**Exercise and its effects on fall prevention in older adults: Review**

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Aging is an inevitable process that every living being must go through. Cells decrease their ability to maintain homeostasis in the body causing biological functions to decrease in efficiency. As humans, we cannot avoid aging. As we get older our bodies undergo physical wear and tear and being to ache. The senior population is at a higher risk of injury due to decreased bone density, muscular efficiency and multiple functions which are affected by aging. A lot of research has been ongoing to study the possibility of increasing longevity, not only of chronological age but biological age as well and the ability to remain independent for longer. Fall related injuries are one of the highest reasons to be admitted into a nursing home in the older population (El-Khoury et al., 2013). The most common risk factors that are associated with falls are leg weakness, imbalance and gait change (Mchahon et al., 2012). All of these risks have the potential to be modified and improved upon through exercise. In this review we will discuss exercises potential to prevent fall related injuries in older adults by improving these risk factors. How can exercise be used as a prevention method in older adults whether the person has been active their whole life or are just beginning to exercise? Another question to consider is the type of exercise necessary for these populations. We will highlight and asses strength, functional and balance exercise as they relate to decreased risk of falling (Chin A Paw et al., 2006). Exercise is also looked at as a prescription method with the diseased older population. Diseases and dysfunctions like osteoporosis can increase the chance of falling through decreased bone density and muscular fatigue. Another common disease prone to the elderly population is Alzheimer’s disease, which will be briefly discussed as its medication effects can have an effect on balance and falls. Therefore, can exercise be used to increase quality of life in older adults as well as increase the time able to live independently? The different studies emphasized will discuss the affects of preventative exercise to decrease risk of falling in both healthy and diseased older populations through functional, strength and balance exercise programs.

**Exercise Type**

A large portion of today’s elderly population may be aware of the fact that exercise may help the risk of falling, but are unaware of where to start regarding type of exercise, duration and frequency if they have never exercised before (Chin A Paw, Van Poppel, Twisk & Van Mechelen, 2006). Studies have looked at various methods of exercise to reduce the risk of falling within the elderly population aged 65 and over, including strength training, functional training and balance training.

Elders who have decreased their total lower body strength have been linked to decrease in performance of both functional activities and gait. It has been shown that gait can be improved by increasing lower body strength, thereby decreasing the risk of falls (Krebs, Jette & Assmann, 1998). Performing either one hour in-home resistance band training or one hour sessions lead by a professional in nursing homes two times per week has been shown to increase lower body strength if attendance/adherence was followed (Chin A Paw et al., 2006; Krebs et al., 1998). By increasing strength and gait performance such as stride length and pace it also increased mediolateral stability and base of support, which is a factor of risk of falling (Krebs et al., 1998). The preceding list of changes that occur with increased lower body strength could approximately take twelve weeks or greater of training with a minimum of two times per week for adaptations to occur (Chin A Paw et al., 2006; Krebs et al., 1998). If the guidelines are not followed, results would not be as accurate and risks of falls may not decrease.

Functional training compared to strength training seemed to be the most beneficial for reducing the risk of falling within the elderly population (Chin A Paw et al., 2006). Functional training such as rising from a chair, walking on different surfaces, knee bends, leg flexion and calf raises are all exercises that target problem areas during gait. If performed two times per week, for at least three months these functional exercises could increase gait performance (Gine-Garriga, Guerra & Unnithan, 2013). Gaining independence and confidence during gait and physical tasks throughout the day will overall decrease the fear of falling within the elderly population (Gine-Garriga et al., 2013). Based on these studies functional training was shown to be more effective in elderly population to get through daily activities in comparison to strength training. More compliance was associated with functional training potentially because participants felt it was relevant to their daily activities (Gine-Garriga et al., 2013).

Balance training, along with Tai Chi has also been studied to decrease the risk of falls and is designed to challenge the visual, vestibular and somatosensory systems (Gine-Garriga et al., 2013). Jensen, Nyberg, Rosendahl, Gustafson & Lundin-Olsson (2004) demonstrated that elders were able to ambulate without support and retained gait speed post balance training. No effect was found in decreasing the risk of falling within these subjects along with other studies. Tai Chi has been shown to increase gait speed, physical function and balance, thus increasing the independence of an elder, but no findings significant to decreasing the risk of falls (Manor, Lough, Gagnon, Cupples, Wayne & Lipsitz, 2014). Overall, balance and Tai Chi showed benefits in gait and function but did not see a correlation in decreasing risk of falls.

