***In adults with intellectual and developmental disabilities (IDD) who are living in a group home setting, what type of exercise and/or parameters are most effective in decreasing falls incidence? How can this evidence be used to reduce falls in a local North Carolinian group home?***

## Falls Prevention in Adults with Intellectual and Developmental Disabilities:

## Recommendations for a Falls Reduction Program

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**Introduction**

It is estimated that 4.6 million adults in America are living with intellectual and developmental disabilities (IDD).1 This number is likely underreported, though, as surveillance of this population is difficult to maintain after transition out of the educational system. Such lack of data is both irresponsible and costly as adults with IDD display increased risk for health complications, high falls rate, and decreased independence.2

IDD is characterized by limited “intellectual functioning and adaptive behavior,” often resulting in difficulties performing physically, socially, and functionally.3 This definition alone identifies the importance of offering services that promote both physical and psychosocial health, as well as self-care, safety, and advocacy. Services must then take into consideration other common features of this population such as living in residential group homes, unique social interactions, and decreased IQ, commonly <75.1 However, with proper consideration of these features, services can be effectively developed to address common impairments and barriers in an effort to increase overall quality of life.

*Impairments*

From a physical therapy perspective, balance and gait capabilities of adults with IDD are of particular importance. The literature suggests that the following factors contribute to balance and gait impairments in this population: decreased cognition, difficulties motor planning, and limited physical activity; additionally, premature aging results in an early decrease of strength, vision, proprioception, and vestibular function.4 These impairments often lead to functional declines including decreased participation in both activities of daily living (ADLs) and in the community. Another detrimental consequence of the aforementioned impairments is increased falls, as adults with IDD can experience up to three times as many falls as compared to their age-matched peers.5 This issue of falls requires further investigation.

A review by Smulders et al. found that the average elderly adult with IDD experiences 1.0 falls per year, while their age-matched peers are more likely to experience only 0.45-0.65 falls per year.2 Furthermore, falling is responsible for 50-60% of annual injuries in adults with IDD with these falls more likely to end up in serious injury4, 6. Common consequences of falls include lacerations, fractures, and brain injury. The CDC reports that, as of 2010, 95% of hip fractures in older adults were secondary to falls. Moreover, adults with IDD experience between 1.7 and 3.3 times more fractures compared to these age-matched peers. Finally, the psychosocial consequences of falls cannot be underestimated; a person who has experienced a fall will often become fearful, resulting in self-limited activity and subsequent decreases in strength and balance—a vicious cycle likely to lead to even more falls.6 Once a client suffers a fall, they are 2-3 times more likely to fall again.7

*Cost*

A review by Cox et al. reports that approximately 50% of medical injuries in adults with IDD are secondary to falls.8 It is no surprise, then, that falls are costly; in fact, falls are reported to cost more than $28 billion annually in the elderly population.9 This high cost in combination with the increasing number of older adults with IDD has been an area of recent interest to the Center for Medicare and Medicaid (CMS). CMS reports that these adults with IDD make up only 4.9% of their clientele yet account for 15.7% of Medicaid expenditures.1 Because development of appropriate programs can help to promote health in this population as well as decrease costs several organizations, including CMS, the Center for Disease Control and Prevention (CDC), and the World Health Organization (WHO), are fervidly working to track this population and create appropriate programs.

*Program Development*

Based on this data, developing a falls prevention program for adults with IDD is vital. Research suggests that the risk of falling for typical adults decreases as a result of physical intervention (i.e. balance training and strengthening).2,4,6 The question must then be asked: do adults with IDD receive the same benefits from physical intervention? In a review by Enkelaar et al., the authors suggest that, with the proper modifications, exercise is an effective method of improving balance in this population.4 However, uncertainly still exists as to how to best develop such a program.

The purpose of this review is to identify established exercise programs that have been effective in decreasing fall incidences in adults with IDD. Exercise parameters including exercise type, individualized versus group training, and staff/caregiver participation were of particular interest. The ultimate goal of this research is to develop a falls reduction initiative for a local organization of group homes for adults with IDD.

**Type: Strength training vs. Balance-specific training**

Many factors play a role in balance capabilities; this has raised the question as to what type of exercise is most effective in decreasing falls in adults with IDD. Strength training and balance training are the two most commonly utilized interventions; thus, comparison of the two is essential.

