Journal of Biomedical and Pharmaceutical Research
Available Online at www.jbpr.in
CODEN: - JBPRAU (Source: - American Chemical Society)
PubMed (National Library of Medicine): ID: (101671502)
Research Article
Volume 8, Issue 3: May-June : 2019, 01-04
ISSN (Online): 2279-0594
ISSN (Print): 2589-8752

BETTER TRAINING METHOD AMONGST TWO IN REDUCING RISK OF SLIP RELATED FALLS IN ELDERLY

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Article Info: Received 20 May 2019; Accepted 25 June. 2019
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Conflict of interest statement: No conflict of interest

ABSTRACT:
Objective: Better training method amongst two in reducing risk of slip related falls in elderly.
Background: A significant health threat facing the older population is their increasing susceptibility to falling with increasing age . In 1999, accidental falls were the 7thleading cause of death for adults age 65 and older in the US. Falls are associated with considerable mortality, morbidity, reduced functioning, and pre-mature nursing home admissions. 31% of the community dwelling elders are at risk of falling.It estimated that one in three persons over the age of 65 is likely to fall at least once a year. While young children may fall more frequently than elderly individuals, the injury rate, particularly for serious injuries, is higher among the elderly. Approximately 50% of older people in residential care facilities fall at least once a year and upto 40% fall more than once a year.
Study design: Experimental study
Methods: 30 subjects were selected through convenient sampling. Two subjects were drop out from the study as they have problem in managing time to attend the intervention sessions daily. After having the informed consent of 28 subjects and fulfillment of inclusion criteria systematic randomization was done for the subjects and assigned to the particular group according to their sequence of approach i.e. 1st,3rd,5th 7th etc in group I and 2nd,4th,6th,8th etc in group II. All the subjects underwent a single intervention session per day having 3 repetitions during each session for three week.
Results: pre and post intervention values of mean, standard deviation & means difference of all the subjects of group A and group B on berg balance scale. pre and post intervention within the group comparisons for both the groups on berg balances scale. The pre and post intervention results obtained show a significant difference in the values of berg balance scale. the within the group comparison of pre and post intervention scores of group A and group B on timed up and go test. The results obtained from both the groups shows a significant difference in pre and post intervention values for timed up and go test.
Conclusion: We concluded that even though both the intervention strategies are equally efficient in slip related fall reduction but low friction surface training proved more efficient slip reduction strategy when measured over Timed up & Go.
Key words: mortality, morbidity, central nervous system, training, health threat

INTRODUCTION

A significant health threat facing the older population is their increasing susceptibility to falling with increasing age.[1] In 1999, accidental falls were the 7thleading cause of death for adults age 65 and older in the US. Falls are associated with considerable mortality, morbidity, reduced functioning, and pre-mature nursing home admissions.[2] 31% of the community dwelling elders are at risk of falling.It estimated that one in three persons over the age of 65 is likely to fall at least once a year. While young children may fall more frequently than elderly individuals, the injury rate, particularly for serious injuries, is higher among the elderly. Approximately 50% of older people in residential care facilities fall at least once a year[3] and upto 40% fall more than once a year.[4-5]

Factors intrinsic to elderly, the types of activities they are engaged in, and the hazard and demands of environment contribute for falls to varying degrees.[6] Many falls in the elderly have multiple contributing factors, including extrinsic environmental factors and intrinsic factors such as age related decline in visual, vestibular, proprioceptive and musculoskeletal system functions.[7] Intrinsic factors are more important among people aged 80 and over,[8] since loss of consciousness (suggesting a medical cause of fall) is more common in this group. Falls among older people under 75 are more likely to be due to extrinsic factors. Extrinsic factors include environmental obstacles associated with foot ground contact and foot contact with ground surface of low friction resistance e.g. wet, waxed floors. Uneven or slippery floor surfaces (including the presence of rugs and mats), tripping obstacles, inadequate lighting, poorly designed or maintained stairs without handrails and inappropriate furniture are cited as the causes leading to increased risk of falling, tripping or slipping for older people.[9] Amongst the above mentioned reasons, falls due to slip alone contribute to 75% of the total number of falls per year.[10]