 Combination training has also been suggested to reduce the risk of falling within the elderly population. Fear of falling decreased and self-reported quality of life increased when strength or functional training was combined with balance training performed twice per week (Chin A Paw et al., 2006; Gine-Garriga et al., 2013). When risk of falling was looked at however, the number of falls did not decrease within the frail population (Jensen et al., 2004). Aerobic training paired with strength training has shown to increase processing speed in the brain and decreased time during a walking test, which could in turn reduce the risk of falling, since the individual would respond faster to a certain situation (Langlois, Vu, Chasse, Dupuis, Kergoat & Bherer, 2012).

**Exercise Prevention**

It is very debilitating for the elderly to sustain a fall. Many who fall in their later years suffer devastating injuries and in many cases can no longer function on their own. When looking at how one can prevent this many solutions come to mind: walkways could be made safer for those walking out side (clear flat paths could be made), improvements to the home could be made in order to eliminate trip or slip hazards. However, these are just ways to improve the external environment around us we can also improve our bodies so that a fall is less likely. It is fairly well established that balance or core stability and strength exercises have shown the best results as far as the type of exercise to prevent falls. As a person age’s, muscle atrophy is seen and falls become more likely but we can significantly decrease our risk of falling by participating in exercise programs. If elderly individuals take part in continuous exercise they can reduce their risk of falls, improve their health and therefore even improve their health-span (Lim, H.S. and Yoon, S, 2014). The intervention performed by Lim, H.S. and Yoon, S observed that the obstacles that caused the elderly to fall had common characteristics. They saw that the elderly could not get around them and had to cross them. It was hypothesized that improving the ability to evade and maneuver around obstacles would decrease the risk of falls. It was found that after an 8 week, 60 minute sessions three times per week participants risk was statistically reduced and their gait stability variables were statistically increased (Lim, H.S. and Yoon, S, 2014). Aquatic programs provide individuals with a safe environment to perform exercises. This is one of the problems many elderly expressed stopping them from exercising. The 8 week program did improve the ability to maneuver around objects at 30% leg length but didn’t seem to affect the ability to maneuver around objects at 40% leg length (Lim, H.S. and Yoon, S, 2014). This finding suggests that a longer exercise intervention would be better for maneuvering around larger objects (Lim, H.S. and Yoon, S, 2014). Another interesting point of the study was that there were no dropouts; this indicates that there was greater adherence to this type of program in comparison to others. Gschwind, Y.J. et al. used iStoppFalls, an at home interactive “video game” with exergame technology to improve balance, muscle strength and quality of life in the elderly population. This international single-blinded, two group randomized control trial of 160 community dwelling elderly individuals for the duration of a year looked at the effectiveness of the iStoppFalls system as a means to integrate an exercise program into daily life. The participants were encouraged to exercise for 180 minutes a week while combining a variety of balance and strength exercises (Gschwind, Y.J. et al., 2014). The home-based exercise system showed promise in reducing the risk of falls. With the addition of regular exercise physical, cognitive and functional performance were positively affected (Gschwind, Y.J. et al., 2014). This interactive at home system provided an easy, enjoyable exercise program in the comfort of their own homes that anyone can take part in. This at home program can be done on the participant’s time and eliminates the potential problem of limited transportation and discomfort in traditional gyms or exercise programs. The iStoppFalls also changes with the participant’s ability and progression over time to make sure the individual gets the most of their workout (Gschwind, Y.J. et al., 2014). Although the iStoppFalls evaluation hasn’t been completed it is believed that ICT-systems such as iStoppFalls have great potential to reduce the risk of falls in older adults (Gschwind, Y.J. et al., 2014).

**Preventative Exercise in Diseased Populations**

 There are a variety of age related diseases associated with the elderly population. Whether these diseases are associated with elderly falls is the question at hand. How can exercise help the elderly diseased population reduce their risk of falls as well as injuries? Common diseases among the elderly include osteoporosis and Alzheimer’s, which will be outlined and emphasized in the following review. Falls are a collective cause of injury among the elderly population, especially those with cognitive impairment (Epstein et al., 2014). Treatment of cognitive deterioration is often approached through multiple medications. These can yield both beneficial and negative effects, thus resulting in an increased incidence of adverse events in the elderly; this can include falls (Epstein et al., 2014). “Many [of the medications used to treat cognitive impairment and deterioration, such as Alzheimer’s] have been implicated in increasing fall risk in elderly, including antidepressants, antipsychotics and sedatives” (Epstein et al., 2014). On the other hand, there has been suggestion that cholinesterase inhibitors (ChEI’s) can improve gait and balance by enhancing attention and executive function, thus leading to a reduction in falls, says Epstein et al., 2014. The purpose of the study was to test the hypothesis of the association between ChEI’s and memantine use and falls in participants with Alzheimer’s Disease (Epstein et al., 2014). Some frequent hospitalizations among Alzheimer patients in general were fractures and also falls not causing fractures. Dementia, similar but mild to Alzheimer’s, can heighten risk of falling by “impairing judgment, gait, visual-spatial proprioception, as well as one’s ability to recognize and avoid hazards” (Epstein et al., 2014). ChEI’s have been suggested to improve gait and balance control, but on the flip side there have been also many reports of falls, syncope and accidental injuries related to ChEI’s and memantines. Results from Epstein et al. study indicates that patients on Alzheimer’s medications have 63% greater chance of falling than those not treated with the medications. It should be noted that this study did not show the association between falls and antidepressants. A correlation was also found between falls and Alzheimer’s medications in specifically a clinical practice setting. It is interesting to see the effect that different medications can have in detriment as they are meant to treat an illness or disease. The results of this study pose a different viewpoint to the effect of disease and falls in an elderly population even though there is not an emphasis on a specific exercise regimen or treatment. This study questions the medications used for Alzheimer’s treatment because there are limits shown in their ability to provide symptomatic benefit (Epstein et al., 2014). When considering the effectiveness of medications, the serious or adverse events should be carefully weighed against the possible small benefit from its use (Epstein et al., 2014).

