



The Role of Physical Therapy in Improving Balance and Fall Prevention in the Elderly

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Abstract

Background: The two leading problems of elderly people are balance disorders and falls, which make them become incapacitated due to critical conditions. Physical therapy is considered as one of the methods which are helpful for such problems, but comprehensive treatment should include efforts of several specialists.

Aim: The purpose of this study is to examine the feasibility of integrated care working models applied to elder care specially in the physical therapy realm to address issues of balance and threat of falling.

Methods: Systematic mediated literature review regarding interdisciplinary teamwork in elderly care and balance and fall prevention.

Results: Role integration with the physical therapist, the doctor, the nurse and others optimizes a patient's balance, concerns related to falling and patient outcomes through teamwork and individual care plans.

Conclusion: The integration of members of different areas of specialization is crucial in handling elderly patients especially because physical therapy ensures proper coordination of movements, improved care and finally a very minimal fall risk.

Keywords: Geriatric, physiotherapy, geriatric Rehabilitation, Risk factors for Falls, Geriatric Syndromes, team approach..

1. Introduction

With the increase in population across the globe it has become significant that the elderly should be supported effectively in any country. Some of the most critical areas of interest in elderly care include balance problems or fall prevention since those complications cause severe bodily harm, loss of mobility, and diminished life satisfaction. These issues are core concerns and where physical therapy comes in, to address the balance, strength, and physical mobility of the elderly. But, the geriatric care is a little different and needs a more personalized approach than mere exercise for the patient. Local and multidisciplinary collaborative systems practices matter significantly in the care of the elderly and thus need to be promoted. The other aspect of the elderly patient care is teamwork utilized by physical therapist, doctors, occupational therapist, nurses and other care professionals to cover all the concerns. The purpose of this study is to understand the provision of care services especially in the aspects of balancing and fall

prevention to elderly's using collaboration framework notion within care providers.[1] The aim of this paper is to provide a general overview of how a multimodal and multiprofessional approach can be applied in elderly patients, focusing on benefits using coordination of communication, joint decision making about the interventions, and their implementation. [2]

One Hour Understanding Balance Issues in Aging

Postural control is a coordinated activity of several physiologic systems; among them is the vestibular system in the inner ear, the somatosensory system in the skin and joints, and the visual system derived from the eyes. These systems change in many ways in the course of an individual's aging and moments of instability could be experienced. For example, the system most commonly affected is the vestibular system that undergoes a loss of hair cells – both in terms of quantity and their sensitivity to movement and balance. Likewise, the somatosensory system

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can experience reduced tactile acuity and reduced nerve conduction velocities leading to proprioception, the body's recognition of position in space being impaired. Reduced depth of field and low contrast acuity also compromise an aged individuals balance especially where there is poor lighting or objects on the floor.[3] Apart from the physical changes, imbalance in the elderly has been laced with more health complications and modifiable risk factors. These diseases include diabetes, arthritis and Parkinson's disease which affect an individual's ability to perform coordinated movements and balanced movements. Other causes include medication use especially those that cause the patient to be sleepy or have low blood pressure. In addition, and of utmost relevance, is the loss of muscle mass and strength known as sarcopenia is an age related decline that in old age directly influences the ability to regain balance. Some psychological factors include fear of falling and these can always reduce mobility thus leading to unwanted deterioration of balance.[4] A awareness of these concerns is important when designing helpful strategies. Early detection and solution for what contributes to balance problems can help healthcare practitioners to devise methods incorporating physical as well as mental aspects. It is less expensive, in terms of both time and money, to address the balance deficit early thus; balance problems are effectively prevented through early recognition and possible remedial steps which include physical therapy programs, modification of the home environment as well as use of assist devices. Such treatments not only create stability, but also positively influence quality of life so that elderly people are capable of preventing falls on their own.[5,6]

Effects of Falls and the Importance of Physical Therapy for Fall Risk Reduction

Older people experiences falls and the consequent falls remains some of the causes of injuries and disability among the older people, hospitalizations, and loss of quality life. As populations globally continue to age the issue of fall risk management has become an important aspect of geriatric medicine. This is why physical therapy is extremely essential in managing the risk factors for falls; as most pertain directly to balance issues, muscle weakness, and coordination. Apart from decreasing the risk of falls, physical therapy involves well planned and bam footing interventional techniques for regaining the balance, confidence, and independence of the elderly.[7] A common target in physiotherapy for fall prevention is muscle power in the lower limbs because weak muscles often make the clients unstable. Resistance training, functional movements and weight bearing exercises make up the kind of exercises that therapists develop for each patient. Strengthening exercises form part of these programs and include reflex on the lonely leg, walking heel-to- toe, and dynamic balance exercises respectively. Such next generation therapies like vestibular rehabilitation are also used to manage dizziness and vertigo- two balance related complaints seen often in geriatric population.[8] The other category of physical therapy is education and awareness. Health care staff evaluate each patient's surroundings for potential danger that includes; slippery floor mat or rug, inadequate lighting or a wobbly floor. Mobility issues also include training on how patients will move around safely, how to use a walking stick or a walker and how to get up again in case they fall. Besides, working as a team with other providers, physical therapists may identify patients with medication side effects, other diseases or psychological issues, such, as fear to fall, which contributes to patients overshadowing their potential

