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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| For a community dwelling older adult (60 yrs or older) with an identified increased risk of falls, is dual-task balance training as effective or more effective at reducing falls risk, as compared to single task balance training? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| During my last clinical rotation at a continuing care retirement community, I spent a great deal of time treating patients who were at an increased risk for falls. While many patients came to therapy specifically for this reason, many were there for other reasons and addressing their falls risk was a part of the comprehensive approach of the clinic. In assessing and treating patients who were at an increased risk for falls, the most common type of intervention I used was balance training. We used a variety of approaches, including static and dynamic training, however I often found myself wanting to challenging patients by adding an additional, often cognitive, task, as I felt that this would be more effective at simulating the demands of the real world, outside clinic walls. I had noticed with a couple of patients that when allowed to concentrate fully on the balance task at hand, they performed well, however when asked to perform the same task while slightly distracted, it was far more difficult. Based on some of the motor learning principles that we have discussed in previous classes, it makes sense to begin with simple task training and to make the environment and task more challenging as the learner progresses; I would like to know if using dual task training also fits well with this progression. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| A total of 10 studies met the inclusion/exclusion criteria related to the clinical question. Three randomized controlled trials with high quality evidence scores were selected for an in depth review.  Dual task balance training appears to improve performance on dual task activities in the short term in community dwelling older adults, however limited evidence is available regarding the long-term outcomes of dual task balance training interventions.  Dual task balance training with variable priority instructions for attention allocation appears to produce the greatest improvement in dual task walking speed.  Dual task balance interventions may produce improvements in the balance performance of healthy older adults however it is less clear whether this is associated with a reduced risk of falls.  Based on the three studies selected for review, there is limited evidence to support the use of dual task balance training in order to reduce the risk of falls in community dwelling older adults.  Future research should focus on the efficacy of dual-task balance interventions in more clinically relevant populations such older individuals with significant balance impairments or an increased risk of falls. |

**CLINICAL BOTTOM LINE**

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| There is limited evidence that suggests that dual-task interventions are more effective at reducing the risk of falls in community dwelling older adults, as compared to a standard single task balance intervention, however no negative outcomes were associated with dual task balance training. The specific dual task practice appears to have greatest influence on dual task performance, suggesting a specific training effect. Incorporating dual task balance training into balance interventions in the clinic appears safe and may produce positive outcomes related to balance, especially in dual task situations, and thus may contribute to a decreased risk of falls. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Older adult  Elderly  Fall\* | Dual-task balance training | Single task balance training | Fall  Balance  Fall\* |

**Final search strategy:**

PubMed

1. Search: fall\* OR fall risk
2. Search: dual task balance training OR dual-task balance training
3. Search: older adult OR elderly
4. Search: Aged [Mesh]
5. Search: #1 or #4
6. Search: #5 AND #2 AND #3

Final search appeared as follows: (((fall\* OR fall risk)) AND (dual task balance training OR dual-task balance training)) AND (older adult OR elderly OR Aged[Mesh])

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| **Databases and Sites Searched**  **(Search performed September 2014)** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed**  **PEDro**  **CINAHL**  **Cochrane Library** | **27**  **2**  **4**  **16** | **Last 10 yrs, English only, RCT (13)**  **Not needed**  **Not needed**  **Not needed** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Studies with a population of community dwelling participants/ assisted living facility residents who are over the age of 60 yrs * Studies that report falls risks or balance measures with established falls risk cut off before and after intervention * Studies that include an intervention with both a physical (balance) task and cognitive task * Randomized control trials only |
| **Exclusion Criteria** |
| * Studies with participants in LTC facilities, nursing homes, rehabilitation centers, hospitals * Opinion papers, commentaries, and editorials * Studies that have participants with reported significant severe cognitive impairment (i.e. MMSE <10) * Studies that are not published in English * Studies that only include a single task intervention (i.e. exercise) |

**RESULTS OF SEARCH**

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| A total of | 10 | relevant studies were located and categorised as shown in the following table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and PEDro quality assessment rating scale |

**Summary of articles retrieved that met inclusion and exclusion criteria**

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Hiyamizu et al (2011)** | **8** | **1b** | **RCT** |
| **Halvarsson et al (2011)** | **8** | **1b** | **RCT** |
| **Halvarsson et al (2013)** | **5** | **2b** | **RCT** |
| **Halvarsson et al (2014)** | **6** | **2b** | **RCT** |
| **Melzer et al (2013)** | **9** | **1b** | **RCT** |
| **Shin sun shil et al (2014)** | **3** | **2b** | **RCT** |
| **Trombetti et al (2011)** | **8** | **1b** | **RCT** |
| **Pichierri et al (2012)** | **4** | **2b** | **RCT** |
| **Schoene et al (2013)** | **8** | **1b** | **RCT** |
| **Silsupadol et al (2009)** | **10** | **1b** | **RCT** |

