

Introduction and Purpose

The number one cause of injury among older adults is falling.¹ Falls often result in injuries that lead to emergency room visits or require the services of health care professionals.¹ According to the CDC, falls are the leading cause of nonfatal injuries, and hospital admissions for trauma in the 65+ populations.¹ Some of the most common injuries from falls are lacerations, head trauma along with traumatic brain injury (TBI) and fractures of the hip, spine, forearm, pelvis, and ankle.¹ These injuries often result in hospital admissions that frequently turn into extended long-term stays at skilled nursing care facilities.¹

Falls also cause a loss of confidence and fear of falling that limits normal activity, which decreases social activities and overall health, while increasing the risk of depression.¹ Thus, falls have several outcomes that are not conducive to the general well-being of older adults and they lead to an increased expenditure of healthcare dollars.¹ In 2010, there were 2.3 million nonfatal injuries from falls, with an estimated cost of 30 million health care dollars spent.¹ These numbers are staggering, but what is even more staggering is to consider the number of deaths associated with falling. In 2010, about 21,700 older adults died from unintentional fall injuries.¹ Furthermore, WHO reports that the world's population of 60 and over has doubled over the past 30 years and they predict it will eclipse 2 billion by the year 2050.²

With the elderly population's estimated growth, we can expect to see an increase in falls, fall related injuries, institutionalism, poorer outcomes and quality of life, and an overall increase in the cost of healthcare.¹⁻¹¹ Therefore the need to identify interventions that reduce the rate of falls, the risk of falling, and their associated injuries is paramount in decreasing overall costs, poorer outcomes as well as quality of life. Exercise is the number one recommended

intervention according to the CDC at reducing the risk of falls.¹ The exercises emphasized are strength, balance, flexibility, and endurance.¹

There has been an increasing trend at the effectiveness of a variety of group classes, as well as multifactorial approaches. Many of the group classes focus on the common exercises, but Tai Chi has also become a popular choice. Wolf et al, defines tai chi as "...slow, rhythmic movements that emphasize trunk rotation, weight shifting, coordination, and a gradual narrowing of lower extremity stance."³ Multifactorial programs have been reported to be superior to single intervention approaches.⁴ They often vary, but commonly include the common exercises, medicine reviews, fall prevention education, and home safety assessments.⁵⁻⁷ The purpose of this review is to compare and contrast group exercise classes to multifactorial based fall-risk reduction interventions; as well as identify effective easy to implement programs that target the community dwelling older adult.

A review of literature for fall prevention interventions directed at community dwelling older adults >60, produced a plethora of randomized controlled trial studies that vary in interventions, outcome measures, and results. The sections that follow will compare group exercise studies, and multifactorial studies in relation to their interventions, measures and results.

Group Exercise Programs

The evidence gathered from group exercise programs support the use of common exercises, functional exercises and Tai Chi to decrease the rate, risk and actual number of falls.^{3,4} Nitz et al, found that a 1x/wk for 10-weeks group circuit training program that included static balance, functional strengthening, and dual task exercises had a positive impact on TUG, SLS, step tests, gait speed and reach tests; but does not report a significant reduction in falls.⁸ This

study was a pilot study and reports that dropouts were a large contributor to its results.⁸ In a study of 163 subjects 65+, Barnett et al reports that a 1hr class consisting of common exercises, offered 37x/year and a HEP, resulted in 40% reduction in falls compared to the control group.⁹ It also reports improvements in secondary measures of gait speed, knee extension strength, step test, 5x sit-to-stand test and SF-36.⁹ In a 59 subject prospective RCT, Halvarsson et al, reports that an individualized progressive balance training program 3x/wk for 3 months resulted in an improvement of gait, reaction time, and step-execution. Halvarsson also reports a drop in fear of falling and depression.¹⁰

The frequency, duration and intensity of these studies varied from short to long, and do not indicate a specific frequency or duration that is needed to elicit significant change. These programs do suggest that the range of interventions should be progressive, and Halvarsson indicates that individualization of training will produce better outcomes not only physically but psychologically as well.^{8,10} Another underlying theme that reflects a reduction in fall risks is that the exercise interventions focused on functional activities that promote strengthening and balance.⁸⁻¹⁰ This suggests that the ability to transfer a learned skill from a controlled environment to an uncontrolled environment is better when the practiced tasks are similar or the same as real life situations.