for movement.[9] It is worthy to note that PT is not all about physical health stability here we note the social cognitive psychological aspect. Through strengthening, mobilizing and firing up confidence, physical therapy enables an individual to have a improved quality of life. People who attend therapy session regularly establish less feelings of falling, enhanced movement, and enhanced social contacts. Such effects lower the treatment expenses of fall-related injuries and at the same time foster the healthy and self-reliant lifestyles of older adults. Therefore, physical therapy is a priceless weapon in multi deionized approaches in the prevention of fall among the elderly.[10,11]

Selected Treatment Strategies to Increase Stability in the Elderly

Given that therapeutic approaches to enhance stability from older adults are targeted at diagnosing and treating the intricate antecedents to balance compromise and falling potential. These interventions include physical therapy, mechanically assisted therapy, and enhancing particular patient activities with customized programs. Through the support of musculoskeletal system, better co-ordination, and sensory integration these approaches enable the elderly to have better balance, decrease incidences of falls and mobility. One of the aspects of the therapeutic Interventions is training of equilibrium, which involves the sensory and motor modalities. Sitting cupped elbow and balance on one leg, heel to toe walking or any activities that help to develop single leg balance aids proprioception and postural control mechanisms. Some of the developed methods are involving the stability boards and or the foam surfaces that focuses on developing response to instability which is common in daily activities.[12,13] Tai Chi and yoga are also often recommended since these exercise involves slow and steady motions and aware-body postures help strength and dexterity over a period of time.[14] Resistance training is just as important and especially for lower limbs because weak muscles in the legs and abdominal area are a big cause of falls. Therapists use such implements as resistance bands, weights, and even involve body weight exercises such as squats, and lunges during the therapy. Besides the strength of muscles these exercises help develop stability of joints and overall endurance that promotes better recovery in case of a momentary or sudden onset of balance. Where the ability to move is significantly reduced, functional activity movements like a rise from a chair, or a trip up a staircase are given more weight to enhance stability in daily life.[15] Besides, touching on movements, some of the therapies may involve vestibular rehabilitation especially for elderly patients suffering from dizziness or vertigo. This therapy consists of learning new patterns of movements to help overcome the problems associated with the malfunctioning inner ear, including movements of the head, stabilization of the gaze and balance training. Sensory training may also be useful for older adults with sensory impairments to improve the client's ability to integrate tactile and proprioceptive input somatosensory integration training.[16] Besides exercises, aids and equipment together with environmental adaptations were also found to contribute toward improving stability. The equipment like walkers and canes, and installation of grab bars offer direct assistance in physical support, whereas changes made to the home setting like fitting proper non slip flooring lower impact home risk factors. Physical therapists then determine the home environment and educations the patients on these changes in order to minimize falls. The elder people should be provided with such aides and be taught how they can

effectively use these instruments in as they seek for balance for health stability.[17,18]The other is patient counseling on measures to minimize the risk of falls. They usually advise their patients on appropriate body positions, correct and safe ways of moving and how to deal with any toppling incidences. This entails enlightening seniors that there is such a thing as a safe fall and will demonstrate ways of minimizing on the losses in case of a fall. In addition, for children and adults who have a serious fear of falling, there is psychological counseling as well as an attempt is made to introduce therapeutic exercises that gradually build up confidence so that patients can accomplish difficult movements in a controlled environment.[19]