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * Schoene D, Lord SR, Delbaere K, Severino C, Davies TA, Smith ST. A randomized controlled pilot study of home-based step training in older people using videogame technology. *PLoS One*. 2013;8(3):e57734. doi: 10.1371/journal.pone.0057734 [doi]. * Silsupadol P, Shumway-Cook A, Lugade V, et al. Effects of single-task versus dual-task training on balance performance in older adults: A double-blind, randomized controlled trial. *Arch Phys Med Rehabil*. 2009;90(3):381-387. doi: 10.1016/j.apmr.2008.09.559. * Melzer I, Oddsson LI. Improving balance control and self-reported lower extremity function in community-dwelling older adults: A randomized control trial. *Clin Rehabil*. 2013;27(3):195-206. doi: 10.1177/0269215512450295 [doi].   The three studies selected for critical appraisal are all RCTs and had amongst the highest scores for quality when assessed with the PEDro scale. These studies also included a variety of training approaches including group interventions, one on one training, and in home interventions; when taken together these will likely provide a more comprehensive evidence base for my PICO question. Also, the selected studies measured a variety of outcomes that were largely clinically relevant outcomes, where as many of the studies that were not selected utilized expensive research equipment to gather outcomes. Because the evidence from my search is meant to be applied to a clinical question, I would like to review the studies that may provide the most relevant information for clinical practice. |

**SUMMARY OF BEST EVIDENCE**

**Description and appraisal of** *Improving balance control and self-reported lower extremity function in community-dwelling older adults: a randomized control trial* **by Itshak Melzer and Lars IE Oddsson, 2013**

