

Overview of the Otago Exercise Program (OEP) – falls prevention efficacy, comparison to other interventions	
Purpose: outline the necessity of evidence-based falls-prevention interventions for older adults and examine the efficacy of the OEP in preventing falls. Additional examination into the OEP compared to other common balance interventions.	
(1) Title/Author/Year	What works to prevent falls in community-dwelling older adults? umbrella review of meta-analyses of randomized controlled trials. Stubbs et al. 2015. ¹
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: The stated purpose of this umbrella review was to “synthesize the highest-quality falls prevention evidence in one place for clinicians.”¹ This review included 16 individual meta-analyses which in turn included 47 pooled analyses.¹ • Interventions and Outcomes: The interventions included in this review were: exercise, Vitamin D supplementation, environmental interventions (namely home visits), surgery (cardiac pacing and cataract), education, and multifactorial interventions comprised of some combination. The primary outcome used was the reduction of falls “including the rate, risk, and odds of falling.”¹ • Results: Stubbs et al. found moderate-to-high quality evidence indicating that exercise significantly reduces falls. Also indicated with moderate or above quality evidence were multifactorial interventions. Evidence surrounding nutritional supplementation was reported as “conflicting,” though the authors ultimately support recommendations to use supplemental vitamin D due to the low risk of harm and its potential benefits.¹ Environmental interventions were reported as being heterogenous across the meta-analyses included, therefore hard to draw conclusions from, but the authors support environmental interventions as part of multifactorial interventions. • Conclusions: As exercise is consistently associated with a reduction in the “rate, risk, and odds of falling (including falls resulting in injury),” the authors conclude that physical therapists occupy a “central position” in falls prevention.¹
Comments	Though the Otago Exercise Program is not specifically discussed, it is clear from Stubbs et al.’s findings that exercise is efficacious in reducing falls risk in older adults.
(2) Title/Author/Year	Does the ‘Otago exercise programme’ reduce mortality and falls in older adults?: a systematic review and meta-analysis. Thomas et al. 2010. ²
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: This systematic review and meta-analysis sought to examine the efficacy of the Otago Exercise Program in reducing risk of death and falls rate in older adults; and to “explore levels of compliance” with exercise.² This review included 7 trials totally 1503 participants aged 65 years or older. • Interventions and Outcomes: This review included studies which used the OEP as a primary intervention, specifically when it was individually tailored to participants, progressive in difficulty, included a walking program, and included home visits.² Outcomes used were risk of death, falls, fall injuries, and 12-month compliance to assigned exercises.

	<ul style="list-style-type: none"> • Results: Risk of death over 12-month follow-up was significantly reduced in the OEP group relative to the control group when fixed-effect, but not random-effect meta-analysis was used.² The OEP demonstrated a positive effect on reducing falls rate over 12 months. In 6 studies which included 12-month follow-up, 747 out of 843 participants remained at follow-up; and of this number, 55.9±14.8% were exercising at least two times/week.² • Conclusions: The authors conclude that, in community-dwelling older adults, the OEP appears efficacious in reducing risk of death and falls rates over a period of 12 months. They conclude that outcomes could have been better with better adherence to the OEP; and cite one of their included studies as finding that participants who exercised 3x/week experienced a 77% lower rate of falls than participants who exercised less than once per week.²
Comments	This meta-analysis follow-up the findings of the Stubbs et al. review by demonstrating that the OEP uses exercises which can reduce falls rates in community-dwelling older adults. Furthermore, the authors hint at an appropriate dosage of exercise as being 3x/week. The 12-month follow-up target is likely incompatible with the UPT implementation of the OEP, which takes place over a period of 5 months.