Preventing Falls: What Works and Where to Find the Evidence

Older people fall frequently and it is now a major public health issue because of the impact that a fall has on the physical, psychological well-being as well as financially. Best practices are important in that they allow maintaining not only the high level of effectiveness of the interventions, but also their individualization in the context of older adults. These measures are backed up with research to show precisely how they can help minimize the elderly's risk of falling as well as enhance their wellbeing. The combination of these processes into patient care plans is standing to greatly reduce the re-occurrence of falls and related harms. Among all fall prevention interventions, exercise programs to enhance strength, balance and flexibility are one of the best supported by the evidence. A lot of authors note that constant performing of physical activity may help to obtain better lower body strength, better postural stability, and higher mobility. The best exercise regimes normally involve use of weights, balance training and function training. For example, the Otago Exercise Program that has strength and balance components has been shown to reduce falls by 50% in older adults after strength and balance exercises have been undergone through. In the same regard, the FICSIT (Fitness and Fall Injury Control Trials) program containing balance training plus aerobic training has proved to reduce falls among the elderly significantly. Tai Chi for instance enhance balance and retrieval of fear to fall due to the slow flow of bodily movements and body awareness.[20,21]It must also be noted that evaluating and changing the physical environment of the home is another key determinant of evidence based practice. Fall prevention is an area of focus which has been accorded much evidence in favor of home safety assessment as an effective intervention. The likelihood of falls are highly amplified by elements in the environment including; inadequate lighting, insecure floor mats, accumulation of barriers on corridors, and slippery floors. Minor changes that have a great impact include having grab bars installed in the washrooms and making sure that there are no barriers on the alleys; having mats that do not slip in areas such as the washrooms, and the kitchen among others. Homing visits, and environmental surveys conducted by health care professionals including occupational therapist have been evidenced to be very efficient on the identification of these risks. In addition, patient awareness on being cautious at home also has the task of ensuring the homes within are free from incidents that lead to falls.[22]Medication review and management also leave much to be discussed as an evidence-based practice useful in the prevention of falls. Some medicines including those that influence the central nervous system including sedatives, antidepressants, and antihypertensive are likely to lead to falls. Health care provider advised medication review can suggest potentially causative agents of dizziness,

hypotensive episodes, or impaired co-ordination. Lifestyle changes, including changes of dosages or other medicines may greatly reduce the risk of falling. Also, older patients may be on multiple medications, polypharmacy, which also increases the risk of falls and should therefore reduce the number of medications not essential. Pharmacists and physicians in the present study are termed as influential in performing medication review to avoid placing elderly patients at greater risk through pharmacological factors.[23]Visual and auditory complications are frequent in the elderly and affect stability and recurring falls. There is research backing appropriate eye care and treatment of diseases like cataract, glaucoma and macular degeneration through correct vision checkups. Vision problems reduce the ability to discern depth, contrast, and get around when there is little or no lighting; all factors that lead to more falls. Corrective glasses, adequate illumination, and vision check up campaigns are useful in preventing the 'sensory fails' as a cause of fall.[24,25]

Specific Exercises for Stability in the Elderly

Stability is important for the elderly so that they do not fall and become immobile or lack any independence. There are several changes that occur within the human body as the person ages and these changes are associated with instability and falls happens as follows; Aerobic exercise programs that are unique to this particular age group can help combat these changes, increase balance and enhance functional fitness. These exercises hence aim at improving the body postural stability response, postural control and postural stability recovered when balance is upset. I found that when exercises are performed as per the fitness level and requirements of elderly clientele, such treatments are not only reasonable but also more effective in enhancing strength, endurance and flexibility.[26]Facilitating the muscles especially the lower limb muscles is one of the most vital concepts of balance training in elderly people. Last but not least, smaller and weaker muscles involving the lower limbs and particularly the thighs, calves and hips are a major cause of instability and balance.(Figure 1)Seated leg lifts, squats, and step-ups are some of the special strength built and maintained for exercising with strength. Such workouts are usually very gentle and do not impact the joint in order to give the required stimulus to the muscles, bones, ligaments and tendons to build up strength. These intervals of exercise progression mean that the exercises are set at a level that is most manageable to the targeted individual at that moment. An example of this is the Otago Exercise Program, which involves functional exercises, appropriate to the person's exercise capacity, centering on lower limb muscle power, and balance.[27]Apart from strength training exercise, balance training is mandatory for stability especially compromising elderly persons. Balance control exercises enable strengthening of the connection between nervous system and muscles in the body. Many exercises are customized for the appropriate need and there are modifications and advances to make the activities more challenging when balance is increasing. It is possible to try standing on one leg, the tandem walking, where one has to walk right with the heel touching the toe of the next foot, or the weight shifting from one leg to another. These exercises involve the contraction of the abdominal and lower body muscles that contribute widely to postural control.[28]

