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A Comparison On the Effectiveness of Low Friction Surface Training and Obstacle Course Training in Reducing Risk of Slip Related Falls in Elderly

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***Abstract*: *Objective:* To determine which training method is best among slip and obstacle (restricted) training to prevent falls in elderly.**

***Method:* The study was conducted on elderly population with H/O of falls in past years. The socio- demographic data and body mass index were obtained from a sample of 30 older adults, age of 65 years or above, including both genders divided into 2 groups for different treatment via randomization. All the participants completed the BBS and Time –Up and Go Test before and after both the intervention.**

***Result:* From the result of the present study it was concluded that both the training methods are beneficial in fall prevention and can be implemented clinically as well as in home set up for elderly individuals. Within the group comparisons revealed both these training methods are equally significant with respect to (BBS) Berg Balance Scale and (TUG) Timed Up and Go Test readings. Post intervention comparison between the groups revealed that low friction surface training group showed better improvement on timed up and go test when compared to BBS.**

***Conclusion:* It was concluded that both the treatment method are equally effective in reducing numbers of falls related to slip but surface training with low friction is found to be more competent in slip reduction strategy as compared with Timed up & Go.**

***Keywords*: Balance, BBS (Berg Balance Scale), Timed –Up and Go Test (TUG), Obstacle training.**

1. Introduction

Significant health threat faced by older individuals as their age increase is more susceptibility to fall [1]. It considers among one of the top cause of mortality, morbidity, reduced functioning, and early nursing home admissions above and over age 65 [2]. It is estimated that one in three persons over the age of 65 is likely to fall at least once a year. Although more number of falls are seen in younger children than elderly individuals but the severity of injury is higher in elderly. In residential care settings approximately 50% of elderly population fall at least once in a year [3] and upto 40% fall more than once a year [4], [5]. These falls in elderly are because of intrinsic (age related decline in visual, vestibular, Proprioceptive and musculoskeletal system functions) and extrinsic (environmental obstacles associated with foot ground contact) factors, the type of activity elderly are engaged in contribute to varying degree of fall [6]. Intrinsic factors are mostly responsible for fall in people aged above age 80 whereas below 75 years of age are more likely due to extrinsic factors [7].

Environmental obstacles due to low resistance in case of wet, waxed, Uneven slippery surfaces (including rugs and mats) or inappropriately designed stairs & furniture are also considered as leading cause of risk for falling, tripping or slipping in elderly population [8]. Amongst all these fall due to slip alone contribute to 75% of the total number of falls per year [9].

Injuries due to fall results in decreased mobility, decline in functions resulting in significant increase in persons morbidity. Upright human posture is controlled by CNS (Central Nervous System) for maintaining proper balance in Activities of daily living. For situations in which COM (Center of Mass) lie outside BOS (Base of Support) CNS exceeds stability limit by activating other systems [9]. Actions like perturbation act on the internal illustration of stable postural to improve adaptive refinement of central parts of nervous system to maintain balance loss. Various intervention strategies are used to prevent slip related falls among elderly. Two among them are induced slip training and obstacle training [10]-[12].

Surface training with low friction promotes neuromuscular protective mechanism suitable for decreasing chances of falls. It focuses on training of motor components in conditions which resembles to real life scenario. The motor skills required for overcoming real life situation challenges i.e. slip accidents are best acquired under conditions resembling real life situations [13], [14].

The CNS can be trained simultaneously to prevent loss of balance and decrease descent of downward body resulting from slips. With repeated exposure to slips, the CNS most likely to develop new networks; or updating the existing internal representation to progress its feed forward control [15]. Modified obstacle course on the other hand has become a safer

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and conventional training strategy as compared to obstacle course, providing rapid and precise feedback to the patient [16]. Currently, the only method of training stepping over responses involves exposing the subjects to actual hazards such as stepping over different sized objects of varying shapes, colors and locations in the subjects path [13].

Both surface training with low friction & obstacles (hurdles) course are useful in reducing number of falls in elderly population due to slip [17], But there was no concluding evidence or literature I had come across which concludes the more effective and safer intervention strategy amongst these two that can be clinically employed to prevent slip related falls among elderly. So present study is done to conclude which training method is best among both slip and obstacle training for preventing falls in elderly population.