Tai Chi (TC) is an ancient Chinese tradition that has recently gained momentum as an effective fall prevention intervention.³⁻⁴ The review of the literature yielded 3 RCT's that vary in approach and conclusion. Wolf et al took 311 community dwelling elderly frail subjects and split them into 2 tai chi groups of varying frequency, and a control group.³ The duration of the study covered 48 weeks, and the frequency was 1x/wk, as well as 2x/wk with a progression from 60 to 90 minutes over the duration.³ Wolf et al reports that both TC groups had a significant

reduction in number of falls, but the control group had a similar figure with just fall prevention education.³ He also reports that though there was a reduction in overall falls, the TC groups reported significant falling in the first month that led to a lower than predicted fall reduction.³ He attributes this to the unfamiliarity of the subjects with TC and the difficulty of learning the movements.³ In a study with 228 subjects, Taylor et al, had a similar approach to Wolf et al, in that there was a 1x/wk TC group, and a 2x/wk TC group, but his control was a low-level exercise group.¹¹ Over a 20 week program and follow ups of 11 and 17 months, Taylor reports that there was an overall decrease in the number of falls, as well as improvements in 30sec chair stand test and step test; however there was not a significant difference between the group's scores.¹¹ Taylor et al concludes that multiple interventions will reduce falls and that adherence seems to play a large role at decreasing risks.¹¹ The last study was an RCT that separated subjects into a 3x/wk for 6mths TC group, and a low-level stretching group of similar frequency and duration.¹² This study by Li et al, differed in that it accounted for social interaction of both groups, and found a positive impact on reduction of falls.¹² Overall, the TC group had 38 falls over a 12month span, compared to the control of 73 falls.¹² The secondary measures improved significantly and included the BERG, dynamic gait index, functional reach, TUG, and gait speed.¹² Li also reports that the risk of multiple falls was 55% lower in the TC group.¹²

The theme in these TC studies is that due to TC's relative newness, the older populations are possibly less willing to learn and adapt to something that is unfamiliar.³⁻⁴ Thus, it seems there is a subset of the elderly population that are more likely to benefit from TC.^{3,4} Elderly people that are more active, open to trying new things, more coordinated, and perhaps more familiar with TC; will be more likely to adhere to a TC program and reduce their falls risk the most.^{3,4} Another theme to take away from the Wolf and Li studies is that there seems to be a

delay in the benefits of TC, and the longer a patient participates the more they will decrease their fall risk.^{3,12} However, Wolf and Taylor report that Tai Chi based programs are as effective as their exercise and fall prevention education controls.^{3,11}

In comparison of the tai chi and standard group exercise programs, there is a greater reduction of falls in studies that have higher frequencies of 2-3x/wk, as well as longer durations.^{10,11} Halvarsson et al and Li et al both have frequencies of 3x/wk and show the greatest reduction in the number of falls, as well as improved secondary measures.^{10,11} Halvarsson and Li also demonstrated a significant decrease in fear of falling (P=0.008 and P=0.001), and they correlated this with a decrease in the risk of depression.^{10,11} All studies had a positive impact on falls but in general, standard exercise groups seemed to have the greatest reduction.^{3,8-12} Li et al was the sole Tai chi program that had similar reductions in falls, as well as secondary measures compared to the standard exercise groups.¹² This could be attributed to the fact that one of the inclusion criteria was that the subject could perform moderate-intensity exercise.¹² Another comparison to make is that Li reports a possible delay in reduction of falls secondary to the TC learning curve, which could indicate that Taylor's conclusion that TC is just as effective as low-level exercise group is skewed.^{11,12} Excluding the first month of falls in the TC groups, could demonstrate an improved fall reduction ratio that is similar to the standard exercise groups.