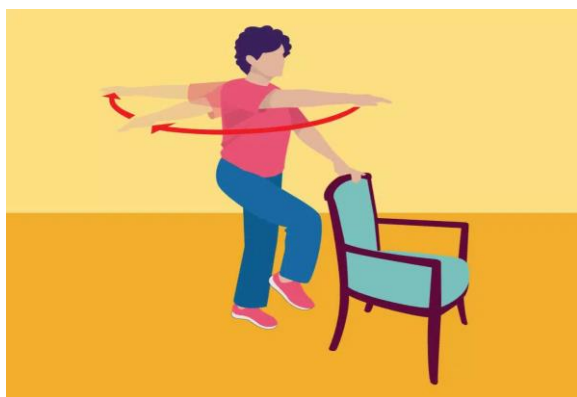


Figure 1: Clock Reach exercise

Other recommended exercise form includes Tai Chi and yoga another feature about it is that it is perfect for elderly people as it combines balance, flexibility, and strength exercises in a gentle way with mindfulness. Tai Chi, to which particular attention should be paid, has been established to be particularly helpful in increasing balance and reducing the frequency of falls in the course of practicing the physical exercise, as Tai Chi implies slow, smooth, and well-measured movements. The other form of exercise is referred to as flexibility exercises which also feature prominently in developing a customized exercise regime for the elderly. Muscles and joints get rigid especially as people age and this interferes with the movements and balances. Greek : Limbering up exercises like hip, ankles, and back help in having better flexibility and joint mobilizations and decrease likelihood of falling down. It is done at the final or initial pre-activation phase of strength or balance session to make the muscle elastic and ready to handle dynamic action. Flexibility can be enhanced by developed Programme and contain such exercises as seated stretching for hamstring, calf stretches and some back bends.[29,30] This is equally important in a training program that includes functional exercises that are a simulation of movement patterns. Specifically, exercises such as sitting and standing from a chair without using arms, climbing stairs, or walking with turns benefits in enhancing the possibility and reliability of performing daily tasks. The training I provide aims at developing strength and balance in realistic movement which is an crucial aspects needed to prevent falls and remain mobile. Functional training also enhances the physical fitness ensure the older adults can counter act sudden changes in posture quickly and in the safest way possible for times when the balance has been off.[31,31]

Control of Fear of Falling through Rehabilitation

It is cited that falling is a concern for seniors and could have the worst effects on their overall wellbeing. Fear of falls is also serious: having not fallen is not the same thing as not fearing a fall, which greatly decreases physical and social activity, and thus the elderly person's quality of life. This is usually brought about by the knowledge of changes in bodily strength, balance and mobility, and the resulting apprehension about loss of autonomy. This fear is not without significant consequence, it discourages the patient from engaging in normal daily activities and over time, due to lack of use of their muscles, the risk of actual falls increases; socially, emotionally, the patient becomes withdrawn, destabilized, and this often leads to depression and anxiety. Fighting the fear of falling is always a critical

part of rehabilitation programs of the elderly as it enhances confidence, activity and ultimately reduces the chances of falls.[32]Most recently, there has been the development of intervention approaches to reduce the fear of falling and various rehabilitation interventions given also incorporate psychological components as well as the physical ones. CBT has been considered as an appropriate method of providing treatment to the psychological factors associated to fall fear. CBT assists a person in changing negative perceptions about balance and safety. Thank you, by reducing cognitive distortions including the unrealistic expectations of falling, individuals start replacing their worries with a more positive outlook to any situation. It also follows the process of exposure gradually in a controlled manner to the fears rocking the patient, in a way that he or she can regain some measure of control over movements. CBT is integrated part and parcel of the comorbid rehabilitation programs that include the cooperation of multiple care givers comprising of physical therapists, occupational therapists and psychologists among other specialists in addressing not only the physical factors that are likely to lead to falls but also the psychological factors as well.[33]Apart from cognitive interventions, important aspects of rehabilitation activities involve physical procedures with aims at strength, balance and coordination. Download file to view full abstract One of the greatest objectives of rehabilitation is to enhance the physical self-assertiveness, that means to augment the functional profile of any subject. LPHN 4 Pts While recommending specific kinds of exercises, the physical therapists can enable people to build up their muscles and flexibilities as well as proprioception – which enables an individual to have balance. Skeletal muscles in the lower part of the body have to be given preference since it established that lower limb muscle weakness is a significant causal factor in falls and imbalance that result in falls among the elderly. Be it story telling, standing on one leg, tandem walking (walking heel to toe), or functional mobility training the balance can be enhanced. Whenever people experience enhanced motor skills the fear to fall equity reduces, primarily because they are convinced that they can maneuver effectively around their environment.[34]

Another important component of the rehabilitation for management of fear of falling is instructions regarding behavior if the client actually falls. This includes evoking safe fall measures in case a senior has fallen down and measures to put in place to ensure the impact is bearable. For example, normal people can train themselves in such a way that if they are to fall they know they have to relax their muscles as well as roll off the force applied. How to lower figures and how to get up after a fall exercises also instill confidence because people have an understanding on how to get up if they slide off balance. Such training is useful to the elderly as it gives them confidence that in case they fall they have the capacity not to get seriously injured.[35] Rehabilitation also entails establishing support from other people socially as well as participation in social group activities. The fear of falling may result in social isolation because people stay away from areas that they feel can cause fall related injuries. Social isolation, in a similar way, may cause more physical deconditioning and a growing sense of endangerment. The group exercise or support, whether disease-specific or cardiac-rehabilitating classes combine encouragement of peer support and exchanged experience in terms of learning from other group members. Besides enhancing motivation this social interaction helps lessen the

potential psychological effects of fall fear by reminding oneself of others also experiencing the same difficulties.[36]