2. Participants

30 elderly participants above 65 years of both genders were recruited from community centers and localities from Agra and Mathura, Uttar Pradesh. The subjects had to be independent in walking with H/O more than one falls during past 2 years. Individuals with previously diagnosed with neurological, musculoskeletal and cardiovascular disorders, impaired cognitive status (mini mental status examination) MMSE score < 24, with osteoporosis, Visual deficits uncorrectable by lens, using external walking external appliances were excluded.

3. Procedure

Elderly adults were recruited based upon the inclusion & exclusion criteria and informed about the objectives of the study. A written consent form was obtained from each participant. Study was approved by the Ethical Committee of School of Medical and Allied Sciences, Sanskriti University, Mathura, Uttar Pradesh, New Delhi. Consent form including identifying information and demographic data, history /screening questionnaires will be kept confidential by using different numeric codes for each subject. Initial evaluation including demographic data such as age, sex, height, weight, (BMI), fall history (duration & frequency), & presence of co-morbidities such as diabetes, hyper/hypothyroidism, and lipid profile dysfunction etc.

Subjects were evaluated for balance, slips other outcomes in the study. Brief fall history was recorded and participants were assessed using BBS (Berg Balance Scale) and TUG (Modified Timed Up and Go Test) pre intervention. Two different groups of subjects were made by convient sampling. This was an experimental study and single intervention session per day having 3 repetitions during each session for three week. There was an assistant standing with the participant during procedure to avoid any falls.

4. Intervention

A. Surface training with Low friction

During both sitting and standing slips was introduced. To start chair sitting position with heels together knees at 100̊ of flexion and ankles at 10̊ dorsiflexion. Than participants were asked to walk normally with comfortable pace without foot wears over a low friction surface. Slips were introduced using a low friction base made up of saw dust. Participants were informed that firstly they will go for non-slip trials and then later on with slip. After 3 regular trials of walking over normal surface, a wedge of 5 alternate slip trials were introduced over low friction surface. After the 1st trial, subjects were informed in advance that during subsequent trail slip 'may or may not'. The same procedure was adopted for remaining two sessions. The researcher was standing around immediate side of patient to protect him/her from falling.

B. Training with Functional Obstacle Course

Each participant was asked to perform obstacle walk without foot wear once researcher demonstrate them the pattern. This walk should be completed at comfortable pace. The Functional Obstacle course includes 12 simultaneous functional setups for activities of the daily living commonly encountered at home. Out of which 4 setups include different floor textures, 2 setups include graded surfaces (up & down ramps). 2 stations include different types of stairs cases (commonly used in rehabilitation settings for the purpose of exercise). 4 setups include functional tasks. The ramp was placed parallel to the wall so that the patient could easily have its support if needed.

5. Statistical Analysis

SPSS version 11.5 was used for statistical analysis. The normality of distribution of all variables was verified using Shapiro-Wilk test. Wilcoxon signed rank test was used to analysis data within two groups whereas for analyzing data between the two groups Mann Whitney U test was used. Level of significance was set as $p \leq 0.05$.

6. Results

For 28 subject's data was analyzed, for both male and females with H/O of fall in past 1year.14 subjects were present in each group. Mean age and SD of participants in both the groups is given in table 1.

Table 1
Mean age and standard deviation of age for subjects of groups A and group B

Subject	Mean Age and Standard Deviation	Gender
Group A	68 ± 2.5	Males = 10, Females= 4
Group B	66.12 ± 2.4	Males =7 , Females= 7

A. Comparison within the group

Table 2
Mean and SD of Berg Balance Scale (BBS) at Pre, Post and Mean Diff. (Pre-Post) for the subjects of Group A and Group B

Berg Balance Scale	Group A		Group B	
	Mean	SD	Mean	SD
Pre – Intervention	39.28	1.85	38.00	3.41
Post – Intervention	44.78	2.66	43.07	2.81
MD (Pre – Post)	5.50	1.65	5.07	1.97

In result of mean differences between pre and post intervention BBS score it was concluded both the treatment approach have mostly similar effect on individual balance control showed in table 2. Whereas table 3 shows significant

differences in the values obtained within group pre and post intervention.