Multifactorial Programs

The review of literature produced three RCT's that attempt to differentiate the importance of multifactorial approaches that include combinations of balance, strengthening, aerobic/endurance, medical assessments, home safety assessments and fall prevention education.

In a study that spanned 17 months, Steinberg et al wanted to assess the effects of multiple combinations of interventions on the prevalence of slips, trips, and falls.⁵ He splits 250 subjects up into 4 groups, with the first group receiving fall prevention education and awareness, the second group receiving education as well as balance and strength training with 1hr/month sessions and encouragement to exercise between classes, the third group received the same as groups 1-2 but also had a home safety evaluation/modification, and the last group received the same as the first three with a medical assessment that included a medication review.⁵ He concludes that all groups significantly reduced slips, trips and falls, but groups 2, 3, and 4 had up to a 40% reduction in falls.⁵ No other secondary measures were reported in this study.⁵ In another study by Freiburger et al, 280 subjects were also split into four groups, with interventions occurring 2x/wk for 16 weeks, and falls were recorded over a 2-year time period.⁶ This study reports that a strength, balance and fitness program, followed by just the strength and balance program, has the greatest impact on improved physical performance measures of TUG, 5x sit-to-stand, 10 meter walk test, and modified rhomberg; at the 12 and 24 month follow ups.⁶ However, there is not a significant difference in number of falls, psychological outcomes, and injurious falls as compared to the control group at the same follow ups.⁶ Freiburger further reports that these results could be skewed due to poor attendance, and the fact that a majority of falls reported were during high-risk activities like sports.⁶ The last study by Shumway-Cook et al took 453 subjects and split them up into an exercise/education group, and an education/home assessment group.⁷ The exercise group attended 1hr session's 3x/wk for a year, as well as 6 hours of education a month.⁷ Exercise routine consisted of 30min of aerobic conditioning, 20 min of progressive strengthening, and 10 minutes of balance and flexibility exercises.⁷ Shumway-Cook reports small but significant improvements in secondary measures of TUG (-

0.7s), BERG (+1.5), and 30sec chair stand test (+1.2) over the 12-month intervention.⁷ Fall incidence however was not significant with a slight difference of 1.77 falls/person/year in the control group, to 1.33falls/person/year in the intervention group.⁷ Shumway-Cook attributes these results to poor attendance, and a few individuals with multiple (>10) falls.⁷

The underlying theme to these multifactorial programs is that exercise that includes strength, balance and aerobic training will produce the best results, as evidenced in all of these studies.⁵⁻⁷ Another theme that seems to be common is that of poor attendance. Freiberger and Shumway et al, both report that poor attendance was a factor in their programs.^{6,7} This suggests that access, transportation, and location could be factors that decrease a program's effectiveness. With Shumway-Cook's study having the greatest frequency over the longest duration, it's surprising that it reports limited improvement compared to the 1x/month intervention Steinberg uses.⁵⁻⁶ There are also inconsistencies found in the fact that Freiberger demonstrates that the most significant reduction of falls occurs in the fitness group compared to a non-significant reduction in the 30 minutes of aerobic training Shumway-Cook employs.^{6,7} This could be indicative of an absence of progression, or just poor attendance in Shumway-Cook's study. Another valid point that Freiberger brings up is that future studies should assess and account for a subjects normal activities that are high risk.⁶ This indicates that there could be a need to educate patients on fall prevention in more than just normal activities of daily life.

