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Effects of Lower Extremity Resistance Training on Unstable Versus Stable Surface to Prevent Fall in Healthy Older Adults: A Comparative Study

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ABSTRACT

Background: In the course of ageing, physical abilities decline and consequently there is an increase in risk of falling and fall incidence. Falls in India showed annual falls rates for older adults between 14 and 51 %. Loss of self- confidence, social isolation, increased dependence on others caused due to fear of fall are among the major consequences faced by elderly in day to day life. The fact that causes of falls are multifactorial loses in lower extremity muscle strength, power and balance seem to be the most prominent intrinsic (i.e. Personal - related) fall risk factor in older adults. Lower extremity resistance training can improve strength, balance and prevent fall in healthy adults. Lower extremity resistance training on unstable surface should be given on bosu ball and lower extremity resistance training on stable surface should be given on floor.
Objective: The aim of this study is to study and compare the effects of lower extremity resistance training on unstable versus stable surface to prevent fall in healthy older adult.
Material and Methodology: The study was conducted at Nanded Physiotherapy College and Research Centre. A convenient sampling was taken consisting of 48 participants, based on inclusion and exclusion criteria. Where they performed Double leg stance, Single leg stance, Marching, Mini-squats, Bridging on Bosuball for group A participants and on floor for group B participants. The subjects were assessed pre-intervention and post-intervention on the basis of Functional reach test and Berg balance scale. Total 48 participants were taken, who were aged 60 and above. These participants were divided into two groups. These participants were administered in lower extremity resistance training for 8 repetitions per set, 2 sets, 1 time a day, 2 days a week for 4 week.
Result: For FRT and BBS the p-value was <0.0001. Hence there was statistical significance of treatment in pre and post within both groups. The study supports that effects of lower extremity resistance training on unstable surface is more effective than stable surface to prevent fall in healthy older adults.
Key words: Falls, healthy adults, resistance training, unstable surface, stable surface, balance, strength.

INTRODUCTION

In the course of ageing, physical abilities decline and consequently there is an increase in risk of falling and fall incidence [1]. Falls in India showed annual falls rates for older adults between 14 and 51 % [2]. Loss of self- confidence, social isolation, increased dependence on others caused due to fear of fall are among the major consequences faced by elderly in day to day life [3]. In 10 to 20% of the cases, falls result in bone fractures and head injuries and can lead to increased mortality. It may not be possible to prevent falls completely, but

people who tend to fall frequently may be enabled to fall less often[26].

The fact that causes of falls are multifactorial loses in lower extremity muscle strength, power and balance seem to be the most prominent intrinsic (i.e. .personal - related) fall risk factor in older adults [4,5]. However, the effects of resistance training are limited and poorly translate into the improvement in balance, functional tasks, activities of daily living and fall rates. Recent studies indicates that measures of trunk muscle strength are associated with variables of static/dynamic balance, functional performance and fall [6]. Balance is important for maintaining postural equilibrium and thus for the avoidance of fall [7].

Programs designed to improve balance and prevent falls and also prevent injuries falls, including those that cause fractures or other severe physical injuries and can also reduce the rate of falls leading to medical care [8].

In geriatric population, balance disorders are multifactorial condition caused due to core muscle weakness, altered muscle activation pattern, inability to control postural sway and most commonly due loss of proprioception. Inability to control normal postural sway in older adults leads to injuries through falls, limits independence, reduces Quality of life and can even lead to death. In geriatric population, there is loss of balance, postural instability and affected gait due to impaired cognitive function mainly due to deficit in sensory, visual, vestibular, somatosensory inputs and likewise loss of muscle strength in lower limb result in postural instability leading to frequent fall incidence [3]

This study aimed to estimate the incidence of falls among the elderly and to determine the predictive factors of falls and recurrent falls. The increased occurrence of falls among the elderly can lead do impairment in elderly health and negative impact on the quality of life, in addition to fear of further falls. This study needs to understand better the predictive factors of falls in the elderly, this study aimed to estimate the incidence of the fall among elderly in community and to determine the predictive factors of falls and recurrent falls [9]

Falls, as a major public health issue, have attracted the attention of many researchers. For older individuals, multiple factors and complications are associated with falls such as obesity, low lower-limb muscle quality and impaired postural control [31].