Fall related injuries can lead to decreased mobility or to a reduced activity level because of an instilled fear of falling. Falls can be markers of poor health and declining function, and they are often associated with significant morbidity .In either case, the result is decreased activity of life. Because human upright posture is inherently unstable, a primary objective for the central nervous system (CNS) must be to prevent falls, achieved firstbypreventing unintended loss of balance. Loss of balance occurswhen the motion state (i.e., instantaneous position and velocity)of the body center-of-mass (COM) with respect to the base ofsupport (BOS) exceeds certain stability limits .Adaptive refinementof the internal representation of postural stability to account for real or potential perturbation may be required to improve the CNS's ability to prevent balance loss. The CNS can then select and execute an appropriate action in a feed for ward control manner, to counter the perturbation and to avert any unintended balance loss. Various intervention strategies are used to prevent slip related falls among elderly. Two among them are induced slip training and obstacle training.[11-14]

Low friction surface training is an intervention strategy that promotes an older adult's neuromuscular protective mechanism appropriate for reducing the incidence of falls. It emphasizes motor training under conditions resembling real life situations. It focuses on prevention of slip related falls due to repeated unannounced exposure to slips during performance of activities of daily living such as in moving from a sitting position to standing position and walking. The motor skills required for overcoming real life situation challenges i.e. slip accidents are best acquired under conditions resembling real life situations.[15-16] The CNS can be trained simultaneously to prevent balance loss and decrease downward descent of body resulting from slips. With repeated exposure to slips, the CNS most likely builds new; or updates the existing internal representation to improve its feedforward control while decreasing a person's reliance on feedback.[17]

Modified obstacle course on the other hand has become a safer and conventional training strategy as compared to obstacle course, providing rapid and precise feedback to the patient.[18] 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.[19] Some obstacles will be placed next to walls which will eliminate need for parallel bars or an extra personal to interchange the

obstacles. Both the above mentioned interventions are beneficial for prevention of slip related falls among elderly individual.

Both low friction surface training and obstacle course are beneficial for prevention of slip related falls among elderly .[20] 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.

Aim and objective

To determine a better training method amongst the two for training performances in response to falls in elderly.

Hypothesis

Either induced slip training or obstacle course will be more effective in reducing risk of slip related falls among elderly.

Statement of question

Will there be any difference in the effectiveness of induced slip training or obstacle course training in reducing risk of slip related falls among elderly?

Operational definitions

Falls

A fall can be defined as unintentionally coming to rest on ground or other lower level with or without loss of consciousness.

Slip

A slip can be defined as an incidence that leads to loss of balance when there is little friction between the feet (footwear) and walking/working surface.

Elderly adults

Elders above 60years of age are considered as elderly adults.[21]

Methodology

Sample

30 subjects were selected from community centers and localities of Agra & Mathura through convenient sampling.

Study design

Experimental study

Inclusion criteria

- Elderly above 65 yrs of age
- Ability to walk independently
- Both genders
- History of more than one falls during past 2 years.

Exclusion criteria

- Any previously diagnosed history of neurological
- Any known musculoskeletal disorder and
- Cardiopulmonary deficit affecting the ability to participate in the study
- Visual deficits uncorrectable by lens
- History of cognitive impairments
- Medically diagnosed osteoporosis ·Use of external appliances

Instrumentation and outcome measure

- Saw dust
- Stop watch,Kadio2005
- Chair (46.5cm seat height)
- artificial turf, jute carpet
- High(95cm W×22cm H) & low steps (4” high× 30” W)
- Marble chips in a shallow tray(61cm× 2.4m× 5.1cm)
- Sand
- Up and down ramps (30” W x 6” D x 1 ½ “” H)

Figure: 3(a) Chair

Figure 3(b) low steps

Berg balance scale

It is a valid instrument used for evaluation of effectiveness of intervention and for qualitative description of functions in clinical practice and research.ICC=0.970.99; IRR=0.99[17]

Timed up & Go

Timed up & go is a simple timed test of mobility designed for use with the frail elderly. TUG is reported to yield a reliable and valid data for use in older people ICC=0.90.18, 19

Protocol

30 subjects were selected through convenient sampling. Two subjects were drop out from the study as they have problem in managing time to attend the intervention sessions daily. After having the informed consent of 28 subjects and fulfillment of inclusion criteria systematic randomization was done for the subjects and assigned to the particular group according to their sequence of approach i.e. 1st,3rd,5th 7thetc in group I and 2nd,4th,6th,8thetc in group II. All the subjects underwent a single intervention session per day having 3 repetitions during each session for three week.