(3) Title/Author/Year	Comparison of 2 Different Exercise Approaches: Tai Chi Versus Otago, in Community-Dwelling Older Women. Son et al. 2016. ³
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: This study operated with randomized groups but without a control: one group performed Tai Chi and the other OEP exercises, both in a group setting. The expressed purpose of this study was to compare the two interventions' outcomes with use by older adults. The Tai Chi group consisted of 21 participants with a mean age of 72.8±4.7 years, while the OEP group featured 24 participants with a mean age of 71.5±3.6 years.³ • Interventions and Outcomes: Both interventions were carried out over a period of only 12 weeks, significantly less time than in the studies used in the Thomas et al. review. Both interventions were featured in twice-weekly group exercise classes and were supervised by physical therapists with experience/training in the respective intervention.³ Outcome measures used included “lower extremity strength measures” 5x Sit-to-stand and 30s sit-to-stand tests, “gait parameter measurements” gait velocity, step length and width, stride time, and cadence, and balance measures TUG, single limb stance time, and functional reach.³ • Results: The Otago group scored significantly better than the Tai Chi group in measures of TUG, functional reach, 5x and 30s sit-to-stand at follow-up.³ The Tai Chi group score better on the single limb stance test and gait velocity, step width, and step length, while the Otago group saw greater improvement in cadence and stride time. • Conclusions: Participants in both Otago and Tai Chi groups improved significantly in measures of balance and lower extremity strength after 12 weeks of program participation.
Comments	The findings of this randomized trial demonstrate the OEP's utility in improving balance and in improving lower extremity strength relative to another common balance exercise, Tai Chi. That the Tai Chi group showed greater improvement in both gait velocity and balance (via the single limb stance test) highlights that the OEP is not necessarily the only option for addressing falls risk in older adults, and a limitation of this study is that it did not clearly comment on

	<p>which intervention improved fall risk the most. Another weakness is the relatively short intervention duration, 12 weeks, compared to UPT use of the OEP, which again is 5 months. Finally, this study used the OEP in a group setting, which is a deviation from the UPT home-based use.³</p>
SYNTHESIS	<p>Fall risk prevention is a critical component of care for individuals over the age of 65, as up to 35% of older adults experience a fall each year.² The findings of Stubbs et al. demonstrate that exercise is a key component of falls prevention in older adults. Other findings show that exercise may be comprised of “endurance, balance, and strength exercises,” and may be delivered either in-home or in group settings.¹ Final considerations from the Stubbs et al. article include the notion that exercise programs should be individually tailored along “frequency, intensity, and type (FIT)” principles, and should account for individual patients’ comorbidities.¹ The Thomas et al. review found that the Otago Exercise Program (OEP) is one feasible exercise option for reducing fall risk in older adults relative to a control. They conclude that a follow-up of 12 months is sufficient, and that exercise frequency of 3x/week or greater is superior to less frequent exercise sessions. The Son et al. study compared the OEP to another commonly used fall risk intervention, Tai Chi, and found that each reduced fall risk and improved performance measures like balance and gait, while the OEP, in particular, improved lower extremity strength among older adults.³</p>
Delivery Models of the OEP – home, outpatient, group	
<p>Purpose: At UNC UPT clinics, the OEP is predominately delivered for use in the home. This section examines the standard home-based use of the OEP along with other implementation examples.</p>	
(1) Title/Author/Year	<p>The Otago Exercise Program Performed as Group Training Versus Home Training in Fall-prone Older People: A Randomized Controlled Trial. Kyrдалen et al. 2014.⁴</p>
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: To compare the original design of the OEP – individualized and at-home – to an OEP group intervention. 125 Norwegian participants (mean age 82.5 years) were randomly assigned to groups and taken through 12 weeks of intervention followed by 3 additional months for follow-up. • Interventions and Outcomes: “The dosage of exercise was designed to be comparable between groups at approximately 90 minutes per week.”⁴ The exercises used by both groups were OEP-specific and included: “hip extension and abduction, knee flexion and extension and ankle plantar and dorsiflexion,” balance exercises, and squats and “stretching exercises.”⁴ The group classes also used OEP exercises, were comprised of between 4 and 8 participants, met twice/week for 45 minutes, and participants were given “individualized load and progression.”⁴ Just as with UNC implementation, both groups were instructed to maintain a 3x/week or more walking program targeting 30 minutes, were given instructions for continuing the OEP exercises beyond the initial plan of care, and were given exercise calendars and ankle weights to independently track exercise compliance and progress their exercises. The primary outcome of this study was the Norwegian version of the Berg Balance Scale. Other outcomes included falls incidence, the TUG, the 30 second sit-stand test (STS), the 7-item Falls Efficacy Scale International, and SF-36 measure of health-related quality of life.