The part played by aids and methods in fall prevention

The outcome of the present study affirms the importance of assistive devices and techniques in fall prevention especially among the growing population of the older people, who often suffer from; muscle weakness, poor balance, restricted mobility, and other chronic health disorders. These devices enable the person to promote mobility, increase stability and decrease risk factors for falls in their daily activities. This paper reveals that mobility devices are critical in maintaining safety and reducing the incidence of falls both during and in between movements. Moreover, what these devices and individual techniques can do when used appropriately is significantly enhance the person's ability to retain higher level of physical activity and decrease the risk of the falling along with the corresponding anxiety level.[37,38]The walker is among the most frequently used AID for preventing falls according to the research. Walkers assist getting around by offloading some body weight on the arms and offering central support for walking. This helps save on the ability of the legs and lessens the opportunity for falling specially in the weak lower extremities or those with balance problems. For instance, walkers are most helpful to the people with extreme locomotive difficulties as they afford torso support. Some of the common types of walkers are Stand walkers, that provides full support but are not portable, and Rolling walkers that are more portable because they have wheels. A walker is very beneficial to a person as it will increase that person's belief in his or her ability to move around without assistance and it decreases the persons' fear of falling. Buttock on fitting and training on how to use a walker is important in order not to adopt improper posture or dependence on the walker such that he or she experiences falls.[39]The other essential mobility aid that should be highlighted is a cane. The canes are mostly used by those who need a walking aid but in a minimal way, they need assistance in their balance.

They are available in different models; simple ones that have only one tip, which provides limited support; and the four-tip ones, which offer more support. Canes are beneficial to clients due to the fact that it assists move some weight from lower limbs to upper limbs hence less stress. However, for a cane to be most effective, the best size must be chosen, and the holder should be on the opposite the side of the weaker leg. This is to make certain the great help of the cane in offering support and directing the sufferer in correct posture and position to prevent falls. However, the cane with a non slip rubber tip will make it even safer especially when walking on slippery and uneven ground.[40]For the others with even limited mobility, Wheelchairs and scooters provide another useful solution. These devices enable elderly men and women to be on their own when walking or standing for long periods because of arthritis or most other neurological ailments. These devices help a person to get around on his/ her own acknowledging that wheelchairs and scooters are free from an added pressure on the lower limbs that increases the chances of falling. Apart from prescription, ergonomics of wheelchairs depends on proper fitting to guarantee users comfort and safety. [41]

For instance, seat height or footrests, armrests, and height of a wheel chair should be fixed at a position of the user's choice in a way that they do not cause discomfort that alters posture or movement. Likewise, the use of powered scooters enables users to cover more extensive areas so as to participate in their social and leisure activities without

limiting them by the potential of developing fatiguing falls.[42]

Interdisciplinary Management of the Elderly in Physical Therapy

Interdisciplinary models of delivery of physical therapy to elderly require collaborative care to meet the diverse needs of elderly patients. Older adults are likely to experience a number of changes that can be physical, cognitive, or emotional, thus getting care from a team of people can reap big benefits. In physical therapy, a team approach is not only the physical therapist, but other workers in the health industry including the physician, Occupational Therapist, nurse, social worker and the caregivers. This total and multifaceted patient-centered approach offers the advantage of attending to all possible dimensions of the patient's recovery, as well as of being efficient and integrated.[43,44]Monitoring the elderly patient is one of the chief advantages of a sophisticated collaboration strategy. PT's have a unique understanding based on their area of practice in muscles, joints, movement, gait and balance; however, other practitioners have their areas of specialty as well. For instance, physicians may discover that patient has arthritis or osteoporosis or cardiovascular problems that may infringe on certain movement or exercises in a fitness course. A occupational therapist evaluates the patients ability to perform self care such as dressing, bathing eating, and suggests the appropriate tools to use in caring for the elderly patient. Nurses will also assess the patient's general condition, coordinate the administration of drugs and advice on any illnesses that may impair the patient's mobility. [45-49]

Conclusion

Thus, there is a shouldering of care of the elderly in the setting of physical therapy acknowledge the interdisciplinary teamwork in supporting the care of the older adults. Since aging comes with challenges such as inability to balance and likely to fall, health care employees get to provide holistic care given that they form a team from different specialties. The efficacy of team care approach can be seen and understood by understanding that true care of the patient entails not only physiotherapy and medical and nursing care but also endures emotional and social and medical care. This model of partnership has beneficial effects on care organization and efficacy, on the patient and his/her family involvement in the process of healing and rehabilitation. As more older people exist in the population, the increased use of interdisciplinary strategies in PT and healthcare for people of the older age will be helpful and effective in enhancing the fulfillment of intimate wishes and helping elderly people preserve health and independence from youthful years up to late ages.