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| **Aim/Objective of the Study/Systematic Review:** |
| This study examined a group of community-dwelling older adults to monitor the effects of a group-based balance-training program, which contained functional balance exercises as well as dual task components. The outcomes of interest were voluntary step execution times and balance control, as these are associated with increased risk of falling; the effects on self-reported physical function were also investigated. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| The study was a single blind randomized control trial, where the blinded investigator collected pre-intervention data (baseline), post-intervention data (3 months after baseline), and follow up data (6 months after baseline; intervention group only). The participants were randomly allocated at the beginning of the study, however the control group was eventually offered the intervention after the post-intervention data collection in order to increase motivation during the study. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| The study was conducted with community dwelling older adults from the Boston metropolitan area, and interventions were held at a Jewish Senior Centre and a senior housing facility in Brighton MA. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Community dwelling older adults were recruited and screened from senior centers and senior living facilities, though the recruitment method was not described. Participants were required to be 65 years or older, to ambulate independently (or with a cane, no walkers allowed), to have a score of 45 or higher on the Berg Balance Scale, and to have a score of 24 or higher on the Mini-Mental State Examination. Participants were excluded if they had severe focal muscle weakness, severe visual impairment, a past medical history of metastatic cancer or neurological disorders, or if they were taking medications that impaired balance or strength. A total of 66 participants met the eligibility criteria, were cleared by their physicians to participate in the study, and were randomly assigned to either the intervention or control group (n=33 intervention, n=33 control). The average age of participants was 77 (+/- 6.5) years old and approximately 75% of participants were female. There were no significant differences between the intervention and control groups for demographic or baseline measures. Two participants in the intervention group dropped out during the study, and one additional participant in the intervention group was unavailable for the 6-month follow-up. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| No intervention. After the pre and post intervention data collection, the control participants were offered the intervention used in the study, however no further data collection occurred afterward for this group. |
| *Experimental* |
| The intervention group participated in one hour-long balance training sessions twice weekly for 12 weeks, resulting in a total of 24 possible training sessions. Intervention sessions with groups of 10-12 participants were held at 2 different locations (a Jewish senior center and a senior living community) and were lead by one physical therapist with the assistance of one additional physical therapist or physical trainer. The intervention was a progressive 5 level balance program that had been described in detail in the authors’ earlier work, however details were not provided in this publication. In general, the lower levels included balance exercises designed to challenge voluntary balance strategies during sitting, standing and functional activities. The highest level included perturbations and dual task activities targeted at maintaining postural control and developing reaction strategies during functional activities. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| A blinded assessor performed all baseline, post-intervention and follow-up testing at two locations (a Jewish senior center and a senior living community).  **Primary outcome measures**  *Voluntary Step Execution Test*  Each participant performed a total of 18 stepping trials during each data collection time point with a variety of conditions (single task, dual task, forward stepping, side stepping, backward stepping). Participants were instructed to step as fast as possible in response to a tap cue on their heel. For the dual task condition, the participants performed a stroop task on the screen in front of them while executing the stepping tasks, where as an X was placed on the screen in front of them during the single task condition. Ground force reaction data were collected and MatLab analysis was used to record/calculate the following: tap cue, step initiation, time to foot-off, time to foot contact, preparatory phase (based on the time from step initiation to foot-off), and swing phase (based on the time from foot-off to foot contact).  *Stabilogram diffusion analysis for evaluation of postural control*  Participants performed a total of 20 trials (10 eyes open, 10 eyes closed) of static balance in a standardized double leg stance position with instructions to stand as still as possible. Center of pressure and ground reaction force data were collected from each trial.  *Late Life Function and Disability Instrument*  Participants gave self-reports about functional abilities using this functional component of this instrument, where higher scores are associated with better balance function (score range 0-100).  **Secondary outcome measure**  *Five-point Likert Satisfaction Rating*  Questions regarding safety, difficulty, enjoyment and perceived effects of training were administered to the 31 participants who completed the intervention. Answers could range from 0 (strongly disagree) to 5 (strongly agree). |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Results from Voluntary Step Execution Test**  A statistically significant group x time interaction was noted for foot contact time in both the single and dual task conditions, with the intervention group demonstrating improvement and the controls demonstrating no change at the post-intervention testing.  Single task: P = .02; Effect size = .34  Dual task P = .036; Effect size = .55  A statistically significant group x time interaction was also noted for step initiation in the dual task condition, with the intervention group demonstrating improvement and the controls demonstrating no change at the post-intervention testing (P = .001; Effect size = .49).  For the intervention group there was no significant difference in step initiation time between baseline and six-month follow-up (P= .86).  A significant group x time interaction was noted for the dual task/single task ratio (a measure of interference of a cognitive task) during step execution, with the intervention group demonstrating improvement and the controls demonstrating no change at the post-intervention testing (P= .002).  **Results from Stabilogram Diffusion Analysis**  A statistically significant group x time interaction was noted for the transition displacement parameter in the eyes closed testing position, with the intervention group demonstrating a decrease in transition displacement and the controls demonstrating no significant change at the post-intervention testing (P= .007; Effect size= .30).  A statistically significant group x time interaction was noted for the short-term scaling exponent (a measure of persistence of postural sway), with the intervention group demonstrating decreased persistence of sway and the controls demonstrating no change at the post-intervention testing (P= .05; Effect size = .36).  **Results from Late-Life Function and Disability Instrument**  A statistically significant group x time interaction was noted for the basic lower extremity function component, with the intervention group demonstrating improvement and the controls demonstrating no change at the post-intervention testing (P = .006; Effect size = .37)  For the intervention group there was no significant difference in self-reported lower extremity function between baseline and six-month follow-up (P= .25).  **Results from Satisfaction Questions**  The averages, standard deviations, and score ranges were reported by participants for the following topics:  Safety of exercises (4.8, .5, 3-5)  Difficulty of exercise (4.8, .5, 4-5)  Program enjoyment (4.9, .3, 4-5)  Perception of balance improvement (4.7, .5, 3-5) |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The results in this study suggest that a progressive balance training delivered in a group setting to community dwelling older adults can be effective at improving postural control and step initiation during a voluntary step task. The results from the step execution test suggest the intervention increased the stepping reactions of participants and improved their ability to perform in a cognitively challenging situation. The results from the stabilogram diffusion analysis suggest the intervention decreased the amount of postural sway exhibited by participants, representing an improvement in balance. The authors indicate that their results are the first to show associated improvements in both dual task voluntary stepping and self-reported lower extremity function. This demonstrates that a progressive balance-training program that targets dual task performance and postural reactions can produce a measurable improvement in balance as well as self-reported functional improvements. Quicker voluntary step reaction times are associated with a lower risk of falls, and thus the authors felt that the intervention used in this study may help to reduce the risk of falls. Because the intervention was simple to administer, required unusual equipment, and could be delivered in a group setting the authors suggest that the intervention may serve as a useful falls prevention program in the community. The authors acknowledged that improvements in voluntary step execution and self-reported function produced during the intervention period were not sustained at the six-month follow-up and that further research is needed to determine how to better retain the training effects. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| This study scored 9/11 on the PEDro quality assessment rating scale indicating that it is a fairly high quality study. The criteria not satisfied on the PEDro scale were the blinding of subjects and the blinding of therapists administering the intervention. Based on the description provided in the methods section, it would have been impossible to blind the subjects and the therapists, as the control group did not receive any intervention, making it obvious who belonged to which group. The intervention description lacked detail and clarity, which would make it difficult to reproduce in another setting. The investigators collecting the outcome measures were blinded, however, and the participants were randomly allocated to groups, which helped to eliminate bias from the results.  The control and intervention groups of the study were not statistically different at baseline and therefore no adjustments were needed when performing the statistical analysis. While the study had low drop out rates, there were two participants in the intervention group that were not available for post-intervention data and an intention to treat analysis was used to account for this missing data. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| The majority of improvements noted in the intervention group during the voluntary step execution test, the stabilogram diffusion analysis, and the Late-Life Disability and Function Instrument represent moderate effect sizes suggesting that they may be clinically meaningful improvements. A power calculation was done prior to the study using previously established cut-off times for step execution testing suggesting that there were enough participants to detect a clinically meaningful change on this test. Unfortunately, the study population did not have significant identified balance impairment, making it difficult to translate the effect size to a clinical population (most individuals being treated using a balance intervention are likely to have significant existing balance impairments). A more dramatic or appropriate effect size might be seen using a more clinically relevant population or balance tool without a ceiling effect. Additionally, the effects may be altered in a more variable or diverse population. The only large effect reported was an improvement in foot contact time during dual task conditions in the intervention group. This suggests that a balance program that includes dual task training may produce specific training effects seen during dual task testing. While improvements in dual task testing do not necessarily equate to improvements in meaningful functional tasks, dual task components in a balance program also appeared to produce moderate improvements in functional tasks (self-report measure), some of which may be dual task. Additionally, the moderate decrease in the dual task/single task ratio during the step execution phase of testing suggests that dual tasking balance training components may contribute to less interference when executing balance and cognitive tasks simultaneously. When estimating the minimal clinically important difference using half of the baseline standard deviation, the improvements in dual task step initiation, dual task foot contact time, and dual task/single task ratio are considered to clinically meaningful improvements based resulting from the aforementioned intervention. |