Resistance exercise training interventions have the potential to counteract the age-related decline of mobility among older adults [32] Lower extremity muscle power is also a more influential determinant of falls, which accelerate other adverse outcomes in older populations, including disability and mortality. Because of the significant relationship between impairments in lower extremity muscle power and mobility-related tasks, we hypothesized that mobility-limited older adults would have significantly greater reductions in lower extremity muscle power compared to healthy older adults.[33]

Resistance training has positive effects on measures of muscle strength and balance in older adults. Combinations of resistance and balance training describe in general a consecutive order, where resistance and balance exercises are executed within the same training session or within the same training block. Those exercise interventions have also shown positive effects on measures of strength, power and balance in older adults. Besides resistance training and balance training applied as a single means and the combination therefore, resistance training conducted on unstable surfaces (unstable resistance training) poses an alternative or complimentary means to improve measures of strength, power and balance[1]

The study is to determine the effectiveness of multifactorial intervention program to prevent fall among older adults [10]. Several studies on falls and balance deficits have reported that physical therapy interventions has reduced falls risk and improved balance in debilitated and medically compromised older adults and others shown improvement

in balance and reduction in falls risk in community- dwelling older adults with supervised group exercise and complementary home exercise programme. Physical therapy interventions can have a positive influence on several modifiable risk factors including muscle weakness and deficits in balance and gait. [11]

The study was conducted to check the effectiveness of lower extremity resistance training on unstable surfaces verses stable surface to prevent fall in healthy older adults.

MATERIALS & METHODS

Approval of the study was given by the institution ethical committee of Nanded Physiotherapy College and Research Centre. Prior to starting the study, a written consent form was taken from all the healthy older adults gathered by convenient sampling method in languages best understood by them. The study was conducted to check the effects of lower extremity resistance training on unstable surface versus stable surface to prevent fall in healthy older adults. Total 48 number of participants were taken and the participants divided into two groups by convenient sampling method:

Group A) Lower extremity resistance training on unstable surface.

Group B) Lower extremity resistance training on stable surface.

Then, taken pre-assessment of participants by using functional reach test and berg balance scale.

After taking pre-assessment. Pre - intervention score should be noted and then administered exercise for lower extremity resistance training on unstable surface such as-double leg stance, single leg stance, mini-squats, marching, bridging. These five types of exercise were taken on Bosu ball for group A participants for 8 repetitions per set, 2 sets, 1 time a day, 2 days a week for 4 week.

EXERCISE WERE TAKEN ON BOSU BALL FOR GROUP A PARTICIPANTS:

1)Double leg stance. 2) Single leg stance 3) Marching



4) Mini-squats 5) Bridging

.


EXERCISE WERE TAKEN ON FLOOR FOR GROUP B PARTICIPANTS

1)Double leg stance

2) Single leg stance

3)Marching

4) Mini-squats

5) Bridging

After taken all the exercise on unstable and stable surface. Take post - assessment of all the participants after 4 week of treatment, using functional reach test and berg balance scale.

STATISTICAL ANALYSIS

Data analysis was done using the Statistical Package for Social Sciences (SPSS version 21). Basic descriptions were presented in the form of mean and Standard deviation. The data were assessed for normality using the Wilcoxon test.

Paired Sample t test was used to analyze the pre and post differences for all parameters. The level of significance was set at $p< 0.05$ for all tests. This study was analyzed in terms improved balance in Functional Reach Test and improved berg balance score. This showed extremely significant improvement in all the parameters post-treatment in both the groups.

The statistical analysis showed the mean values for FRT were 7.91 pre-treatment and 9.16 post-treatment in lower extremity resistance training on unstable surface and in lower extremity resistance training on stable surface it was 6.91 pretreatment and 9.29 post- treatment.

The mean values for BBS were 42.45 pre-treatment and 45.12 post-treatment in lower extremity resistance training on unstable surface and 36.29 pre-treatment and 42.66 post-treatment in lower extremity resistance training on stable surface.

The mean difference for FRT was -1.250 in lower extremity resistance training on unstable surface and -2.375 in lower extremity resistance training on stable surface; BBS the mean difference was -2.667 in lower extremity resistance training on unstable surface and -6.375 in lower extremity resistance training on stable surface.