References

1. Arkkukangas, M., Söderlund, A., Eriksson, S., & Johansson, A.-C. (2019). Fall preventive exercise with or without behavior change support for community-dwelling older adults: A randomized controlled trial with short-term follow-up. *Journal of Geriatric Physical Therapy*, 42(1), 9–17. <https://doi.org/10.1519/JPT.0000000000000114>
2. Liu-Ambrose, T., Davis, J. C., Best, J. R., Dian, L., Madden, K., Cook, W., Hsu, C. L., & Khan, K. M. (2019). Effect of a home-based exercise program on subsequent falls among community-dwelling high-risk older adults after a fall: A randomized clinical trial.

- JAMA, 321(21), 2092–2100. <https://doi.org/10.1001/jama.2019.5795>
3. Martínez-Carbonell Guillamón, E., Burgess, L., Immins, T., Martínez-Almagro Andreo, A., & Wainwright, T. W. (2019). Does aquatic exercise improve commonly reported predisposing risk factors to falls within the elderly? A systematic review. *BMC Geriatrics*, 19(1), 52. <https://doi.org/10.1186/s12877-019-1060-6>
4. Papalia, G. F., Papalia, R., Diaz Balzani, L. A., & Torre, G. (2020). The effects of physical exercise on balance and prevention of falls in older people: A systematic review and meta-analysis. *Journal of Clinical Medicine*, 9(8), 2595. <https://doi.org/10.3390/jcm9082595>
5. Thomas, E., Battaglia, G., Patti, A., Brusa, J., Leonardi, V., Palma, A., & Bellafiore, M. (2019). Physical activity programs for balance and fall prevention in the elderly: A systematic review. *Medicine*, 98(27), e16218. <https://doi.org/10.1097/MD.00000000000016218>
6. Valdés-Badilla, P. A., Gutiérrez-García, C., Pérez-Gutiérrez, M., Vargas-Vitoria, R., & López-Fuenzalida, A. (2019). Effects of physical activity governmental programs on health status in independent older adults: A systematic review. *Journal of Aging and Physical Activity*, 27(2), 265–275. <https://doi.org/10.1123/japa.2018-0025>
7. Chen, Y., Zhang, M., Guo, Z., Bao, D., & Zhou, J. (2021). Comparison between the effects of exergame intervention and traditional physical training on improving balance and fall prevention in healthy older adults: A systematic review. *Journal of NeuroEngineering and Rehabilitation*, 18, 1–17. <https://doi.org/10.1186/s12984-021-00878-2>
8. Cikajlo, I., Rudolf, M., Mainetti, R., & Borghese, N. A. (2020). Multi-exergames to set targets and supplement the intensified conventional balance training in patients with stroke: A randomized pilot trial. *Frontiers in Psychology*, 11, 572. <https://doi.org/10.3389/fpsyg.2020.00572>
9. Liao, Y. Y., Chen, I. H., & Wang, R. Y. (2019). Effects of Kinect-based exergaming on frailty status and physical performance in prefrail and frail elderly: A randomized controlled trial. *Scientific Reports*, 9, 1–9. <https://doi.org/10.1038/s41598-018-36698-1>
10. Peng, H. T., Tien, C. W., Lin, P. S., Peng, H. Y., & Song, C. Y. (2020). Novel mat exergaming to improve the physical performance, cognitive function, and dual-task walking and decrease the fall risk of community-dwelling older adults. *Frontiers in Psychology*, 11, 1620. <https://doi.org/10.3389/fpsyg.2020.01620>
11. Bohannon, R. W., & Wang, Y. C. (2019). Four-meter gait speed: Normative values and reliability determined for adults participating in the NIH toolbox study. *Archives of Physical Medicine and Rehabilitation*, 100(4), 509–513.