	<ul style="list-style-type: none"> • Results: After the initial 12-week intervention, the group exercise participants experienced significantly more improvement for the BBS, the STS, and the SF-35.⁴ By the three-month follow-up, the TUG times of the group exercise participants had improved significantly more, though the improvement seen in the BBS scores did not carry across time. Exercise compliance and walks, as measured in exercise calendars, were not significantly different between groups. • Conclusions: The authors hold that the results of the BBS, STS, and TUG indicate that group OEP classes may improve functional balance more than traditional home-based OEP and hypothesize that this may be due to the increased level of supervision afforded to members of the group exercise classes. Limitations of the study include a relatively small sample, inadequate follow-up time of 3 months (vs 5 months at UNC), and high dropout rates of 25% across the 12-week intervention.
Comments	<p>This study, while impaired in its generalizability by its stated limitations, serves to introduce group iterations of the OEP as a feasible method of improving functional balance in older adults. Notable is the authors' hypothesis that supervision may play a key role in improving outcomes, which has implications for clinical practice. The home-based group received "supervision" in the form of visits from a PT + weekly phone calls throughout the 12-week intervention– UNC PTs should similarly be sure to administer regular check-ins of OEP patients.</p>
(2) Title/Author/Year	<p>Otago Exercise Program in the United States: Comparison of 2 Implementation Models. Shubert et al. 2017.⁵</p>
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: The authors of this study sought to compare the OEP model most commonly used in the United States (US OEP) and a second model called the Community OEP. This comparison was made through a translational study of implementation and did not feature a control group. The purpose of the study was to compare the results of participants of both modified OEP models along functional and self-report measures. The US OEP differs from the original OEP model by virtue of being delivered primarily in the home or in outpatient physical therapy, by PTs or PTAs, with a focus on the first 8 weeks of the program and making the final 4-10 months more predicated on self-management.⁵ This model is similar to that used in UNC PT services, with variations in length of intervention. The other model in this study, the Community OEP, utilizes Certified Occupational Therapy Assistants (COTAs) and personal trainers as the primary conductors of OEP experiences, with PTs involved primarily in a team role, or with higher-risk patients as necessary. This model is "substantially less expensive" than the US OEP and the authors of this study argue that it may prove to have more wide-spread utility as a result.⁵ • Intervention and Outcomes: The intervention used in both models included original OEP exercises with appropriate individualized progression, though specific duration and visit parameters differ in typical use of the models:

	<p style="text-align: center;"><u>US OEP⁵</u></p> <ul style="list-style-type: none"> • 4 visits in the first 8 weeks, followed by 1 or 2 follow-up visits across the remaining time. • Phone calls designed to be completed monthly through 12 months, though this is “typically not done” • Rarely completed for a whole year, “many clients discharged at 8 wk” • Most similar to UNC UPT use of the OEP 	<p style="text-align: center;"><u>Community OEP⁵</u></p> <ul style="list-style-type: none"> • 3 face-to-face visits in the first 3 weeks followed by monthly visits for 6 months and finally alternating months for up to a year, for an average of 10-12 visits • Phone calls designed to be weekly for 6 months, then reduced to monthly • Lower expense leads to intervention for a full 12 months
	<ul style="list-style-type: none"> • Interventions and Outcomes: A total of 210 individuals, 108 in Community OEP interventions and 102 in US OEP (mean age Community OEP = 76.83 years, US OEP = 83.4 years) participated. Primary outcomes were the TUG, the 30s sit-stand test, the four-stage balance test. Other measures included self-report measures like health status and functional ability, and the number of falls experienced.⁵ Providers were instructed to take initial measurements then at 8 weeks, 6 months, and at discharge.⁵ • Results: The Community OEP group reported significantly higher falls rate in the previous year than did the US OEP group (mean 2.18, SD 2.03 to mean 1.05, SD 1.46), and performed worse on initial 30s sit-stand tests.⁵ Both groups demonstrated statistically significant improvements in all three primary outcome measures, excepting that the US OEP group did not demonstrate significantly improved TUG scores. There were no statistically significant differences in either primary or secondary outcomes between groups reported.⁵ • Conclusions: The authors of this study conclude that the results support the notion that the Community OEP model is an efficacious version of the OEP, as there were no significant differences between groups in outcome measures. If more widely used, this model may reduce the burden for PTs and improve duration of treatment and cost efficiency of the OEP. The authors state that these findings should not reduce the importance of the PT in OEP implementation, but that PTs should be available to determine appropriateness for OEP participation, evaluate participants for impairments and differential diagnoses.⁵ Limitations include a lack of a control group, a loss to follow-up of 54% or greater in both groups, and limited diversity of participants (95% described as non-Hispanic white).⁵ 	