After comparison of the pre and post data, we got the result that lower extremity resistance training on unstable surface were more effective than lower extremity resistance training on stable surface in improving strength, balance and prevent fall in healthy older adults.

The p value for all the parameters in both the groups were less than 0.001, which indicates that the results are highly significant. However, within both the groups we could conclude that, lower extremity resistance training on unstable surface was more effective, as the mean difference for all the parameters was more in lower extremity resistance training on unstable surface as compared to lower extremity resistance training on stable surface.

As a result, we found that, although the post-treatment results were highly significant in both the groups, the participants in the lower extremity resistance training on unstable surface performed better than those in the lower extremity resistance training on stable surface.

Unaired Sample t' test was used to analyse the pre-pre and post-post differences for all parameters.

The statistical analysis of unpaired t test showed the mean values for FRT were 7.91 and 6.91 pre-treatment and 9.16 and 9.29 post treatment in lower extremity resistance training on unstable and stable surface respectively.

The mean values for BBS were 42.04 and 36.29 pre-treatment and 44.70 and 42.66 post-treatment in lower extremity resistance training on unstable and stable surface respectively.

After comparison of pre- intervention and post- intervention data of lower extremity resistance training on unstable surface and stable surface , we got the result that lower extremity resistance training on unstable surface was more effective than lower extremity resistance training on stable surface to improve strength, balance and to prevent fall in healthy older adults.

RESULT

The study was conducted with two groups. Group A has undergone lower extremity resistance training on unstable surface and Group B undergone lower extremity resistance training on stable surface. Total sample size was 48, 24 in each group. Result of this study were analyzed in terms to improve strength, balance and to prevent fall in healthy older adults. Paired ‘t’ test and unpaired ‘t’ test were used to analyze the pre and post differences for FRT and BBS score. The level of significance was set at $p<0.05$ for all tests. Paired sample ‘t’ test showed significant improvement in FRT and BBS score. Post treatment in both group but unpaired ‘t’ test is showing insignificant results in FRT and BBS score.

Table 1: Pre-post comparison of FRT on unstable surface.

Sr. No.	Outcome variable	Pre-mean ± SD	Post-mean ± SD	Mean difference	't' Value	'p' Value
01	FRT	7.916 ± 1.886	9.166 ± 2.120	- 1.250	6.191	< 0.0001

Paired Sample't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)

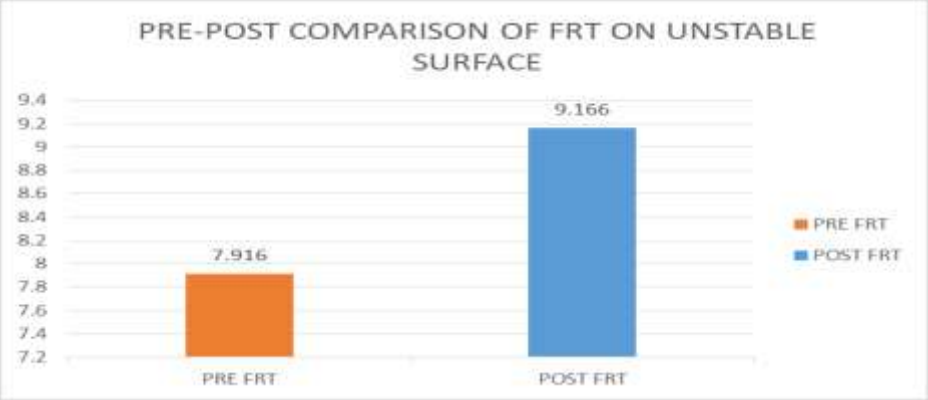


Table 2: Pre-post comparison of BBS on unstable surface.