Procedure

From the available subjects, the participants who met the inclusion criteria were selected after having their informed consent signed. Demographic data and brief fall history was recorded and participants were assessed using Berg Balance scale and modified timed up and go test pre intervention. Two different groups of subjects were recruited. The participants were properly guided about the procedure before intervention and researcher stood by the side of patient throughout the procedure to prevent him/her from falling. After performing their particular intervention strategies, participants from each group were again assessed using Berg Balance Scale and modified Timed up & Go. Pre and post intervention data obtained from both the groups will be analyzed for comparison.

Berg balance scale

Berg balance scale was developed to measure balance among older people

With impairment in balance by assessing the performance of functional tasks.[42] It is a 14 item scale with a completion time of 15-20 mins. Participants were instructed to complete the task at their normal pace without taking any external support.

Timed "Up and Go"

Timed up and go is a simple timed test of mobility designed for use with frail elderly. Subjects were instructed to get up from a straight backed arm chair, walks to a line 3m from the front legs of the chair, return

and sits down. Time to administer = 1-3 mins. Outcome is the time taken to perform this sequence of movements.

Intervention

Low friction surface training

Slips were induced during sit to stand and walking over the surface. Trials begin with the subject sitting on a chair in a standardized position such that the heels were aligned, knees to 100 degrees from the anatomic position and ankles at 10 degree dorsiflexion. The participants were instructed to walk at their normal and comfortable pace without foot wears over a low friction surface. Slips were introduced using a low friction base made up of saw dust. Subjects were originally informed that they would initially be performing non-slip trials and that later on slip would take place. After three regular trials of walking over normal surface, a block of five consecutive slip trials were introduced by walking over low friction surface. After the first slip trial, subjects were beinformed that a slip 'may or may not' occur during subsequent trials. The same procedure was adopted for remaining two sessions. The researcher stood at the side of patient to protect him/her from falling.

Obstacle course training

All the participants were instructed to complete the course at a comfortable pace. Participants were advised to perform the course without wearing of footwear. All participants were instructed to follow the instructions that the researcher will give to them. A trial walk through the obstacle course was demonstrated by the researcher. Each participant was then asked to walk through each obstacle course.

The Functional Obstacle course consists of 12 simulations of functional mobility tasks or situations commonly encountered at home. Four stations include different floor textures .Two stations includegraded surfaces (up & down ramps).Two stations includedifferent types of stairs (exercise stairs commonly used in rehabilitation settings).Four stations include functional tasks. The ramp was placed parallel to the wall so that the patient could easily have its support if needed.

Figure 3(e): Marble chips and ramp

Figure 3(f): Functional task, carpet and objects along the pathway

Figure 3(g): Obstacle course training set up including low steps, carpet, saw dust, chair and stool

Figure 3(h): Obstacle course training set up having sand and stairs

Results

The data was analyzed for 28 subjects, including 17 males and 11 females with a past history of fall from 1year.14 subjects were present in each group. Mean age of Participants in group A was 68 years and in group B was 66.12 years with a standard deviation of 2.5 and 2.4 respectively.

Table 5(a) Mean age and standard deviation of age for subjects of groups A and group B

Subjects	Mean age	Gender
Group A	68 ± 2.5	Males=10 Females=4
Group B	66.12 ± 2.4	Males=7 Females=7

Descriptive

Comparison within the group

Table 5(b) shows the pre and post intervention values of mean, standard deviation & means difference of all the subjects of group A and group B on berg balance scale

Table 5(b) 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

Table 5(c) shows the pre and post intervention within the group comparisons for both the groups on berg balances scale.

The pre and post intervention results obtained show a significant difference in the values of berg balance scale

Table 5(c) 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

Figure: 5(a)shows the graphical presentation of pre and post intervention mean values of berg balance scale for both group A and group B.