Table 3
Comparison of mean value for Berg Balance Scale (BBS) between Pre and Post Interval within Group A and Group B

Berg Balance Scale	Group A		Group B	
	z value	p value	z value	p value
Pre – Interval Vs Post – Interval	-3.311	0.001	-3.321	0.001

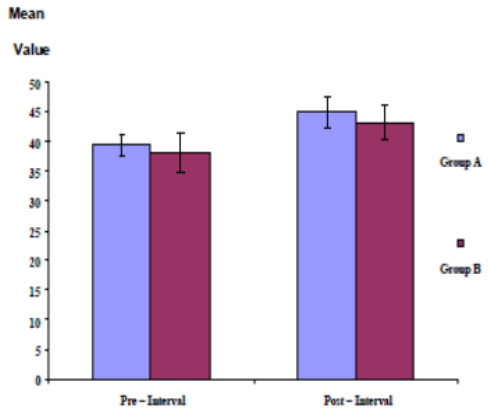

Fig. 1. Graphical presentation of pre and post intervention mean values of Berg Balance Scale for both group A and group B

Table 4
Mean and SD of TUG at Pre, Post and Mean Diff. (Pre-Post) for the subjects of Group A and Group B

TUG (Timed Up and Go Test)	Group A		Group B	
	Mean	SD	Mean	SD
Pre – Intervention	19.92	1.73	20.14	2.03
Post – Intervention	16.00	1.46	17.71	1.77
MD (Pre – Post)	3.92	1.32	2.42	1.08

As a result of within group comparison of post intervention TUG score significant result was shown in both the groups shown in table 4 and table 5 shows the significant difference between the pre and post intervention values within groups.

Table 5
Comparison of mean value for TUG between Pre and Post Interval within Group A & Group B

TUG (Timed Up and Go Test)	Group A		Group B	
	z value	p value	z value	p value
Pre – Intervention vs Post – Intervention	-3.311	0.001	-3.346	0.001

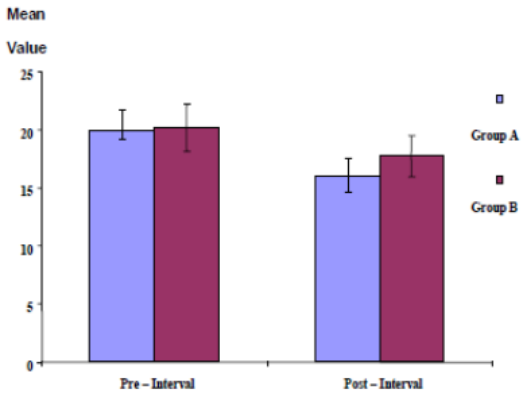

Fig. 2. Graphical presentation of pre and post intervention comparison of mean values within the group A and B for Timed Up and Go Test

B. Comparison between the groups

As a result of comparing both groups pre and post intervention mean and mean difference values obtained shows insignificant values of mean on BBS in group A and group B shown in table 6. Whereas table 7 shows that between group pre and post intervention comparison of mean and mean difference on TUG shows a significant difference in the post intervention mean and mean difference values for both the groups.

Table 6
Comparison of mean value for Berg Balance Scale (BBS) at Pre, Post Interval and Mean Diff. (Pre – Post) between Group A and Group B

Berg Balance Scale	Group A vs. Group B	
	U value	p value
Pre – Interval	-1.367	0.171
Post – Interval	-1.623	0.105
MD (Pre – Post)	-0.748	0.454

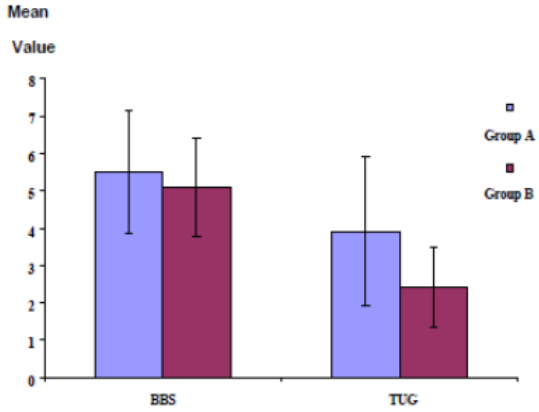

Fig. 3. Graphical presentation of pre and post intervention comparison of mean values between the group A and B for Berg Balance Scale and Time Up and Go Test

Table 7
Comparison of mean value for TUG at Pre, Post Interval and Mean Diff. (Pre – Post) between Group A and Group B

TUG	Group A vs. Group B	
	U value	p value
Pre – Intervention	-0.164	0.870
Post – Intervention	-2.481	0.013
MD (Pre – Post)	-2.820	0.005

7. Discussion

In result present study states that both the training methods are beneficial in fall prevention and can be implemented clinically as well as in home set up for elderly individuals. Within the group comparisons revealed both these training methods are equally significant with respect to BBS (Berg Balance Scale) and TUG (Timed up and go) test readings. Post intervention comparison between the groups revealed that low friction surface training group showed better improvement on timed up and go test when compared to BBS.