*Strength*

Strength plays a vital role in both automatic postural reactions (APR) and anticipated postural adjustment (APA) balance strategies. Strength is also necessary for efficient and safe ambulation. Adults with IDD typically present with a sedentary lifestyle and premature aging both of which can result in decreased muscular strength.2 Based on such anatomy, it is feasible that simple strength training would be effective in decreasing the incidence of falls in adults with IDD.

A cohort study by Podgorski et al. implemented an exercise program at a day service designed for adults with IDD. Interventions consisted of dancing, balance training, and upper/lower extremity strengthening, with specific strength exercises including hand weights, ankle weights, and hip flexion/extension exercises. Strength gains were analyzed through use of 1 rep max, in accordance with the American College of Sports Medicine’s (ACSM) guidelines. All subjects made strength gains.10 These results show that adults with IDD can make gains in strength, but the question remains: Do such gains truly impact balance and are they more effective than balance specific training?

The results of a study by Carmeli et al. would argue no.11 In this randomized control trial (RCT) of 27 subjects, Carmeli et al. used the SF-36, Physical Performance Test (PPT) and Functional Reach (FR) to assess physical ability post-training. The PPT looks at ability to complete functional tasks such as dressing, eating, walking, and stairs, while the FR has been cited as a valid balance measure. Group A performed balance-specific activities such as tandem walk and side stepping, intended to challenge static and dynamic balance. Conversely, Group B performed resistive training in accordance with the ACSM standards. While both groups made general gains, only the balance group made significant gains on both the PPT and FR; furthermore, only the balance group improved in every component of the PPT and SF-36.11

While both of these studies have small sample sizes and lack a power discussion, they are appropriate for considering the role of strengthening in falls prevention. Both Podgorski and Carmeli suggest that adults with IDD do benefit from strengthening; however, such strengthening does not appear to be a more effective intervention for increasing balance skills.10,11 According to Carmeli et al., balance-specific training is extremely effective in producing long term changes in balance abilities, seen by significant gains in the FT.11 Is there more evidence to support this? If so, what type of balance training is most effective?

*Balance*

Balance-specific training should consist of exercises that challenge one’s static and dynamic balance. As mentioned, Carmeli et al. utilized large body movements such as tandem walking, throwing, and sidestepping to successfully increase balance scores.11 A RCT by Jankowicz-Szymanska et al. also used traditional balance training. Specifically, they used stability balls, an obstacle course, reaching outside the base of support (BOS), pelvic control, barefoot walking, and varying terrains, all of which led to significant increases in single leg stance (SLS) times and decreased center of mass (COM) displacement on a biofeedback machine.12

Less traditional interventions are also effective in increasing balance skills within this population. A single subject design with a strong power analysis by Hawkins et al. found that yoga is effective in increasing balance skills in young adults with IDD. The class was classified as Vinyasa method as it incorporated breathing techniques, postural alignment, and posing.13 Aquatic therapy (AT) can also be effective in increasing balance; a cohort study by Salem et al. found that AT, possibly due to the aquatic medium or ability to challenge balance in a safe environment, was successful in producing significant gains in the Timed Up and Go (TUG), Berg Balance Scale (BBS), and grip strength.14 Finally, in a sample of convenience, Tsimaras et al. used traditional Greek dancing to address balance in adults with IDD. The authors found that simple dance moves were effective in significantly increasing SLS time and dynamic balance as measured through a timed obstacle course. The dance moves were all chosen based on their simplicity, tempo, and entertainment; the moves required the subjects to stand in a circle holding on to one another and typically consisted of footwork that brought the subjects into some form of SLS. The control group in Tsimaras et al.’s study, who underwent no intervention, displayed decreases in balance skills.15

*Recommendation*

Overall, the author’s in each of these studies propose that balance-specific training can play an important role in increasing balance skills. As poor balance is a significant contributor to falling, it can be deducted that balance-specific training is an effective method of falls prevention. While strengthening may also have a role to play, research has suggested that multifaceted falls programs may not be the most effective strategy for adults with IDD.16 Thus, choosing just one intervention—balance-specific training—appears to be the most promising option for decreasing falls in adults with IDD.

**Setting: Individualized exercise vs. Group classes**

What is the best implementation strategy for these balance-specific exercises? Traditional physical therapy falls intervention typically takes place in a clinic with one-on-one interaction between the therapist and client. This allows for balance screening, education, and training. While this may be appropriate for some adults with IDD, a portion of this population resides in group homes. The group setting provides a unique environment for screening and intervention. As research has already suggested that a majority of adults with IDD are at risk for falling, it seems appropriate to provide a group balance-training course, assuming it is as effective as or more effective than individualized training.