Table 5(d) shows the pre and post intervention values of mean, standard deviation and mean difference for group A and group B on timed up and go test.

Table 5(d): Mean and SD of TUG at Pre, Post and Mean Diff. (Pre-Post) for the subjects of Group A and Group B

TUG	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

Table 5(e) shows the within the group comparison of pre and post intervention scores of group A and group B on timed up and go test. The results obtained from both the groups shows a significant difference in pre and post intervention values for timed up and go test.

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

TUG	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

Figure 5(b) shows the graphical presentation of pre and post intervention comparison of mean values within the group A and B for timed up and go test.

Comparison between the groups

Table 5(f) shows between the group pre and post intervention mean and mean difference values of berg balance scale. The results obtained show insignificant values of mean on berg balance scale in group A and group B.

Table 5(f): 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

Table 5.7 shows between the group pre and post intervention comparison of mean and mean difference on timed up and go test. The results obtained show a significant difference in the post intervention mean and mean difference values for both the groups on timed up and go test.

Table 5(g) 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

Figure 5(c)shows the 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.

Discussion

Our study aimed at knowing which among the two training methods is more effective in preventing slip related falls among elderly adults. 30 elderly adults (two dropouts) aged 65 years or above, divided into two equal groups took part in the study and were trained for two separate training methods of fall prevention . The scores obtained from each group were analysed on berg balance scale and timed up & go to conclude the better among two training methods.

Our findings suggest that both the training methods are beneficial in fall prevention and can be implemented clinically as well as in home set up. Within the group comparisons revealed both these training methods are significant with respect to berg balance scale and timed up and go test. Post intervention comparison between the groups revealed that low friction surface training group showed better improvement on timed up and go test compared to BBS.

Within the group comparison of low friction surface training

Repeated slip exposure leads to adaptation of subjects to slippery surface. Most of the slips take place during sit to stand position.[42] Low friction surface leads to practising of subjects to get up from sitting position and walking over low friction surface thus preparing them to adapt a posture preventing the risk of fall. Adaptive changes in stability control can be shown in proactiveadjustments, which occur before or in anticipation of perturbationonset and rely predominantly on feed forward control. Similarlythey can occur in the reactive response, which relies on

feedbackmechanisms As the intervention proceeded, at each slip exposure after non slipping trials, the memory of initial strategies adopted to prevent fall helps the subject to refine the posture each time while getting up and walking.

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.[43] Stability control can be characterized as the control of therelative motion state (position and velocity) between the bodycenter of mass (COM) and its base of support (BOS). A slip takes place when the body's centre of mass increases the base of support. Recent studiesbased on inducing slips during the task of sit-to-stand havesuggested that repeated exposure to such low friction surface can beused to adaptively improve one's COM state stability, and subsequentlyreduce the likelihood of balance loss and fall. In the walkover pattern, the subject's response to a slip fromreduced surface friction resembled a natural walking pattern with minimal forward BOS displacement.[42] Repeated exposure to slips leads the person to acquire a posture so as to maintain center of mass within the base of support which reduces the risk of fall andthus replacing the protectivestepping response with a walkover strategyunder the existing low-friction conditions.

Due to decreased mobility level comparable to young adults, the older adults have difficulty in generating efficient reactive postural response when they slip.[43,44,45]The slip-training appeared to prepare the reflexive initiation of the recovery step as well as the conscious control of step length. 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.

Within the group comparison of Obstacle course training

The results suggest that the obstacle course is potential as a useful tool in the evaluation of older persons with balance and mobility impairment.[46] 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.[47-48] Obstacle course comprises various surfaces of different textures and materials which can probably cause slip.

The subjects through repeated practice for crossing and moving over the obstacles helps them to differentiate various forms and textures thus decreasing the risk of fall.[49] The subjects learned to maintain a particular step length and velocity at each obstacle through sensory feedback obtained from each surface thus assisting them to maintain balance at each surface.[50]

Age related sensory changes in older adults contribute to their difficulty in preventing a fall when they are moving around obstacles in the environment. Visual information is important for navigating towards objects and obstacles in the environment. The visual system detects information about features of an object and provides feedback for the control and

guidance of movement. Themotor system uses that information to coordinate the appropriatemovement to maneuver around the object successfully. Adaptationof the perceptual-motor systems occurs when the personadjust the position of body with respect to changing visual information in the environment. By utilizing the information from the environment, the subjects perceived changes in the body position to target locations. Through the use of visual information from the environment to change body position in relation to obstacle location, the subjectsavoidedobstacle collisions when they were traversing the obstacle course.[49] Age-related sensory and motor changes did not preclude the healthyolder adults in this study from generalizing learned perceptual-motor relationships to mobility performance on the obstacle course.