Comments	<p>This study demonstrated the utility of two different designs of the OEP other than the original OEP out of New Zealand. The US OEP, similar to the functional use of the OEP in UNC UPT clinics, and a less PT-dependent model, the Community OEP both improved functional measures in older adults. While it is out of the scope of this capstone project to propose a practice shift in the OEP at UNC that includes overhauling which professionals conduct OEP interventions, this study shows that the US OEP does work, and introduces an alternative for additional consideration.</p>	
(3) Title/Author/Year	<p>Does modified Otago Exercise Program improves balance in older people? A systematic review. Martins et al. 2018.⁶</p>	

<p>Article Overview</p>	<ul style="list-style-type: none"> • Purpose/Design/Subjects: The stated purpose of this systematic review was to “to identify OEP modified formats and investigate their effects on balance when compared to its original form of delivering.”⁶The authors conducted a qualitative analysis of eight studies (5 RCTs, 2 quasi-experimental, and one qualitative study). The RCTs were reported to have low-moderate quality on the PEDro scale, with sample sizes ranging from 21 to 165.⁶ In total, the number of community-dwelling older adults was 604 with a mean age of 76.75 years.⁶ Because of the small numbers of included studies and the variability of types of studies, a meta-analysis was not performed in favour of a narrative synthesis of the data. • Interventions and Outcomes: The modifications made to the OEP across the 8 included studies were: “additional vestibular or multisensory balance exercises, augmented reality, exercise in group and a DVD delivering format (in group or individual).”⁶Each study used its own balance and functional mobility outcome measures, including the TUG, the BBS, single-limb stance, lower extremity strength, the 6-minute walk test, incidence of falls, and the 30s sit-stand test. Control groups ranged from standard OEP at home to OEP group classes, other exercise classes (seated), and no intervention groups. Follow-up periods ranged from 3 to 12 months. • Results: The authors state that each of the RCTs and quasi-experimental studies demonstrated improvements in “balance and general mobility outcomes with OEP modified formats.”⁶For example, in a study utilizing video-supported and group-based OEP, the intervention group performed better than a no-intervention control group on the TUG, BBS, and lower extremity strength after 4 months. Especially in studies which used no-intervention control groups, there are “expected physical benefits with exercise interventions when compared with no intervention.”⁶ • Conclusions: The authors conclude that despite limitations, including the small number of included studies, the variabilities in methodologies, and the use of quasi-experimental studies and no-intervention control groups in their selected studies, this review provides insight into additional intervention options and modifications to the original OEP. The authors conclude that the value of modified versions of the OEP comes if they can provide a more “interactive, feasible and personalized fall prevention program.”⁶
<p>Comments</p>	<p>Drawing generalizable and actionable conclusions from this study is nearly impossible given the heterogeneity of the studies included. It is worth noting, however, that this review supports the use of both home-based and group-based OEP, includes support for OEP augmented by DVD or video resources, and highlights compliance as a concern for participants involved with OEP, as the number of dropouts exceeded 30%.⁶ The utility of modified versions of the OEP, as the authors note in a quote above, comes from making a falls prevention intervention <i>individually relevant</i> – including tailoring exercises to match impairments, and providing additional resources (including video resources, feedback, and interventions in both the clinic and at home) as needed.</p>
<p>SYNTHESIS</p>	<p>Common themes from the articles discussed in this section include the importance of ensuring adequate dosing of exercise interventions in a fall prevention plan of care. These articles all reported drop-out as a limitation of their study, and Kyrдалen et al. hypothesize that a significant benefit of group OEP classes is the additional supervision afforded to an in-person intervention relative to a home-based intervention.⁴ Accordingly, PTs in UNC clinics who wish to implement the OEP may benefit from pursuing strategies to <i>enhance adherence</i> to OEP exercise, falls calendar use, and scheduling</p>

	regular check-ins that can promote long-term performance of exercises and limit drop-out following initial OEP implementation. The results of the Shubert et al. study point to the potential efficacy of outpatient-based OEP use, as is seen in UNC clinics. Shubert et al, Kyrдалen et al, and Martins et al. all also propose alternative delivery methods of the OEP, of which group ⁶ and community OEP ⁵ stand out as feasible alternatives.