12. Fairhall, N., Sherrington, C., Cameron, I. D., et al. (2017). A multifactorial intervention for frail older people is more than twice as effective among those who are compliant: Complier average causal effect analysis of a randomised trial. *Journal of Physiotherapy*, 63(1), 40–44.
13. Farrance, C., Tsofliou, F., & Clark, C. (2016). Adherence to community-based group exercise interventions for older people: A mixed-methods systematic review. *Preventive Medicine*, 87, 155–166.
14. Franco, M. R., Sherrington, C., Tiedemann, A., Pereira, L. S., & Monica, R. (2020). Effect of senior dance (DanSE) on fall risk factors in older adults: A randomized controlled trial. *Physical Therapy*, 100(4), 600–608.
15. Meng, X., Li, G., Jia, Y., et al. (2020). Effects of dance intervention on global cognition, executive function, and memory of older adults: A meta-analysis and systematic review. *Aging Clinical and Experimental Research*, 32, 7–19.
16. Sherrington, C., Fairhall, N. J., Wallbank, G. K., et al. (2019). Exercise for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews*, 1, CD012424.
17. Tangen, G. G., & Robinson, H. S. (2020). Measuring physical performance in highly active older adults: Associations with age and gender? *Aging Clinical and Experimental Research*, 32, 229–237. <https://doi.org/10.1007/s40520-019-01190-x>
18. Wang, S., Bhatt, T., Liu, X., & Pai, Y. C. (2020). The role of recovery lower limb segments in post-slip determination of falls due to instability or limb collapse. *Annals of Biomedical Engineering*, 48(1), 192–202. <https://doi.org/10.1007/s10439-019-02327-9>
19. Lee-Confer, J. S., Finley, J. M., Kulig, K., & Powers, C. M. (2023). Reactive responses of the arms increase the margins of stability during a slip perturbation. *Journal of Biomechanics*, 157(July), 111737. <https://doi.org/10.1016/j.jbiomech.2023.111737>
20. Lee-Confer, J. S., Kulig, K., & Powers, C. M. (2022). Constraining the arms during a slip perturbation results in a higher fall frequency in young adults. *Human Movement Science*, 86, 103016. <https://doi.org/10.1016/j.humov.2022.103016>
21. Lee-Confer, J., Lo, M., & Troy, K. (2023). Young adults accelerate their arms significantly faster and earlier than old adults resulting in improved center of mass dynamics during an overground slip perturbation. *bioRxiv*, 2023, 12. <https://doi.org/10.1101/2023.12.09.570848>
22. Arnold, C. M., Lanovaz, J., Farthing, J. P., Legg, H., Weimer, M., & Kim, S. (2022). Fall arrest strategy training improves upper body response time compared to standard fall prevention exercise in older women: A randomized trial. *Clinical Rehabilitation*. <https://doi.org/10.1177/02692155221087963>
23. Allin, L. J., Brolinson, P. G., Beach, B. M., Kim, S., Nussbaum, M. A., Roberto, K. A., et al. (2020). Perturbation-based balance training targeting both slip- and trip-induced falls among older adults: A randomized controlled trial. *BMC Geriatrics*, 20(1), 1–13. <https://doi.org/10.1186/s12877-020-01605-9>
24. Karamanidis, K., Epro, G., McCrum, C., & König, M. (2020). Improving trip- and slip-resisting skills in older people: Perturbation dose matters. *Exercise and Sport Sciences Reviews*, 48(1), 40–47. <https://doi.org/10.1249/jes.0000000000000210>
25. Liu, X., Bhatt, T., Wang, Y., Wang, S., Lee, A., & Pai, Y. C. (2021). The retention of fall-resisting behavior derived from treadmill slip-perturbation training in