A. Within the group comparison of low friction surface training

Repeated slip exposure leads to adaptation in subjects to slippery surface by adapting posture preventing fall. Most of the slips take place during sit to stand position [15]. Proactive adjustments depict adaptive changes in stability control because

of before anticipation of perturbation onset predominantly associated with feed forward control. Trials over slippery and non-slippery surface makes the subjects differentiate among the two types of surfaces through sensory feedback thus allowing adequate postural adaptations to take place [18]. Repeated exposure to slips leads the person to acquire a posture so as to maintain COM inside BOS to reduce the fall risk and thus replacing the protective stepping response with a walkover response under the existing low-friction conditions. Because of less mobility as compared to young population older one have difficulty in generating efficient reactive postural response in case of slip [18], [19]. Thus slip-training given in the current study appeared to prepare the reflexive initiation of the recovery step to prevent fall. By regular training sessions these subjects learned to manage their speed of walking according to the stability demands imposed by the surface thus gaining better stability over low friction surface as well.

B. Within the group comparison of obstacle course training

As results it was suggested that the obstacle training is useful for the treatment of older adults with impairment in mobility & balance [20]. Most of the slips in elderly age group occur when they come across obstacles in the form of different flooring, carpets and objects along the pathway [21].The subjects through repeated practice for crossing and moving over the obstacles to maintain a particular step length and velocity at each step through sensory feedback obtained from each surface thus assisting them to maintain balance at each surface [22], [23].The visual system detects information and by utilizing that subjects perceived changes in the body position to target locations [22].

C. Between the group comparisons of Berg Balance Scale

In low friction surface training and obstacle course the subjects showed a marked improvement with respect to balance. In both the training methods due to more involvement of dynamic components the subjects learned the strategies to adapt to various surfaces, textures and obstacles in the pathway leading to falls but as the berg balance scale has no gait component [24], the subjects comparatively scored less on berg balance scale. Both the training methods resulted in anticipation of slippery surfaces and the significant changes in stepping and walking strategies reduced the potential of falling, on the other hand berg balance scale did not involve any anticipatory strategy needed for prevention of slip related falls. Insights gained through adaptation though resulted in improvement of stability in both the groups but due to lesser utilization of factors responsible for slip related falls in berg balance scale there is almost equal amount of improvement in both the groups.

Both the training groups when evaluated after training on timed up & go test showed improvement in balance but low friction surface group due to involvement of almost similar tasks included in TUG and repeated practice of same components took lesser time by subjects to walk over the same surface without losing balance. Strategies gained by repeated practice helped them to rectify the posture according to the demands imposed thus resulting in more stable and safe movement [25]. There are two limitation of current study is one the sample size is very small and another is that no follow up is done on any patient. For other future researches male and female subjects should be considered separately because of hormonal influences both the genders show different responses.

8. Conclusion

From the present study it was stated that both the intervention protocols are equally effective in reducing numbers of falls related to slip, but surface training with low friction proved to be more efficient in slip reduction when measured over TUG scores. More over this study will help in providing a better intervention strategy for researchers, health care professionals, elderly and their families for reduction in the likelihood of slip-induced falls. Reduced falls It will ultimately lead to decreased cost expenditure on health care, better QOL with enhanced mobility, independence.