Adherence, Internal and External Supports	
Purpose: As discussed in the section above, adherence is particularly important to patients using the OEP, as exercise interventions are primarily conducted in the home. This section discusses challenges and potential solutions with patient exercise adherence, including a primary intervention in the OEP, physical therapist phone calls.	
(1) Title/Author/Year	Predictors of adherence to home-based physical therapies: a systematic review. Essery et al. 2017. ⁷
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: The authors of this systematic review state that its purpose is to identify and understand factors that influence adherence to self-managed and home-based physical therapy programs (HBPT).⁷ A total of 30 individual articles were included in this review, most of which were longitudinal prospective studies, cross-sectional studies, or included secondary data analysis from an RCT. The studies included a heterogeneous set of participants, featuring individuals following ACL repair, pelvic floor muscle exercises, and falls prevention intervention, for example. This heterogeneity of the included study designs and participants contributed to the authors taking a narrative synthesis approach in describing their findings. • Interventions and Outcomes The outcome measures used in the included studies predominately include self-reported measures of adherence, which the authors describe as having poor psychometric properties, and as being “non-validated measures potentially less likely to accurately measure target concepts.”⁷ This, combined with basic issues with self-report measures, namely their susceptibility to “social desirability and memory bias,” highlight the <i>importance of interventions which can limit inaccuracies in self-reporting</i>.⁷ The authors categorize the factors associated with adherence as follows “perceptions of illness, condition or injury; characteristics of, and perceptions about, therapy; perceptions of ability to complete therapy; motivation and intention; behaviours related to home physical therapy; stress and coping; negative cognitions or emotional experiences and social support.”⁷ • Results: Of the eight factors that the authors identify as influencing adherence, the authors found the strongest evidence to support “intention to engage in the HBPT, self-motivation, self-efficacy, previous adherence to exercise-related behaviours, and social support” as predictive factors for adherence in HBPT.⁷ The authors relate self-motivation, self-efficacy, and intention to Self Determination Theory, which holds that intrinsic motivation is superior to extrinsic motivation.⁷ A key discussion in this vein: “In a self-managed therapy programme, relatively free of external motivators, individuals reporting higher intentions and self-motivation are likely to have comparatively high intrinsic motivation and, therefore, should be most likely to adhere.”⁷ • Conclusions: The authors state their findings, above, but acknowledge that heterogeneity among the included studies and the relatively poor quality of individual studies limits their ability to make widespread conclusions.