*Individualized Exercise*

Individualized exercise certainly has a place in falls prevention; however, research consistently points towards group exercise being more effective in adults with IDD.5,13-15 Hawkins et al. followed two college students with IDD over the course of a semester. Each was instructed to participate in individualized exercise followed later by a group yoga class. Rating of perceived exertion (RPE), physical activity enjoyment scale (PAES), and periods of consecutive participation were all used to track success. The yoga class had statistically higher participation, RPE, and enjoyment displaying that the individualized training was not as effective as the group class.13 Kerse et al. conducted a clustered-RCT with strong power that also looked at the effect of individualized exercise in 682 subjects at residential group homes. The intervention group all met with the nursing staff to establish: 1) a goal for increased physical function and 2) an intervention plan. Staff, including nursing, PT, and OT, were all available to help the subjects over the course of 6 months. Subjects were then encouraged to continue independently. Measures used included the Elderly Mobility Scale, TUG, and EuroQoL. No significant gains were made on any measures; furthermore, subjects that also presented with IDD made fewer gains than their fellow subjects with typical cognition. The authors concluded that an individualized program in this group home setting was not effective in producing functional gains. They also suggested that adults with IDD may require more specialized or intentional programming than their peers.5 Overall, these studies suggest that individualized interventions are not effective for adults with IDD.

*Group Classes*

If individualized exercise is not effective, group exercise must be considered. In the previous case study on college students and group yoga, a correlation was seen between the group setting, enjoyment, and intensity of exercise. Each participant’s enjoyment progressed the more classes they attended, which was then associated with increased RPE. Not only does this display the potential for adults with disabilities to participate in group classes, the authors also suggest that group classes can be more effective than individualized training and appear to have higher adherence.13

Increased adherence is confirmed by several other studies. Salem et al. conducted a cohort study on adults with multiple sclerosis (MS) looking at the effect of aquatic therapy on strength, balance, and functional ability. Despite the fact that MS is not an IDD, the positive effects of group exercise on individuals with a serious medical condition is clear. Not only were there significant gains in balance, but the group also had an overall 88% attendance record; all participants stated that they would be interested in continuing the class.14 It is not a surprise that high attendance is correlated with gains as the subjects are receiving more intervention. However, the authors questioned if this high participation led to increased motivation; motivation, in turn, could produce greater gains.14 The authors in the previously mentioned study on traditional Greek dance also discussed the potential impact of a group intervention; they describe the class as “promoting fun, cooperation, and friendship”15 It appears that the class environment can potentially have a positive impact on functional gains.

Group classes offer more than just increased participation and a fun atmosphere. Safety is also an important element. Fear can be an immobilizing factor, so ensuring that the patients feel safe is important. All of the group classes had assistants who were able to help the participants.13-15 The aquatic medium in aquatic therapy also helped to decrease fear as there is less risk of injury.14 Finally, the Greek dance had patients holding hands in a circle helping to decrease the risk of falling while also building community.15

*Recommendation*

The evidence points to group exercise classes being more effective than individualized exercise for adults with IDD. Group classes produced more significant balance gains and are associated with increased participation, motivation, satisfaction, and safety. Combined with the previous findings, it appears that adults with IDD should be participating in group balance classes as part of a falls prevention program.

**Support: Role of staff and/or caregivers**

A final trend noted in this review on falls prevention in adults with IDD was the importance of support staff. A good instructor and adequate assistants are essential.13,14 The research suggests that having a good staff increases safety and motivation.

Similarly, having support of the group home’s staff is important. Not only do they help with logistics such as transportation and home exercise programs, staff can also have an effect on actual falls incidence. In a study by Bonner et al., 68 of the staff members participated in monthly training and weekly interdisciplinary sessions on how to prevent falls in their homes. The training was led by physical therapy students from the local university. The fall rate decreased from 16.1% to 9% after just two months of this program.17 Podgorski et al. also discussed the importance of staff participation, finding that an involved staff helped to increased client motivation, contributing to significant longitudinal gains in physical activity.10

*Recommendation*

Staffing, both of the exercise programs and of the living settings, should not be overlooked as they can play an important role in supporting and motivating the clients. Training courses can be an effective method of increasing staff ‘buy-in’ and should be used to complement the development of the falls program.