References

[1] G. Cappellini, Y.P. Ivanenko, N. Dominici, R.E. Poppele, F. Lacquaniti, Motor patterns during walking on a slippery walkway, J. Neurophysiol. 103 (2010) 746–760.
[2] A.P. Brown, Reducing falls in elderly people: A review of exercise interventions, Physiother. Theory Pract. 15 (1999) 59–68.
[3] L.Z. Rubenstein, K.R. Josephson, A.S. Robbins, Falls in the nursing home, Ann. Intern. Med. 121 (1994) 442–451.
[4] G. Salkeld, I.D. Cameron, R.G. Cumming, S. Easter, J. Seymour, S.E. Kurrle, S. Quine, Quality of life related to fear of falling and hip fracture in older women: A time trade off study, Br. Med. J. 320 (2000) 341–345.
[5] P.B. Thapa, P. Gideon, R.L. Fought, W.A. Ray, Psychotropic drugs and risk of recurrent falls in ambulatory nursing home residents, Am. J. Epidemiol. 142 (1995) 202–211.
[6] S. Kim, Biomechanical analysis for effects of neuromusculoskeletal training for older adults on the likelihood of slip-induced falls, 2006.
[7] M. Chakravarty, A. Sörman, Guidelines for prevention of falls in people aged over 65. Health improvement plans must incorporate falls and osteoporosis strategies., BMJ. 322 (2001) 554–555.
[8] G. Powell-Cope, S. Thomason, K.M. Pippins, H.M. Young, Preventing Falls and Fall-Related, AJN Am. J. Nurs. 118 (2018) 58–61.
[9] Y.C. Pai, J.D. Wening, E.F. Runtz, K. Iqbal, M.J. Pavol, Role of movement stability in reducing slip-related balance loss and falls among older adults, Int. IEEE/EMBS Conf. Neural Eng. NER. 2003-Janua (2003) 253–256.
[10] P.F. Tang, M.H. Woollacott, Inefficient postural responses to unexpected slips during walking in older adults, Journals Gerontol. - Ser. A Biol. Sci. Med. Sci. 53 (1998) 471–480.
[11] K.L. Troy, M.D. Grabiner, Recovery responses to surrogate slipping tasks differ from responses to actual slips, Gait Posture. 24 (2006) 441–447.
[12] K.M. Means, D.E. Rodell, P.S. O'Sullivan, R.M. Winger, Comparison of a functional obstacle course with an index of clinical gait and balance and postural sway, Journals Gerontol. - Ser. A Biol. Sci. Med. Sci. (1998).
[13] K.M. Means, P.S. O'Sullivan, Modifying a functional obstacle course to test balance and mobility in the community, J. Rehabil. Res. Dev. 37 (2000) 621–632.
[14] Y.C. Pai, J.D. Wening, E.F. Runtz, K. Iqbal, M.J. Pavol, Role of feedforward control of movement stability in reducing slip-related balance loss and falls among older adults, J. Neurophysiol. (2003).
[15] Y.C. Pai, T.S. Bhatt, Repeated-slip training: An emerging paradigm for prevention of slip-related falls among older adults, Phys. Ther. 87 (2007) 1478–1491.
[16] K.M. Means, The obstacle course: A tool for the assessment of functional balance and mobility in the elderly, J. Rehabil. Res. Dev. (1996).
[17] A. Shumway-Cook, M. Woollacott, Attentional demands and postural control: The effect of sensory context, Journals Gerontol. - Ser. A Biol. Sci. Med. Sci. (2000).
[18] C.W. Luchies, N.B. Alexander, A.B. Schultz, J. Ashton-Miller, Stepping Responses of Young and Old Adults to Postural Disturbances: Kinematics, J. Am. Geriatr. Soc. 42 (1994) 506–512.

[19] W.E. McIlroy, B.E. Maki, Age-related changes in compensatory stepping in response to unpredictable perturbations, Journals Gerontol. - Ser. A Biol. Sci. Med. Sci. 51 (1996) 289–296.
[20] M. KM, R. DE, O. PS, C. LA, Rehabilitation of elderly fallers: pilot study of a low to moderate intensity exercise program., in: Arch. Phys. Med. Rehabil., 1996.
[21] M.E. Tinetti, M. Speechley, S.F. Ginter, Falls among elderly persons, N. Engl. J. Med. (1988).
[22] R.R. Buccello-Stout, J.J. Bloomberg, H.S. Cohen, E.B. Whorton, G.D. Weaver, R.L. Cromwell, Effects of sensorimotor adaptation training on functional mobility in older adults, Journals Gerontol. - Ser. B Psychol. Sci. Soc. Sci. 63 (2008) 295–300.
[23] J. Beling, M. Roller, Multifactorial intervention with balance training as a core component among fall-prone older adults, J. Geriatr. Phys. Ther. (2009).
[24] M.M. Lusardi, G.L. Pellecchia, M. Schulman, Functional Performance in Community Living Older Adults, J. Geriatr. Phys. Ther. 26 (2003) 14–22.
[25] R. Grönqvist, J. Abeysekera, G. Gard, S.M. Hsiang, T.B. Leamon, D.J. Newman, K. Gielo-Perczak, T.E. Lockhart, C.Y.C. Pai, Human-centred approaches in slipperiness measurement, Ergonomics. 44 (2001) 1167–1199.