**Description and appraisal of** *Effects of Single-Task Versus Dual-Task Training on Balance*

*Performance in Older Adults: A Double-Blind, Randomized Controlled Trial* **by Patima Silsupadol, Anne Shumway-Cook, Vipul Lugade, Paul van Donkelaar, Li-Shan Chou, Ulrich Mayr, Marjorie H. Woollacott, 2009**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this study was to compare the effects of single task balance training, dual task balance training with variable instructions, and dual task balance training with fixed priority instruction on the dual task walking performance of community dwelling older adults with an identified balance impairment. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This study was a double blind randomized control trial, with neither the testers nor the participants aware of the group assignment. After having satisfied the eligibility requirements, the participants were randomly allocated to treatment groups. The primary outcome measure was reported at baseline, halfway through the intervention (2 weeks), post-intervention (4 weeks), and at follow-up (12 weeks after training ended). Secondary outcome measures were collected at baseline and post-intervention (4 weeks). |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| This study was conducted in a university research laboratory with participants from the local community, however no further details were given regarding the geographical location and setting for the testing or training sessions. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Fifty participants were recruited using flyers in the local community. Participants underwent a two-step screening process in order to determine eligibility for the study. A telephone interview was used to determine if the following inclusion criteria were met: age 65 years or older, able to ambulate >10 m without assistance of another person, no significant neurological or orthopaedic conditions, no significant visual or auditory impairments, and approval of the participant’s primary care physician. Participants were excluded if their score on the Mini-mental State Exam was below 24. An in-person assessment was used to determine if balance impairment existed. Participants were eligible for the study if they scored less than 52/56 on the Berg Balance Scale or if their self-selected gait speed on the 10 m walk test was less than or equal to 1.1 m/s. Of the 50 participants initially recruited, 27 did not meet the inclusion criteria and 10 declined participation in the study, resulting in a total of 23 participants. Participants were randomly assigned to one of three groups after eligibility was determined: single task training (n=8), dual task training with fixed priority instructions (n=8), and dual task training with variable priority instructions (n=7). There were no significant differences between the groups at baseline regarding demographics and clinical outcome measures. The average age of participants was 75 years (range 65-85) and 81% of participants were female. Of the 23 participants who were assessed at baseline, 22 participants completed the training program and 21 participants were available for follow up data 12 weeks after training ended. One participant from the single task-training group died during the training period and one participant from the dual task variable priority-training group underwent a major surgery just prior to the end of training. For these participants an intention to treat analysis was performed. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| **Single task condition**  One-on-one training sessions occurred 3x/week for 4 weeks and each session was 45 minutes. During each session, there were four stations each with different activities, with one trainer at each station. Participants spent approximately 12 minutes at each station. All participants received the same amount of contact with each trainer and each exercise. Participants performed progressive balance training that included activities from four domains: body stability, body stability plus hand manipulation, body transport, and body transport plus hand manipulation. Some examples of activities include: tandem stance, stance on a compliant surface, eyes closed balance conditions, standing on foam while tossing a ball, tandem walking, and backward walking.  \*\*\*The balance training was described using examples, however complete details were not available. |
| *Experimental* |
| **Dual task condition with fixed priority instructions**  Balance interventions were delivered in the same format as described in the single-task condition. Participants performed simultaneous cognitive tasks during the balance training, such as object naming or counting, and were directed to maintain equal focus on both tasks.  **Dual task condition with variable priority instructions**  Balance interventions were delivered in the same format as described in the single-task condition. Participants performed simultaneous cognitive tasks during the balance training, such as object naming or counting, and were directed to maintain focus on the balance task during half of the training session and on the cognitive task during the other half of the session.  \*\*\*The cognitive tasks used during the dual task conditions were not described in detail in this publication. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| A blinded assessor obtained measurements, however no further details regarding data collection were provided.  **Primary Outcome Measure**  *Gait Speed*  A global measure of function and predictor of physical performance and falls during which participants walk their “comfortable” speed for 10 m, and the time to complete the middle 6 m is recorded. Data was collected during two separate trials for each condition.  Single-task condition: Participant walks at self-selected comfortable speed for 10 m. For the older adult population the MDC is .05 m/s and the MCID is .1 m/s.  Dual-task condition: Participant walks at self-selected comfortable speed for 10 m, while responding to basic addition/subtraction questions. No established MDC or MCID for gait speed during dual-task condition.  **Secondary Outcome Measures**  *Berg Balance Scale (BBS)*  The BBS is a 14-item balance performance measure with scores ranging from 0-56 (higher scores indicate better balance). For the older adults with balance impairment the MDC is 3 points.  *Activities-specific Balance Confidence (ABC) Scale*  The ABC Scale is a self-report questionnaire the measures confidence during 16 daily activities using a 0-100% scale (higher percentages represent greater confidence). No established MDC for ABC Scale. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Results from Gait Speed**  *Single task conditions*  A statistically significant improvement in gait speed was noted for all participants under single task conditions between pre and post testing (P= .02, Effect size= .27).  No statistically significant group x time interactions were noted in the single task testing conditions (P= .35, Effect size= .11).  *Dual task Condition*  A statistically significant group x time interaction was noted with the dual task training groups demonstrating greater improvement in gait speed during dual task conditions, as compared to the single task training group (P= .03, Effect size = .34).  There were no significant improvements in gait speed under dual task conditions in the single-task training group from baseline to post intervention testing (P= .46, Effect size= .03).  There were statistically significant improvements, from baseline to post testing, in gait speed during dual-task conditions for both the variable priority and fixed priority dual-task training groups (P < .001, Effect size= .46; P <.001, Effect size= .57)  **Results from BBS**  A statistically significant improvement in BBS scores was noted across all participants from baseline to post-testing (P<.001, Effect size= .72).  