**Limitations of the evidence**

It is important to note that all articles discussed have undergone extensive analysis. Unfortunately, the scarcity of research conducted within this population has resulted in studies of small sample size and of convenience, lack of power, and simple case studies. Only the studies by Kerse et al. and Hawkins et al. discussed power to support their statistically significant findings.5,13 Six of the eight studies had small samples and most were a sample of convenience.11-15,17 Four of the eight (Carmeli, Jankowicz, Kerse, and Tsimaras) were randomized control trials, but once again with small sample sizes and samples of convenience.5,11,12,15 The single subject and single group designs by Hawkins et al. and Bonner et al. provided a good foundation of evidence, but further research should be done to confirm their findings.13,17

Another limitation to take into consideration is the intervention descriptions. The studies by Carmeli, Hawkins, Jankowicz, and Salem all designed programs for adults with IDD, but did not provide an adequate description to make the programs replicable.11-14 More information should be provided on activities, instructors, directions, feedback, and periods of rest. There was also limited discussion of blinding throughout all of the studies. Support staff and caregivers are necessary for providing care to this population, so blinding them while still ensuring subject safety would be challenging; however, the lack of blinding also causes the research to lose credibility. Finally, myriad outcome measures were used. Jankowicz et al. and Tsimaras et al. both used SLS times while Salem et al. and Kerse et al. both used the TUG; beyond this, similarity in measures was lacking.5,12,14,15 More research should be done to determine the best balance measure in this population and to ensure unity in later studies. Despite these weaknesses, all trends have pointed towards the effectiveness of a group balance program for adults with IDD.

**A need for further research**

It is important to note that while these findings are good groundwork for program development, there are still a lot of questions that need to be answered. Evidence is lacking on the most appropriate balance measure to be used in this population. For example, the BBS or dynamic gait assessment may not be the best measure as this population often displays difficulties following directions. Best parameters for producing gains were also not extensively discussed. How long should classes be? How many days a week? How does this compare to what is feasible for adults with IDD? Finally, more research should be done on realistic logistics. Factors such as ability to follow directions, body awareness, home exercise programs, transportation, and safety should be studied in more detail. Overall, current research has provided a solid foundation, but more research needs to be done to ensure that an effective balance class can be developed. Such program development will be further discussed as this information is applied to practice.

**Application to Practice**

The research gathered for this review has highlighted significant trends for developing a falls prevention program in adults with IDD, specifically the importance of 1) balance-specific training, 2) influence of group therapy, and 3) the vitality of staff support. This evidence, in conjunction with the recommendations for further research, should be at the foundation of future program development for falls prevention in the >4.6million adults with IDD.1

Physical therapists have the unique opportunity to continue research on this topic as well as utilize current evidence in clinical practice. While both approaches play an important role in decreasing prevalence of falls, further research is warranted for understanding best practice. In an effort to encourage said research, the American Physical Therapy Association (APTA) has put out a call for continued research, signifying the need to address falls in this population. Results of these recent studies will be shared at the APTA Section on Pediatrics Annual Conference (SoPac) in October 2014. In fact, the University of North Carolina-Chapel Hill’s Department of Physical Therapy and the Carolina Institute for Developmental Disabilities (CIDD) have partnered with a local group home, Residential Services, Incorporated (RSI), to conduct further research.

RSI has a mission to “promote quality of life [in adults with IDD] by maximizing self-determination, development of independent living skills, community involvement, meaningful social roles, and socially responsible behavior.”18 As a part of this mission, RSI runs a series of group homes for residential living, in which housing coordinators have recently noted an increase in falls incidence; as a result a falls prevention program will be implemented in the Spring of 2014.

This joint team spent the fall of 2013 conducting a retrospective study, identifying risk factors specific to falls at RSI. This information, in combination with the results of this current literature review, helped to identify potential falls prevention programs. Instead of building a new program from the ground up, the research team has decided to modify a pre-existing falls program—the Otago Exercise Program (OEP)—for adults with IDD The modified OEP (mOEP) program will serve as a pilot study for subsequent program development and the continuation of evidence on falls prevention in adults with IDD.