Comparison of Group Exercise and Multifactorial Approach

In a cross comparison of the literature, it is clear that exercise is the number one intervention at reducing the risk of falling.³⁻¹² The group exercise programs as a whole and the exercise groups of the multifactorial programs demonstrate similar results of fall reduction.³⁻¹²

What is unclear is how much the education, home safety assessment and medication review interventions of the multifactorial approach have on fall reduction. Freiberger et al, reports that the “Matter of Balance” group that included education and exercise, actually scored worse on the TUG than the control group.⁶ Steinberg et al, also reports that the education group had more incidences of slips, trips and falls than its counterparts.⁵ However, Wolf et al reports that the wellness education (WE) program that was his control, had a slight decline in falls.³ The WE group consisted of handouts and education on fall prevention, exercise and balance, diet and nutrition, pharmacological management, legal issues relevant to health, changes in body function, life changes, and how mental health issues affect overall health.³ The other studies do not provide a detailed account of their education, other than it was about fall prevention. A comparison of the fear of falling scores shows less fear and increased confidence in studies that encouraged mastery of body awareness and increased practice of functional tasks.^{6,12} This is evident when you compare Li’s significant decrease in fear of falls ($p=0.001$) to Freiberger’s non-significant difference in fear of falling, even though subjects had improved physical performance tests.^{6,12}

Limitations of the Evidence and Missing Knowledge

There are several limitations of the reviewed literature, with one of the biggest being poor attendance or dropouts that the authors report as being responsible for skewed results.^{3,6,7} Another limitation that Freiberger identifies is the lack of reporting on physical and social activities that subjects participate in outside the intervention and how it affects results.⁶ None of the studies provide a detailed account of the exact sets and reps of exercises. Another common

limitation is that studies often rely on subjects to report falls, which indicates that subjects might over/under report falls due to a variety of reasons.^{3-7,11-12}

Another confounder is that studies had varying definitions of falls and injurious falls, while others did not define falls at all.⁴ Wolf et al defines falls as the unintentional event where the subject comes to rest on an object that prevents center of mass from exceeding base of support (like chest of drawers or wall) or they came to rest on the floor or lower object.³ Barnett defines falls as events that lead to the subject resting inadvertently on the ground.⁹ Nitz et al, doesn't report a definition for falls.⁸ Depending on how strict of a definition the study uses there is the potential to have a larger impact on the results. For instance, Wolf et al reports that intense TC has little effect on fall reduction, but if he lowered his definition of falls to coming to rest on the floor, then results would have been more greatly improved.³ The lack of uniformity in defining falls and injurious falls can greatly confound study comparisons.

Li et al was the only study that accounted for the role of social interaction into both the intervention and control groups to allow for more accurate results.¹² However, there is not a study that has tried to quantify the effects social interaction plays on outcomes. Wolf et al reports that there needs to be more research on the apparent delay of fall reduction within the initial phase of Tai Chi.³ Wolf also reports that the mechanism as to how TC decreases fall risks needs to be researched.³

Conclusions and Applicability

The review of literature has demonstrated that interventions that consist of progressive balance, strength, and aerobic training will have the largest impact on fall reductions.⁴⁻¹⁰ However, there is no definitive evidence that suggests standard group exercise or multifactorial

approaches are more effective at reducing falls risk in the community dwelling older adult, than the other.⁵⁻⁷ There are mixed results as to the effectiveness of tai chi, possibly due to stricter definitions of a fall.^{3,11-12} The average duration of these studies suggests that better outcomes are associated with programs of longer durations, possibly due to increased exposure.

To develop an effective program for a capstone project, one of the biggest factors to consider is attendance.⁶ Transportation, location and access are essential components to attendance. Social interaction also seems to play a key role in patient adherence.¹² Secondary measures that should be included are TUG, FES, 30sec sit-to-stand, gait speed, and QOL/depression scales.³⁻¹² Utilizing exercises that are functional will lead to better carry-over.⁸⁻¹⁰ Multi-component interventions that include education on several topics of general healthy living have been shown to promote better lifestyle changes, as well as decrease falls risk.³ The circuit training that Nitz employs, could be used for more advanced patients.⁸

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