osteoporosis, improve their quality of life, and increase their compliance with the diagnosis and treatment of osteoporosis.⁵ During a 5 year study an endocrinologist provided education to osteoporotic women and their caregivers regarding the disease progression, nutrition, lifestyle choices, fall avoidance, physical activity, the necessity of taking calcium and vitamin D supplements, and assistive devices. At the conclusion of the study, the participants had a lower risk for fragility fracture, lower pain scores, higher BMD, and higher intake of vitamin D supplements.⁵ This study emphasizes the importance of understanding and addressing barriers at the various levels of the Social Ecological Model. If we develop specific individualized interventions that minimize the barriers this population faces regarding the prevention and management of their disease, then we will see drastic improvements in our patients quality of life and functional mobility.

Osteoporosis is a debilitating condition that is highly prevalent and affects populations worldwide. Early intervention and education are vital for the prevention of management of this condition. We as physical therapist are appropriately suited to treat

this condition, we just have to ensure we address all aspects of the condition at every level.

Program Goals

'Lift Loads for Strong Bones' program aims to improve the strength, balance, confidence, and functional capacity of osteoporotic individuals who participate in the program. Participating in this program will not only decrease osteoporotic disease progression, it will also decrease the risk of subsequent disability from occurring.

1. In 12 weeks participants will perform the 30 second chair stand test within 2 reps or better of their gender and age predicted normative value to demonstrate improved lower extremity strength and an improved functional capacity.
2. In 12 weeks participants will decrease their TUG time to at least 12 seconds or less to demonstrate a decreased falls risk and an increased functional capacity.⁶
3. In 12 weeks participants will improve their MEFS score by at least 10 points to demonstrate an improved self-perception of their balance and to reduce the risk of activity avoidance from occurring.
4. The program will maintain at least a 75% adherence rate throughout the duration and at the conclusion of the program to demonstrate a sufficient rate of participant compliance as well as to demonstrate the efficacy of the program.

Methods

1. Personnel

Ideally the program hopes to enroll at least 25 participants in the program, with a ratio of two physical therapist for every 25 participants. Although, only two physical therapist are required to supervise a session, six physical therapists will be recruited and any two physical therapists can attend a session at a time. This is done to account for the inability of a therapist to attend a session due to unexpected emergencies, as well as a way to provide flexibility for the PT's due to the fluctuating and fluid patient schedules they often endure at work. The PT's will be responsible for supervising and instructing all activity performance as well as providing meaningful information/education to the participants. This a non-profit program therefore, all PT's will be volunteers who are unpaid. 'Lift Loads for Strong Bones' will be a 12-week program with sessions that are held 2x a week.

2. Location

The 'Lift Loads for Strong Bones' program will be located in Durham, NC. The hope for the program is to partner with a local YMCA that will allow the program to utilize its equipment and classroom space. Although, the local YMCA may charge the program to occupy its spaces and utilize its equipment, the primary goal for 'Lift Loads for Strong Bones' is to provide free services for all its participants. Therefore, a fundraiser will be held on a crowdfunding platform that seeks to raise the required money of the potential charge the YMCA may bill the program.

3. Enrollment and Program Schedule

Information regarding the program will be posted on all social media platforms, flyers will be posted in various healthcare clinics around the city as well as in the clubhouse/lobby of senior living communities. An email account for the program will be created which will be the contact information that is listed on the flyers and where individuals can reach out if they have questions. Program enrollment can occur via email or over the phone, whichever the potential participant prefers. The YMCA will be the home for every session of the program. 'Lift Loads for Strong Bones' will be a 12-week program with sessions that are held 2x a week on Tuesday's and Thursday's at 5:30pm. However, there will be an initial informational session that will take place on the Wednesday before the first session of the program. Program sessions will last for 60 minutes and outcomes measure assessments will be administered during the initial, mid-point, and final sessions of the program.

4. Intervention Specifics

Participants will be given the option to either participate in the land exercise group or the aquatic exercise group. There will be one therapist in charge of supervising each exercise group. However, educational sessions that will be held throughout the program and scheduled outcome assessment sessions will consist of all the participants and both PT's. During the educational sessions the PT's will educate the participants on Osteoporosis, the importance of exercise, the detrimental effects of inactivity, how deficits in balance can affect falls risk, as

well as strategies to avoid falls both at home and in the community. The education sessions will be interactive and participants are allowed to ask questions and provide feedback as they desire, these sessions will be held every 3 week. The specific exercises, time allocation, and rep scheme for each intervention group is provided in the chart below.