**The Otago Exercise Program (OEP)**

*Development and Validation*

This exercise program was designed to prevent falls in adults >65y.o. It was originally developed in New Zealand by a group of researchers at The University of Otago in Dunedin. It has since undergone a series of randomized control trials (RTC), all of which have validated its effectiveness in decreasing incidences of falls. The OEP has become an internationally recognized program and is now promoted by the Centers for Disease Control and Prevention (CDC) as an effective intervention for preventing falls in adults >65y.o.7

*Parameters of the OEP*

Traditional OEP protocol has a duration of 52 weeks. After performing a thorough assessment of the client’s strength and balance, the therapist will develop an individualized exercise program from a preselected group of exercises; the program will then be progressed over the year to ensure moderate challenge for making gains. Progression is determined by a combination of follow-up visits and phone calls. Clients are also to participate in a walking program as able.

*Benefits of the OEP*

Several factors have caused the OEP to be recognized as a leading falls prevention program. The OEP is cited as reducing falls by 35% in high risk adults. High risk adults are typically described as >80y.o. with multiple comorbidities; however, many adults with IDD are consider a high falls risk secondary to their comorbidities and severely decreased balance and strength, despite being of a younger age.

Not only does the OEP decrease falls, it is also associated with decrease mortality. A 2010 systematic review by Thomas et al. found that adults who participated in the OEP not only had less falls, but also became more physically active. These findings were then associated with a significant reduction in mortality rate (p=0.007).19 The CDC reports that annually, as of 2010, more than 21,000 older adults die from accidental falls. The same source states that every 29 minutes, an elderly adult passes away as the result of a fall.7,20 A program that can decrease these numbers should clearly be considered when choosing a falls prevention program.

Finally, the OEP is also considered one of the most cost effective falls prevention program. The OEP manual cites a return of $0.70 for every dollar invested.20 A 2010 review by Davis et al. confirms this high return on investment as well as the overall value of the OEP. The authors went on to compare the OEP to two other falls prevention programs: an individualized multifactorial program and a home safety program, finding that not only was the OEP the most effective in reducing falls, but it was also the least expensive.21

*Modification*

A 2013 study by Krydalen et al. suggests that the OEP can be modified while still resulting in significant falls reduction.22 The UNC-CIDD team hopes to follow in these footsteps by modifying the OEP for adults with IDD. A pilot study is currently underway and will continue through 2015, with initial progress being presented at SoPAC in October 2014.

**Conclusion**

Several important conclusions have been drawn based on the literature reviewed. Most importantly, while adult with IDD are at high risk for falls, they can benefit from intervention, helping to decrease the many detrimental risks associated with this type of incident. Furthermore, intervention should be balance specific while also attempting to integrate a group atmosphere, as appropriate. Based on these findings as well as other supporting evidence, the effectiveness of the OEP made it an ideal program to be modified for adults with IDD. Results on OEP program modification for adults with IDD living in an RSI group home should be available in the summer of 2015. Final results will ideally help to expand the frontier on falls reduction in adults with IDD.

References:

1. Morstad D. How prevalent are intellectual and developmental disabiliities in the united states? Bethesda Institute Web site. <http://bethesdainstitute.org/document.doc?id=413>. Published March 2012. Updated 2012. Accessed November 11, 2013.

2. Smulders E, Enkelaar L, Schoon Y, Geurts AC, van Schrojenstein Lantman-de Valk H, Weerdesteyn V. Falls prevention in persons with intellectual disabilities: Development, implementation, and process evaluation of a tailored multifactorial fall risk assessment and intervention strategy. *Res Dev Disabil*. 2013;34(9):2788-2798. doi: <http://dx.doi.org.libproxy.lib.unc.edu/10.1016/j.ridd.2013.05.041>.

3. Definition of intellectual disability. American Association on Intellectual and Developmental Disabilities Web site. <http://aaidd.org/intellectual-disability/definition#.UoeuteKgZDs>. Updated 2013. Accessed November 12, 2013.

4. Enkelaar L, Smulders E, van Schrojenstein Lantman-de Valk H, Geurts AC, Weerdesteyn V. A review of balance and gait capacities in relation to falls in persons with intellectual disability. *Res Dev Disabil*. 2012;33(1):291-306. doi: 10.1016/j.ridd.2011.08.028; 10.1016/j.ridd.2011.08.028.

5. Kerse N, Peri K, Robinson E, et al. Does a functional activity programme improve function, quality of life, and falls for residents in long term care? cluster randomised controlled trial. *BMJ*. 2008;337:a1445. doi: 10.1136/bmj.a1445.