No statistically significant group x time interactions were noted on the BBS (P= .50, Effect size= .07).  **Results from ABC Scale**  A statistically significant group x time interaction was noted for the ABC scale (P= .01, Effect size= .38), with only the single task training group demonstrating statistically significant improvement at post testing (P <.001, Effect size= .61)  **Comparison of variable and fixed priority instruction sets**  There was no statistically significant difference between the fixed priority and variable priority instruction groups on any of the outcome measures between baseline and post testing, however there were two statistically significant training effects noted in the variable priority instruction group at other time points in the study:   1. A significant training effect was noted mid-way through the intervention (2 weeks after baseline) (P= .003). 2. A significant training effect was present at the 12 week post intervention time point (P= .006).   Adherence to variable priority and fixed priority instructions was demonstrated by calculating the percentage of training tasks where participants appropriately allocated their attention to the assigned task. On average participants allocated their attention appropriately 70% of the time (range 70-88%). |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The results of this study suggest that an individualized progressive balance intervention delivered 3x/week over 4 weeks is effective at improving single-task gait speed and BBS performance among older individuals with an identified balance impairment. The results also suggest that gait speed during dual task conditions improves only when a dual task component is included in the intervention. During the training period, there was an overall improvement in gait speed of approximately .1m/s and an overall average increase in BBS scores of 5.85 points, both of which meet the MDC threshold; the average scores at the end of training were 1.24 m/s and 54.6/56, respectively. Improvements in gait speed and BBS suggest that the balance interventions were effective at reducing falls risk and normalizing gait speed among older individuals with balance impairments. Scores from the ABC scale indicated that single task balance training is more effective at improving balance-related confidence than dual task training, though the authors hypothesize that this result may be due to the increased challenge of the balance activities in the dual task training group, where as the single task group may have experienced greater feelings of success during the balance activities.  When interpreting the results of the dual task balance training effects and the different instruction sets, the authors of this study reference the Task Integration Hypothesis. The Task Integration Hypothesis suggests that practicing 2 tasks at the same time allows for task coordination skills to develop; such skills may improve performance on dual task measures such as dual task walking. Additionally, shifting attention between two tasks may lead to quicker task coordination development and improved retention, as would be suggested by the earlier appearance and longer persistence of a training effect in the variable priority training group.  Overall, the authors confirmed that progressive balance training improves single task balance performance, and they concluded that dual task training was an effective way to improve performance during dual task walking. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| The study scored 10/11 on the PEDro quality assessment rating scale indicating that this is a fairly high quality study, however there were still several issues with the methods of the study that should be mentioned. The only criteria not met on the PEDro scale was blinding of the therapists delivering the intervention, as this was not feasible. While the methods described in this study were sufficient to meet the other criteria on the PEDro scale, there was still a lack of detail regarding patient recruitment, data collection and interventions that may affect the generalizability of this study. Few details were given regarding the setting of the interventions and testing, and no detail was provided about the geographic location of the study/participants. Additionally, the qualifications of the intervention “trainers” and the testers were not specified (i.e.; PT, PTA, personal trainer, no specific training), which may affect the reliability of the measurements and the quality of the interventions. Also, the lack of detail about the cognitive tasks used during the dual task training and the vague example-based description of the balance interventions would make reproducing the interventions in this study rather challenging.  Although data was collected at multiple time points (at baseline, mid way through training [2 weeks], post-intervention [4 weeks], 12 weeks after the end of training), the published analysis appeared to compare only baseline and post-intervention data. The only information provided from other time points were the training effects noted in the variable priority group at mid intervention testing and 12 week follow up testing. While there may not have been any other significant findings at the other time points, the omission of the data makes it challenging to gain a full understanding of the results and long-term effects of the interventions.  There were no significant differences in the baseline characteristics of the three groups, meaning no adjustments were needed during the statistical analyses. Given the small sample size of the study, it was important that for the two participants who were unable to complete the study, an intention-to-treat analysis was performed.  The systematic verification of attention allocation during the dual task training helps to distinguish between and clarify the effect of the fixed priority and variable priority instruction sets. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| The uniform improvement in gait speed during single task conditions across all groups represents a small effect size and does not exceed the MCID (estimated using half the baseline standard deviation), which suggests that these improvements may not be clinically relevant. The uniform improvement in BBS scores across all groups represents a moderate-large effect size and does exceed the MCID, which suggests that while changes in single task gait speed may not be clinically relevant, the changes in the BBS score likely are. The relative improvement in gait speed under dual task conditions in the dual task training groups, compared to the single task training group, represents a small effect size, however when the change in gait speed under dual task conditions is considered individually for the variable priority instruction group and the fixed priority instruction group, the effect sizes are somewhat larger (small-moderate). Additionally, the improvement in gait speed during dual task conditions (estimated using half the baseline standard deviation) exceeds the MCID, which suggests that the results may be clinically relevant. Taken together, the results for gait speed suggest that balance training can produce clinically important improvements in gait speed and that specific dual task training may be able to produce clinically significant improvements in specific dual task activities. It is difficult to determine whether the balance training or dual task interventions produced lasting effects on single and dual task gait speed, respectively, since a complete follow-up data set was not provided. The only follow-up analysis that was included suggested that variable priority instruction dual task training produced a significant lasting training effect on dual task gait speed performance at 12 weeks. No data or effect size information was included, so it is difficult to determine whether this effect would be clinically meaningful. |