<u>Exercise Group</u>	<u>Warm-Up</u>	<u>Main Exercises</u>	<u>Cool-Down</u>
Land Resistance Training ⁷	Leisure walking pace around the gym x 5 minutes Dynamic stretches led by PT x 3 minutes	Squats, Step-ups, Upright Row, Sideway Step-ups, Diagonal Lift, Chest Press, Bicep Curl Perform each exercise for 90s with a 30s rest break in-between each exercise. Every exercise will be performed twice.	Slow walking around the gym x 5 minutes Static stretches led by PT x 5 minutes

Aquatic Therapy ⁸	Leisure walking pace in the pool x 5 minutes	Single-leg jumps, ankle hops, tuck jumps, jumps with hip abduction and adduction Perform each exercise consecutively for 20s each. Performing all 5 exercises for 20s each = 1 round. 20 rounds will be performed with a 30s rest in between each round	Slow walking and stretching in the pool x 5 minutes
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The land resistance exercise group will be set-up as a circuit based exercise routine in which the participants will be rotate clockwise after the completion of each exercise. The PT leading this group will supervise all activity performance and modify activity performance for each participant as needed. There will be music playing while the participants exercise and a buzzer will sound which will indicate when it is time to change stations. This is intended to be a high-intensity exercise routine that will require participants to work to a level of 13-14 on a scale from 6-20 on the Borg Rating of Perceived Exertion Scale.

The aquatic exercise group will be also be led by a PT who can either enter the pool with the participants or instruct them from the edge of the pool. Similar to the land resistance group, music will be playing as the participants exercise and a buzzer will sound that indicates when it is time for the participants to perform the

next exercise. The participants will be instructed to perform the exercises at an all-out intensity that requires maximal effort. The leading physical therapist will modify exercises as needed for each participant.

Program Evaluation

The physical therapists of 'Lift Loads for Strong Bones' will administer 3 outcomes measures during the initial, mid-point, and final sessions of the program. The outcome measures performed during the initial session will serve as the participants baseline and will be used to track participant progression throughout the program. The outcome measures performed during the half-way mark of the program will be utilized to ensure the participants are demonstrating functional improvements and are on pace to meet their goals. The outcomes measures performed during the final session will be utilized to demonstrate the effectiveness of the program as well as way for participants to acknowledge and feel proud of the progress they have made through participation in the program. The 30s chair stand test is a performance based outcome measure that measures lower body strength.⁹ A decrease in muscle mass is a normal age-related, however in people with osteoporosis muscle atrophy may occur at a faster rate due to inactivity which can lead to detrimental subsequent disability. The age and gender predicted normative values for the 30s chair stand test will serve as a goal for participants in the program to achieve as obtaining this goal indicates the participant has adequate lower extremity strength despite having osteoporosis. Sufficient lower extremity strength is required to reduce falls risk,

and to maintain balance and functional independency.⁹ Therefore, following the conclusion of the program participants should perform the 30s chair stand test within 2 reps or better of the age and gender predicted normative values.

The Timed Up and Go (TUG) test is a performance based outcome measure that measures physical performance and predicts falls in the elderly.⁶ A slow TUG time as described by a time greater than 12 seconds has been shown to be associated with an increased risk of hip fracture and major osteoporotic fracture in osteoporotic women.⁶ Therefore, a goal of the program will be to reduce and/or maintain a participants TUG to a time of 12 seconds or less to reduce the risk of falls and fracture from occurring.

The Modified Falls Efficacy Scale (MEFS) is questionnaire that is designed to measure the self-perceived fear of falling.¹⁰ Fear of falling is not a common consequence but also a determinant of falls.¹⁰ Osteoporotic individuals who suffer a fall can face very devastating effects such as a fracture, hospitalization, immobilization, frailty, and possible mortality. An important factor to decreasing the self-perceived fear of falling is providing individuals with the proper education regarding balance, falls, and fall avoidance. The MEFS will serve not only as a self-reported outcome measure but also as a questionnaire that can inform the program of the effectiveness of the education that is being provided. The exercise interventions will promote improvements in balance and the educational sessions will increase the participants confidence and belief in their ability to avoid a fall.

During the half-way mark of the program and following the conclusion of the final session, participants will be asked to complete an anonymous survey for the program and its physical therapists. The survey will consist of questions regarding the effectiveness of program, what participants liked/disliked about the program, how the program can be improved, and how likely are the participants to recommend the program to a friend.

Conclusion

'Lift Loads for Strong Bones' will serve as an accessible community-based wellness program that aims to reduce the disease progression of osteoporosis and improve the health and function of its participants. Osteoporosis is acknowledged as the most prevalent bone disorder in the world that predisposes an individual to an increased risk of fractures of the hip spine, and other skeletal sites.² Hip fracture in osteoporotic individuals is the most devastating fracture that can lead to subsequent disability, mortality and costs – both personal and societal.¹ Participating in "Lift Loads for Strong Bones" will reduce the disease progression of osteoporosis, as well as maintain and improve the balance, strength, confidence, and functional capacity for all its participants. The exercise interventions that are prescribed in the program have been researched and have been proven to be effective for treating osteoporotic individuals. Every session of the program will be led by experienced and compassionate physical therapists. 'Lift Loads for Strong Bones' will serve as a pillar in Durham, NC that is

responsible for improving the health, function, and knowledge of local osteoporotic individuals.

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