 Risk of injury and falls increase as age increases often due to age related musculoskeletal deterioration, proprioception and balance (Stolzenberg et al., 2013). It is important to maintain muscle coordination and balance in the elderly population to prevent falls but even more so in those with low bone density or osteoporosis (Stolzenberg et al., 2013). Bone fracture is of particular concern to older women with reduced bone density. The aim of Stolzenberg et al. was to examine the effect of classical balance training and whole body vibration training and postural control in post-menopausal women with low bone density (ie. Osteoporosis) (Stolzenberg et al., 2013). Balance training is considered a useful method to prevent falls (Stolzenberg et al., 2013). The training was performed progressively to present a constant challenge for the adaptation of the proprioceptive and vestibular system (Stolzenberg et al., 2013). Progressive balance and coordination were tested in the balance group while the vibration group underwent 4 minutes of vibration every month for nine months. Whole-body vibration has been suggested as a tool to improve balance (Stolzenberg et al., 2013). It can “improve neuromuscular function, lumbo-pelvic proprioception and there is also evidence suggesting that it stimulates muscle activity via the muscle spindle system” (Stolzenberg et al., 2013). Main tests included a standard single leg stance on an unstable surface; tested in four different forms on a ground reaction force plate. Conclusions were made that strength training combined with proprioception training or whole-body vibration was associated with improvements in some, but not all postural control measures (Stolzenberg et al., 2013). There was also no significant difference in impact of vibration and balance training on postural control. Against their hypothesis, this study implied that a whole-body vibration program alongside resistive exercise can improve postural control to a similar extent as resistive training combined with balance training (Stolzenberg et al., 2013). Balance training and Tai Chi have also proved effective in conjunction to improve postural control (Stolzenberg et al., 2013).

 In osteoporosis, the compression of vertebral bodies can be treacherous. Absence of pain does not always indicate the absence of a fracture, micro fracture or deformity. Exercise is a part of a comprehensive management for patients with osteoporosis and has also been associated with increased quality of life and decreased risk of future fracture (Sinaki, 2012). It is imperative that exercise prescription is matched with patient needs. If not prescribed properly then there may be negative consequences (Sinaki, 2012). For individuals with osteoporosis, a general exercise program, whether it is therapeutic or recreational, needs to address flexibility, muscular strength, core stability, cardiovascular fitness, and gait steadiness (Sinaki, 2012). Axial strength and stability are of primary importance in those with osteoporosis. To address falls specifically, “an exercise program should also include balance and lower extremity strength training” (Sinaki, 2012). Loading exercises are preferable to endurance exercise.

**Conclusions**

 In accordance to type of exercise, the main findings of these studies showed that functional training and balance training are essential if improvements are to be made to decrease risk of falling. Functional training allowed the elderly to complete tasks that they would do on a regular basis. As well, balance training was important to improve proprioception and ability to avoid obstacles in both healthy and osteoporotic older individuals. It is important to note that falls are still defined as accidents and cannot be completely avoided. But through this review, exercise has shown benefits in increasing strength and balance, which are both involved in risk factors of fall related injuries such as gait change, imbalances and leg weakness. In relation to the diseased population it is crucial to listen to the individual’s health practitioner. Although benefits from exercise are shown in osteoporotic individuals other diseased populations could still be negatively effected if not approved by health practitioner. For example in Epstein et al.’s study (2014) medication prescribed for Alzheimers disease showed decreased balance and proprioception which could increase risk of injury during exercise. Overall, in conclusion, exercise has shown many benefits to decrease risk of falling in older adults but it should still be cleared with physician based on individual differences and basis. To increase independence and quality of life it is encouraged to be active throughout life.

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