**Description and appraisal of** *A Randomized Controlled Pilot Study of Home-Based Step Training in Older People Using Videogame Technology* **by Daniel Schoene, Stephen R. Lord, Kim Delbaere, Connie Severino, Thomas A. Davies, Stuart T. Smith (2013)**

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| **Aim/Objective of the Study/Systematic Review:** |
| This study used an unsupervised home-based step pad training program among community dwelling older adults in order to understand the safety, feasibility, and stepping performance effects of such an intervention in order to determine its usefulness in altering the risk of falls. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This pilot study was a single blind randomized control trial where the testers were blinded to group allocation. Block randomization was used to produce two groups of similar size. Participants who resided together were considered a “couple” and couples were treated as a single unit; an equal number of couples were randomized to each group. Personnel not involved in any other aspect of the study performed randomization and group allocation. Data collection was standardized across participants and occurred at baseline and again within 7 days of completion of the intervention. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| The study took place in a retirement community in Sydney, Australia. The interventions took place within the participants’ homes, and data collection took place in a quiet, isolated room within the retirement community. No other details regarding the setting were provided. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Recruitment methods for this study were not specified, other than stating that all participants belonged to a single retirement community. All participants resided in independent living units within the community. Other inclusion criteria were age 65 years or older, ability to walk 20 m without a walking aid, ability to step in place unassisted on a stepping pad, and ability to perform ADLs/IADLs without significant disability. Exclusion criteria were as follows: any major cognitive impairment (MMSE<24), any diagnosis of a degenerative disease, presence of any significant health conditions that may impair stepping ability (acute joint inflammation, impaired motor control post-stroke), or unstable health conditions. Eighty-one individuals were screened for participation in the study. Of these, 14 did not meet eligibility criteria and 30 declined participation. A total of 37 participants were randomized to either the control (n=19) or intervention (n=18) group. There were no statistically significant differences between the control and intervention groups at baseline with regards to demographic characteristics or initial outcome measures. The average age of participants was 78 years (range 69-85), and gender distribution was not specified.  One participant in the intervention group did not receive the intervention due to lack of space in the home. Two participants from each group were lost at follow up, leaving a total of 32 participants available for final analysis (control n=17, intervention n= 15). |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| Participants were instructed to perform activities as usual during the 8-week intervention period. No additional intervention was delivered. |
| *Experimental* |
| All participants in the intervention group had step pads and computers units installed in their home.. The step pad/computer units were connected to the participants TVs and were loaded with an open source exergame called Stepmania, similar to DDR. The stepping game required participants to synchronize their steps with a visually presented stimulus, and their performance was scored both in terms of accuracy and timing. The visual stimulus was in the form of a drifting arrow that directed the participant to step in a particular direction at a particular time. After each step, the participant returned to the center of the step pad. Participants received instantaneous feedback on their accuracy (perfect, good, or miss), and earned points for performance during the game.  A cognitive task was incorporated in the game and involved the use of occasional circular “bombs” drifting on the screen in places of an arrow. When these bombs were presented, participants were instructed to avoid stepping on the bombs, which required a step inhibition response. Points were deducted if the participants failed to avoid stepping on the bomb.  Music accompanied the intervention and was selected by the participant, however the musical rhythm was unrelated to the stepping stimulus. Music selection time was considered a rest break during the exercise session, and brief rest breaks therefore occurred approximately every 3-4 minutes.  The game had three levels of difficulty which were affected by the stimulus presentation rate (drift speed), the number of stimuli on the screen at one time (varied between 2 and 4), the distractions presented (bombs and excessive colors), and the prompted step rate (varied between one step every 2 seconds to 1 step per second). Participants were instructed to progress to the next level when they felt proficient at the current level or did not feel challenged enough; they were also told that they were allowed to revert to an easier level, if the current level was too difficult.  Each participant received an individualized 90-minute instruction session and instruction manual about how to use the system and play the game. Participants were also encouraged to call if they required assistance to use the game. Participants were instructed to play the game as much as they liked, however the recommended dose was 2-3x/week, for 15-20 minutes per session. The intervention lasted a total of 8 weeks. In addition to the recommended dose of exercise, the participants were instructed to participate in a choice reaction stepping task (described in the outcome measures) once per week.  Phone calls were made to participants at 1 week, 2 weeks, 3 weeks, and 6 weeks to provide any necessary assistance and to enhance compliance. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All assessments were performed by a blinded assessor in a quiet room in the retirement community. Test conditions were standardized among participants and between time points. During stepping tasks (Choice stepping reaction time and inhibitory stepping task), the participant was allowed four practice trials prior to data collection.  **Primary outcome measure**  *Choice Stepping Reaction Time (CSRT)*  Participants were asked to stand on a step pad. Arrows pointing in one of four directions were presented indicating the direction the participant should step (forward left, side right, side left, or forward right). Stimuli were presented randomly and data was collected for 32 stepping trials. Reaction time, movement time and total response time (reaction + movement) were recorded.  **Secondary outcome measures**  *Physiological Profile Assessment (PPA)*  Five physiological tests (contrast sensitivity, proprioception of the lower extremities measured as knee joint position sense, lower extremity strength measured as isometric knee extension, postural sway on a compliant surface, and simple hand reaction time) were used to estimate fall risk. A higher score indicates a greater fall risk with a score between 0-1 classified as a mild fall risk, a score between 1-2 classified as a moderate fall risk and a score > 2 classified as a serious fall risk.  *TUG*  The time to rise from a chair, walk 3 m, turn around, return to the chair, and sit down was recorded and used as an indicator of mobility.  *5x sit to stand*  The time to perform 5 sit to stands was recorded as a measure of functional strength.  *Alternating step test*  The time to perform 8 alternating stair taps (using a 7” step) was recorded.  *Inhibitory stepping task*  Participants were asked to stand on a step pad. Arrows pointing in one of four directions were presented with a directional word (not necessarily the same as the actual arrow) inside the arrow. Participants were asked to step in the direction indicated by the word. Time to complete 20 stepping trials was recorded and errors were recorded as well.  *Trail making test*  The Trail making test was used to evaluate cognitive function and included parts A and B. The difference in execution time between parts B and A was recorded.  *TUG cognitive*  Dual-task performance was assessed using a verbal fluency task with the standard TUG. Time to complete the task was recorded.  *Falls Efficacy Scale*  Measured perceived concern using a 4-point Likert scale about performing 10 different daily activities related to balance. Higher scores indicated greater concern.  *Feedback Questionnaire*  Questions regarding incidents, safety and enjoyment were administered to participants following the intervention.  *Adherence*  Participation data was collected from in-home computers used during the intervention as well as via self-reports from participants. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Effects of Intervention**  *Choice Stepping Reaction Time*  The intervention group demonstrated statistically significant improvements post intervention as compared to the control group on the step reaction time (P= .001), the step movement time (P=.018), and the overall step response time (P< .001).   |  |  |  |  | | --- | --- | --- | --- | |  | **Baseline Mean (SD)** | **Post-intervention Mean (SD)** | **Change from baseline to post-intervention** | | **Step reaction time-Intervention** | 755 (81) | 679 (67) | 76 | | **Step reaction time- Control** | 730 (74) | 738 (92) | 8 | | **Step movement time- Intervention** | 252 (44) | 210 (47) | 42 | | **Step movement time- Control** | 245 (44) | 241 (63) | 4 | | **Step Response Time- Intervention** | 1007 (116) | 890 (97) | 117 | | **Step Response Time- Control** | 975 (104) | 979 (134) | 4 |   *Secondary Outcomes*  The intervention group demonstrated statistically significant improvements post intervention as compared to the control group on the PPA composite score (P= 0.001), the postural sway sub-component (P= .049), the contrast sensitivity sub-component (P= .044), and the dual-task TUG (P= .049).   |  |  |  |  | | --- | --- | --- | --- | |  | **Baseline Mean (SD)** | **Post-intervention Mean (SD)** | **Change from baseline to post-intervention** | | **PPA composite score- Intervention** | 1.75 (.6) | 1.15 (.8) | 0.6 | | **PPA composite score- Control** | 1.55 (.8) | 1.56 (.8) | 0.1 | | **Postural Sway- Intervention** | 386 (132) | 301 (133) | 85 | | **Postural Sway- Control** | 355 (118) | 330 (95) | 25 | | **Contrast Sensitivity- Intervention** | 21.7 (1.9) | 22.1 (1.4) | 0.4 | | **Contrast Sensitivity- Control** | 21.4 (2.3) | 21.0 (1.5) | 0.4 | | **Dual Task TUG- Intervention** | 14.1 (5.6) | 11.5 (3.7) | 2.6 | | **Dual Task TUG- Control** | 11.9 (2.9) | 12.0 (3.5) | 0.1 |   The intervention group demonstrated a trend toward improvement post intervention as compared to the control group on the time recorded during the inhibitory stepping task.   |  |  |  |  | | --- | --- | --- | --- | |  | **Baseline Mean (SD)** | **Post-intervention Mean (SD)** | **Change from baseline to post-intervention** | | **Inhib step task time - Intervention** | 2.5 (.8) | 2.1 (.3) | 0.4 | | **Inhib step task time - Control** | 2.5 (.5) | 2.4 (.7) | 0.1 |   **Adherence, Enjoyment, Adverse Reactions**  Participants reported a median participation rate in the exergame of 2.75 sessions/week (IQR= 2.25-3.15) lasting a median time of 15 minutes (IQR= 11-22.5) and engaged in the choice stepping reaction task 7 times (IQR= 5-8.5) during the study.  No incidents or adverse events were reported by any of the participants during the intervention.  Positive responses to the enjoyment questionnaire were noted in all participants who participated in the intervention, with only one exception.  **Progression**  During the first week of the intervention 80% of participants elected to play the easy level of the game however during the last week of the intervention, 53% had progressed to the hard level, 33% had progressed to the moderate level and 13% remained at the easy level.  **Dose Response Effects**  The level of difficulty was significant associated with the amount of improvement noted in PPA scores, and participants playing at the easy level at the end of the intervention had no significant improvement. (No data/statistical values provided.)  Participants playing at the hard level at the end of the intervention demonstrated greater improvement in the time recorded for the inhibitory stepping task, as compared to participants playing at the easy/medium levels (p = .030). |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| Based on the results of this study the authors concluded that an unsupervised home-based exergame that utilizes step pad training was feasible, safe and well received by participants. They suggest that the improvements in step response time and on the PPA may represent a reduced risk of falls. They also suggest that the improvement in the dual task TUG and the trend toward improvement on the step inhibition task could be representative of positive changes in daily activities that require both a motor and cognitive component, and thus the cognitive component of the intervention could also contribute to a decreased risk of falls. Finally, the authors admit that study limitations prevent strong conclusions from being drawn from the work and suggest additional trials be performed to understand how the intervention may affect falls risk among older individuals. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| This study scored 8/11 on the PEDro quality assessment rating scale indicating that it is a relatively high quality study with some design flaws. The participants and the personnel administering the interventions in this study were not blinded, as it would not have been feasible with this particular intervention. Additionally, even though a number of participants were unable to complete the final assessment, there was no intention-to treat-analysis performed. Details of participant recruitment were not provided, however the sample used in the study was small and was likely very homogenous, as all participants were high functioning older adults from a single retirement community; this may have biased the participants that enrolled in the study as well as their outcomes.  This study used validated outcome measures that have been previously associated with falls risk such as choice reaction stepping time and PPA scores, lending strength to their claims that the intervention may be useful in decreasing the risk of falls. Additionally, the broad spectrum of outcome measures seemed appropriate in this pilot study so that any significant changes regarding physical function or altered falls risk might be detected.  The analysis of dose response relationships seemed appropriate for this pilot intervention study in order to understand how the progression through the intervention was associated with the outcomes; such analysis may be useful in further research on this intervention. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| The improvements in the choice stepping reaction tasks and the PPA were statistically significant, and when using half the baseline standard deviation to estimate the MCID, the improvements also appear to be clinically relevant. Unfortunately, when using the PPA score as a falls risk indicator, the intervention group’s scores did not drop below 1.0, which is the threshold to indicate a lower fall risk. Additionally, the authors mention that a difference of 150 ms on the choice stepping reaction time is generally used to discriminate fallers from non-fallers, but they do not include any actual normative data for fallers vs non fallers on this task. The authors suggest that the 117 ms difference in the intervention group between baseline and post testing is similar to the 150 ms used to discriminate between fallers and non-fallers, however this may be misleading since the participants were not categorized as fallers vs non-fallers during the study. Based on this, the improvements noted during the study may have limited meaning in a clinical scenario.  The improvements on the dual task TUG were statistically significant, however the change did not exceed the MCID (as estimated using half the baseline standard deviation), meaning the improvements are likely not clinically meaningful. As my clinical question related to dual task training, the dual task outcome measure would have served as a nice indicator of improved motor-cognitive function or a direct training effect of dual task activities.  While data for outcomes related to progression, adherence, and safety were limited, the information provided by the authors does suggest that the intervention is safe and enjoyable. Additionally, the exercise dose used in the intervention is clinically realistic and the adherence rates demonstrate that it was well accepted by participants. Finally, the progression from easy to difficult levels within the game is relevant to consider if applying this intervention in practice; this study suggests that the participant needs to be challenged in order to demonstrate improvement. |

**IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

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| In summary, it appears safe and potentially helpful to include dual task components in a balance-training program designed to improve balance performance and reduce the risk of falls. It is less clear whether dual task training produces greater benefit than a single task balance training approach, so it may be advisable to utilize dual task elements during balance training rather than a dedicated dual task training approach. It is also unclear how well the training effects will be maintained after the training program ends; this suggests that incorporating dual task components into a long term balance training program may be most effective as continuous training would occur. A progressive approach to balance training was seen among the interventions that were reviewed. Dual task components or increased cognitive demand appeared to be associated with greater difficulty. In applying dual task balance interventions in the clinic, it may be useful to remember that they are indeed higher-level tasks and should be introduced when patients are appropriately prepared with single task balance training. The finding by Silsupadol et al that variable priority instructions during dual task intervention are most effective may also be helpful when designing dual task balance interventions. The dual task interventions were delivered in a variety of settings (group, individualized, home-based), and in different formats (circuits, class, exergame step pad training) suggesting that clinicians have some flexibility when designing their own dual task interventions. Dual task balance training appeared to produce effects that were specific to dual task performance, suggesting that in order to demonstrate improvement in the clinical setting, appropriate outcome measures must be used. The dual task TUG and dual task gait speed were measures used in these studies that are simple enough for clinical use, however these may not provide simple information regarding falls risk. It may also be beneficial to use measures with well-established falls risk cut-off scores to detect changes in falls risk. It may be especially relevant to use dual task balance training in individuals that present with a clear deficit during dual task performance measures, as dual task interventions have been shown to produce specific training effects. If individuals present the greatest difficulty during cognitive-motor tasks or report concern over their balance while walking and performing other tasks, they may gain greater benefit from dual task balance training.  Further research on the topic of dual task balance training in older adults is needed to fully understand how dual task interventions alter balance performance and the risk of falls among older individuals. Future studies should aim to use dual task measures with established falls risk cut-off scores and to gather more information about the long-term efficacy of dual task balance interventions, as this may effect how the interventions are applied in practice. Additionally, more diverse participant populations would help to generalize the use of the interventions; patients with a wider range of balance impairments and falls risks might be more representative of the patients seen in clinical practice. In future work on dual task intervention delivered by exergame, it would be ideal to use a more generalized population such as individuals that have a wider range of abilities and resources (not solely high functioning, moderate falls risk, living arrangements other than a retirement community). Additionally, it would be interesting to investigate whether this intervention has similar effects when applied as a home based program versus as part of clinic-based training program. Finally, a better understanding of the dose effects of an exergame intervention would be helpful in determining how this intervention may fit in to a more comprehensive balance and falls prevention program. |

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