- community-dwelling older adults. *Geroscience*, 43, 913–926. <https://doi.org/10.1007/s11357-020-00270-5>
26. Marzuca-Nassr, G. N., Alegría-Molina, A., SanMartín-Calisto, Y., Artigas-Arias, M., Huard, N., & Sapunar, J., et al. (2023). Muscle mass and strength gains following resistance exercise training in older adults 65–75 years and older adults above 85 years. *International Journal of Sport Nutrition and Exercise Metabolism*, 1(aop), 1–9. <https://doi.org/10.1123/ijsnem.2023-0087>
 27. Junata, M., Cheng, K. C., Man, H. S., Lai, C. W., Soo, Y. O., & Tong, R. K. (2021). Kinect-based rapid movement training to improve balance recovery for stroke fall prevention: A randomized controlled trial. *Journal of Neuroengineering and Rehabilitation*, 18, 1–12. <https://doi.org/10.1186/s12984-021-00922-3>
 28. Santos, L. E., de Sá Ferreira, A., Vilella, R. C., & Crepaldi, L. (2024). The importance of physical therapy in the evaluation of fall prevention programs in older adults: A scoping review. *Topics in Geriatric Rehabilitation*, 40(1), 83–92.
 29. Lee-Confer, J. (2024). Strength in arms: Empowering older adults against the risk of slipping and falling—a theoretical perspective. *Frontiers in Sports and Active Living*, 6, 1371730.
 30. Wu, K. A., Kutzer, K. M., Kugelman, D. N., & Seyler, T. M. (2024). Fall prevention after hip and knee arthroplasty. *Orthopedic Clinics*.
 31. Dudás, V. (2024). A comprehensive analysis of fall risk and prevention. *Science Insights*, 44(5), 1365–1373.
 32. Horta, R. d. S. T. (2024). Falls prevention in older people and the role of nursing. *British Journal of Community Nursing*, 29(7), 335–339.
 33. Rodríguez-Almagro, D., Achalandabaso-Ochoa, A., Ibáñez-Alfonso, J., ... (2024). Effectiveness of virtual reality therapy on balance and gait in the elderly: A systematic review. *Healthcare*, 12(2), 158.
 34. Mittaz Hager, A. G., Mathieu, N., Carrard, S., Bridel, A., & Wapp, C. (2024). Partially supervised exercise programmes for fall prevention improve physical performance of older people at risk of falling: A three-armed multi-centre randomised controlled trial. *BMC Geriatrics*, 24(1), 311.
 35. Colón-Emeric, C. S., McDermott, C. L., Lee, D. S., & Berry, S. D. (2024). Risk assessment and prevention of falls in older community-dwelling adults: A review. *JAMA*.
 36. Pitchai, P., Dedhia, H. B., Bhandari, N., Krishnan, D., D'Souza, N. R., & Bellara, J. M. (2019). Prevalence, risk factors, circumstances for falls, and level of functional independence among geriatric population—a descriptive study. *Indian Journal of Public Health*, 63(1), 21. https://doi.org/10.4103/ijph.ijph_332_17
 37. Leem, S.-H., Kim, J.-H., & Lee, B.-H. (2019). Effects of Otago exercise combined with action observation training on balance and gait in the old people. *Journal of Exercise Rehabilitation*, 15(6), 848. <https://doi.org/10.12965/jer.1938720.360>
 38. Chiu, H. L., Yeh, T. T., Lo, Y. T., Liang, P. J., & Lee, S. C. (2021). The effects of the Otago exercise programme on actual and perceived balance in older adults: A meta-analysis. *PLoS One*, 16(8), e0255780. <https://doi.org/10.1371/journal.pone.0255780>
 39. Lee-Confer, J., Bradley, N., & Powers, C. (2022). Quantification of reactive arm responses to a slip perturbation. *Journal of Biomechanics*, 133, 110967. <https://doi.org/10.1016/j.jbiomech.2022.110967>
 40. Rasmussen, C. M., & Hunt, N. H. (2021). Unconstrained slip mechanics and stepping reactions depend on slip onset timing. *Journal of Biomechanics*, 125, 110572. <https://doi.org/10.1016/j.jbiomech.2021.110572>
 41. Lee-Confer, J. S. (2023). Overground walking slip perturbations induce frontal plane motion of the trunk indicating that slips are not just a backwards but also a sideways loss of balance. *bioRxiv*. <https://doi.org/10.1101/2023.11.25.568692>
 42. Kleiven, S. (2020). Hip fracture risk functions for elderly men and women in sideways falls. *Journal of Biomechanics*, 105, 109771. <https://doi.org/10.1016/j.jbiomech.2020.109771>
 43. Beato, M., Dawson, N., Svien, L., & Wharton, T. (2019). Examining the effects of an Otago-based home exercise program on falls and fall risks in an assisted living facility. *Journal of Geriatric Physical Therapy*, 42(4), 224–229. <https://doi.org/10.1519/jpt.0000000000000190>
 44. Liu-Ambrose, T., Davis, J. C., Best, J. R., Dian, L., Madden, K., Cook, W., ... (2019). Effect of a home-based exercise program on subsequent falls among community-dwelling high-risk older adults after a fall: A randomized clinical trial. *JAMA*, 321(21), 2092–2100. <https://doi.org/10.1001/jama.2019.5795>
 45. Chitrakul, J., Siviroj, P., Sungkarat, S., & Sapbamrer, R. (2020). Multi-system physical exercise intervention for fall prevention and quality of life in pre-frail older adults: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, 17(9), 3102. <https://doi.org/10.3390/ijerph17093102>
 46. Papalia, G. F., Papalia, R., Diaz Balzani, L. A., Torre, G., Zampogna, B., Vasta, S., ... (2020). The effects of physical exercise on balance and prevention of falls in older people: A systematic review and meta-analysis. *Journal of Clinical Medicine*, 9(8), 2595. <https://doi.org/10.3390/jcm9082595>
 47. Kadir, M. I., Hardiyanty, N., & Adliah, F. (2021). A pilot study of the effect of Otago exercise program on fall risk and quality of life of older women. *Physical Therapy Journal Indonesia*, 2(1), 1–4. <https://doi.org/10.51559/ptji.v2i1.16>
 48. Maryam Kohansal, Yasemin Khudiar Alghanimi, Shaimaa R Banoon, Abdolmajid Ghasemian, Hamed Afkhami, Abdolreza Daraei, Zhangling Wang, Najmeh Nekouian, Jindong Xie, Xinpei Deng, Hailin Tang . CircRNA-associated ceRNA regulatory networks as emerging mechanisms governing the development and biophysiology of epilepsy. *CNS Neurosci Ther*, . 2024 Apr; 30(4):e14735. doi: 10.1111/cns.14735 .
 49. Zahraa Kamil Kadhim Lawi, , Feryal Ameen Merza, , Shiamaa R. Banoon, Mohammed Abd Ali Jabber Al-Saady, Aswan Al-Abboudi Mechanisms of Antioxidant Actions and their Role in many Human Diseases: A Review. *Journal of Chemical Health Risks*, (2021) 11, 45-57