	<p>The authors conclude that future research could further investigate the factors they found to be most impactful towards predicting adherence, like self-motivation and self-efficacy. They also posit that narrower, more specific research that focuses on specific patient populations, or conditions, or patient circumstances could elicit more specific and clear-cut findings of the most effective ways to improve adherence.</p>
Comments	<p>One important finding of this review surrounds the methodological limitations that come with self-report outcome measures, discussed above. The authors highlight the <i>utility of daily diary use in minimizing reporting inaccuracies</i> while also not presenting as a significant participant burden (when compared to video recording of exercise completion, for example) and likely not capturing participation any less accurately than some objective means (like accelerometers, which may not be valid to capture aspects of therapeutic movement as in the OEP).⁷ In addition, the discussion regarding intrinsic motivation, self-efficacy, and intention to participate has ramifications for the OEP, as patients who are <i>highly motivated to participate</i> and believe that their participation can improve their functional mobility may be most likely to <i>consistently</i> participate.</p>
(2) Title/Author/Year	<p>Telephone Calls Make a Difference in Home Balance Training Outcomes: A Randomized Trial. Light et al. 2016.⁸</p>
Article Overview	<ul style="list-style-type: none"> • Purpose/Design/Subjects: The purpose of this RCT was to examine the relationship between a weekly phone call and balance for “community-dwelling frail older adults participating in home-exercise programs.”⁸ 75 older adults, mean age 76 years, predominately men (3 women) participated in the study, which incorporated balance exercises over 12 weeks. Participants were supposed to be at risk for falls and be considered frail. Accordingly, inclusion criteria stated that participants must have reported at least two falls within the last 12 months, must have a decline in 2 or more IADLs on the Fenclay Activities Index, must be able to walk 20 ft, and must attain a score of 24 or more on the MMSE.⁸ • Interventions and Outcomes: Participants were randomly placed into “telephone call” and “no telephone call” groups, with the telephone call group receiving weekly, scripted, follow-up calls from a PT. Participants in both groups received individualized instructions on a home exercise program at their initial evaluation and returned to the clinic monthly for reassessment and exercise progression. Individual strengthening interventions were assigned based on performance on “hip abductors, quadriceps, plantarflexors, and dorsiflexors” tests using dynamometry.⁸ Additional endurance training instructions were given to patients unable to walk 500ft in 2 minutes. The Berg Balance Scale served as the primary outcome measure in this study. • Results: Both groups significantly improved their scores on the BBS over time, and there was an interaction between both group assignment and time as the telephone call group improved their BBS scores by 6.3 points (close to the MCID of 6.5 points) compared to the no telephone call group’s 3.9 points (P=0.038).⁸ The authors used drop-out as a proxy for adherence, as more no telephone group

	<p>participants dropped out (8 to 3) but they do not report data from exercise logs assigned to each participant.</p> <p><u>Conclusions:</u> The authors conclude that a home-based exercise program can demonstrate significant improvements in balance, as measured by the BBS, and that <i>weekly telephone calls can enhance such improvements</i> and offer a cost-efficient means of supplementing home exercise programs. Study limitations included relatively small sample size; limited generalizability due to predominately male set of participants.</p>
Comments	<p>This study is in line with other studies which demonstrate the efficacy of home-based strengthening exercise regimens on reducing falls risk (in this case, in improving balance). This study may have had more impact had the authors reported incidence of falls across the 12 weeks of their study, reported results of the exercise logs they gave to patients, and reported changes in LE strength from pre to post-test. The most pertinent finding to the OEP at UNC was the additional improvement in BBS that participants in the phone call group had relative to the no phone call group, which highlights the importance of the phone call component of the OEP. At UNC, these calls occur once monthly instead of weekly.</p>
SYNTHESIS	<p>Most every physical therapist has likely worked with patients for whom consistently adhering to a home exercise program presents a significant challenge. Non-adherence rates with predominately unsupervised home-based physical therapy may reach as high as 70%.⁷ In order to optimize the noted benefits of the Otago Exercise Program, UNC PTs should seek strategies to promote regular patient adherence to its strength and balance exercises while at home. The Essery et al. study argues, despite poor methodology of included studies in its review, that patients with <i>high intrinsic motivation</i> (as expressed in self-efficacy, self-motivation, and intention to participate) <i>may most benefit from interventions</i>, like the OEP at UNC, that are primarily used at home.⁷ Furthermore, Essery et al. highlight a key component of the OEP, the patient <i>exercise calendar</i>, by proposing synchronous self-report strategies like diaries may improve adherence. The Light et al. study propose an external source of adherence improvement in home-based interventions in the form of a weekly <i>phone call</i> from a PT to a patient to check-in and remind patients of their intervention program.⁸</p>

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