Vision seems to be the only sensory mode that proactively allows a person to identify a surface before stepping over it. Visual control of locomotion has been classified into both avoidance and accommodation strategies. Avoidance strategies include, for instance, changing the foot placement, increasing ground clearance, changing the direction of gait, and controlling the velocity of the swing foot. Accommodation strategies involve longer term modifications, such as reducing step length on a slippery surface.[32]Also, through visual perception of obstacles the subjects learned the strategies to manage their stepping and crossing over pace to gain safe mobility.[50] The ability to step over objects is an essential component of ambulation that enables a person to safely function in real world environments.Immediate turn over from one surface to the other while performing obstacle course decreased the response timing for a particular surface each time the subject moves over it and helped them to prevent themselves from slipping.

Between the group comparisons of Berg balance scale

The berg balance scale is designed to evaluate a person's performance on 14items (1 sitting item and 13 standing items) related to balance function tasks that are frequently encountered in everyday life. Berg balance scale is a tool to assess the balance specifically in older group.[51] 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[51], 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.

Adaptation is reactive in nature and involves the coordination of neuro musculoskeletal system while anticipation is proactive and entails navigating through complex and often cluttered environments by using multiple sensory inputs to assist in control and adaptation of stability[39]. Both the training strategies involves tasks providing the required sensory input thus helped in improvement of balance but berg balance though solely confined to limited tasks with least involvement of sensory inputs resulted in scores being equal for both the groups.

Between the group comparison of Timed up & Go test

Timed up & Go is a balance test focusing on walking speed and functional ability of elderly adults.[37] Functional perspectives are important when dealing with problems related to balance.[33] Both the training methods include all the functional aspects required by a person to carry out his/her daily activities of living that may further lead to occurrence of a slip while walking. Low friction surface training serves as an intervention to gain balance through feedback and feedforward mechanisms. Proactive adaptation strategies developed through sensory perception of various objects, textures and surfaces in both the training methods resulted in improvement of balance in both the groups.[39]

Both the training groups when scored after training on timed up & go 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 reduced the time taken by the 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.[33]

Timed up and Go test's performance itself provides the same sensory feedback and the memory of previously acquired strategies through low friction surface training helped the subjects to complete the test with more accuracy.[52] In contrast the obstacle course having the components relying more on stepping over and crossing over strategies trained the subjects to adapt a particular step length aiding in safer mobility. The slip-training appeared to prepare the reflexive initiation of the recovery step as well as the conscious control of step length, whereas the step-training only affected the step length. The low friction surface training improved the response time and center of mass position at step lift-off when compared with the step-training thereby reducing likelihood of balance related instability leading to slips.[32]The trained subjects in low friction surface training group were able to transfer the skill in timed up & go test to avoid a fall on the slippery surface because they were better at controlling the landing foot during slip. They slowed down the movement of the foot as it began to slide forward with respect to obstacle course group which has practiced controlling the step length.[32]The low friction surface trained group maintained their stability while walking at their customary speed in timed up and go whereas obstacle course group due to more practice of crossing over or stepping over obstacle took more time complete the tasks involved in timed up and Go.

Limitations and Future Research

Limitations of the study

- Small sample size
- No follow up

Future research

- This study could be done over a large group of population
- The study could be done to know its efficacy in males and females separately
- Symptomatic population could be included.

Conclusion & Clinical Significance

Conclusion

We concluded that even though both the intervention strategies are equally efficient in slip related fall reduction but low friction surface training proved more efficient slip reduction strategy whenmeasured over Timed up & Go.

Clinical significance

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. It will ultimately lead to reduced health-care costs, enhanced mobility, independence and improved quality of life.

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