6. Finlayson J, Morrison J, Jackson A, Mantry D, Cooper SA. Injuries, falls and accidents among adults with intellectual disabilities. prospective cohort study. *J Intellect Disabil Res*. 2010;54(11):966-980. doi: 10.1111/j.1365-2788.2010.01319.x; 10.1111/j.1365-2788.2010.01319.x.

7. Falls among older adults: An overview. Centers for Disease Control and Prevention Web site. <http://www.cdc.gov/HomeandRecreationalSafety/Falls/adultfalls.html>. Published 2013. Updated 2013. Accessed March 3, 2014.

8. Cox CR, Clemson L, Stancliffe RJ, Durvasula S, Sherrington C. Incidence of and risk factors for falls among adults with an intellectual disability. *J Intellect Disabil Res*. 2010;54(12):1045-1057. doi: 10.1111/j.1365-2788.2010.01333.x; 10.1111/j.1365-2788.2010.01333.x.

9. Cystic fibrosis: Pulmonary function testing. Hartford Hospital Web site. <http://www.harthosp.org/CysticFibrosis/PatientEducation/PulmonaryFunctionTesting/default.aspx>. Updated 2014.

10. Podgorski CA, Kessler K, Cacia B, Peterson DR, Henderson CM. Physical activity intervention for older adults with intellectual disability: Report on a pilot project. *Ment Retard*. 2004;42(4):272-283. doi: 2.

11. Carmeli E, Zinger-Vaknin T, Morad M, Merrick J. Can physical training have an effect on well-being in adults with mild intellectual disability? *Mech Ageing Dev*. 2005;126(2):299-304. doi: 10.1016/j.mad.2004.08.021.

12. Jankowicz-Szymanska A, Mikolajczyk E, Wojtanowski W. The effect of physical training on static balance in young people with intellectual disability. *Res Dev Disabil*. 2012;33(2):675-681. doi: 10.1016/j.ridd.2011.11.015; 10.1016/j.ridd.2011.11.015.

13. Hawkins BL, Stegall JB, Weber MF, Ryan JB. The influence of a yoga exercise program for young adults with intellectual disabilities. *Int J Yoga*. 2012;5(2):151-156. doi: 10.4103/0973-6131.98244; 10.4103/0973-6131.98244.

14. Salem Y, Scott AH, Karpatkin H, et al. Community-based group aquatic programme for individuals with multiple sclerosis: A pilot study. *Disabil Rehabil*. 2011;33(9):720-728. doi: 10.3109/09638288.2010.507855; 10.3109/09638288.2010.507855.

15. Tsimaras VK, Giamouridou GA, Kokaridas DG, Sidiropoulou MP, Patsiaouras AI. The effect of a traditional dance training program on dynamic balance of individuals with mental retardation. *J Strength Cond Res*. 2012;26(1):192-198. doi: 10.1519/JSC.0b013e31821c2494; 10.1519/JSC.0b013e31821c2494.

16. Petridou ET. What works better for community-dwelling older people at risk to fall?: A meta-analysis of multifactorial versus physical exercise-alone interventions. *J Aging Health*. 2009;21(5):713; 713-729; 729.

17. Bonner A, MacCulloch P, Gardner T, Chase CW. A student-led demonstration project on fall prevention in a long-term care facility. *Geriatr Nurs*. 2007;28(5):312-318. doi: 10.1016/j.gerinurse.2007.04.014.

18. Mission. Residential Services, Inc.: A Traditionl of New Possibilities Web site. <http://www.rsi-nc.org/>. Updated 2014. Accessed April 10, 2014.

19. Thomas S, Mackintosh S, Halbert J. Does the 'otago exercise programme' reduce mortality and falls in older adults?: A systematic review and meta-analysis. *Age Ageing*. 2010;39(6):681-687. doi: 10.1093/ageing/afq102; 10.1093/ageing/afq102.

20. Tools to implement the otago exercise program: A program to reduce falls. In: First ed. Center for Disease Control and Prevention.

21. Davis JC, Bryan S, Marra CA, et al. An economic evaluation of resistance training and aerobic training versus balance and toning exercises in older adults with mild cognitive impairment. *PLoS One*. 2013;8(5):e63031. doi: 10.1371/journal.pone.0063031; 10.1371/journal.pone.0063031.

22. Kyrdalen IL, Moen K, Roysland AS, Helbostad JL. The otago exercise program performed as group training versus home training in fall-prone older people: A randomized controlled trial. *Physiother Res Int*. 2013. doi: 10.1002/pri.1571 [doi].