Sr. No.	Outcome variable	Pre-mean ± SD	Post-mean ± SD	Mean difference	't' Value	'p' Value
01	BBS	42.458 ± 6.372	45.125 ± 5.980	- 2.667	10.540	< 0.0001

Paired Sample't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)

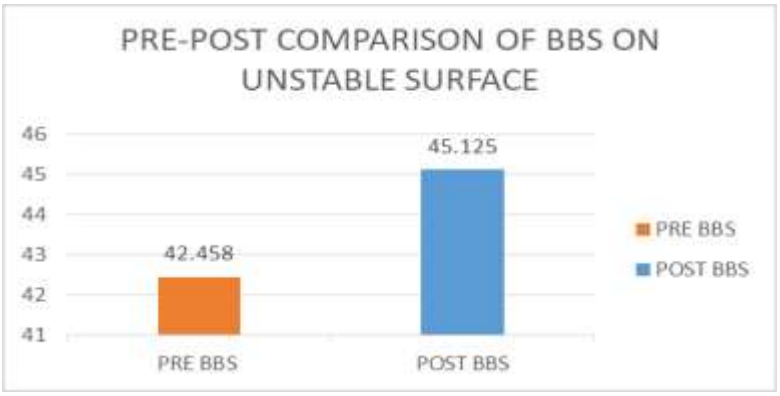


Table 3: Pre-post comparison of FRT on stable surface.

Sr. No.	Outcome variable	Pre-mean ± SD	Post-mean ± SD	Mean difference	't' Value	'p' Value
01	FRT	6.916 ± 1.954	9.291 ± 2.896	- 2.375	6.253	< 0.0001

Paired Sample't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)

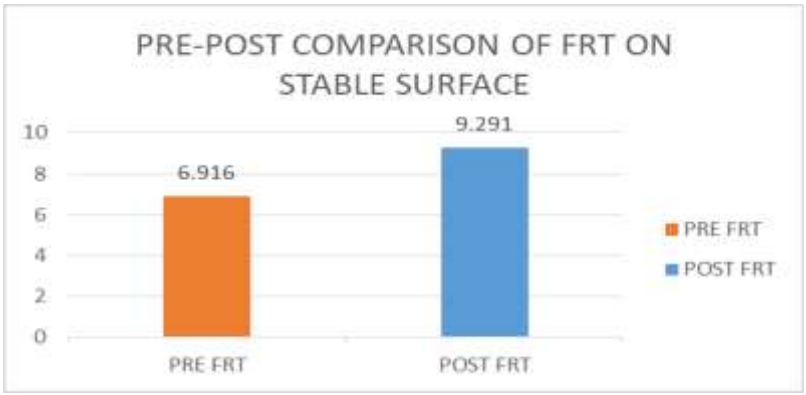


Table 4: Pre-post comparison of BBS on stable surface.

Sr. No.	Outcome variable	Pre-mean ± SD	Post-mean ± SD	Mean difference	't' Value	'p' Value
01	BBS	36.291 ± 7.760	42.666 ± 7.487	- 6.375	7.400	< 0.0001

Paired Sample 't' Test: *P < 0.05 (Significant), **P > 0.05 (Not Significant)

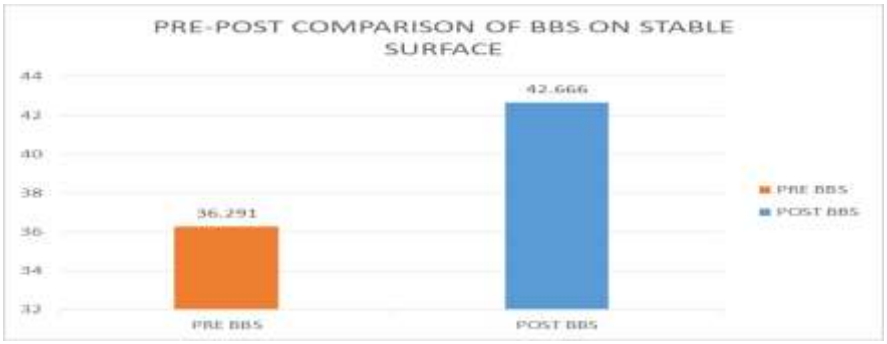


Table 5: Pre-post comparison of FRT & BBS on unstable surface.

Sr. No.	Outcome variable	Mean ± SD	Mean difference	't' Value	'p' Value
1	FRT				
	PRE	7.916 ± 1.886	-1.250	6.191	< 0.0001
	POST	9.166 ± 2.120	-1.250	6.191	< 0.0001
2	BBS				
	PRE	42.458 ± 6.372	-2.667	10.540	< 0.0001
	POST	45.125 ± 5.980	-2.667	10.540	< 0.0001

Paired Sample 't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)

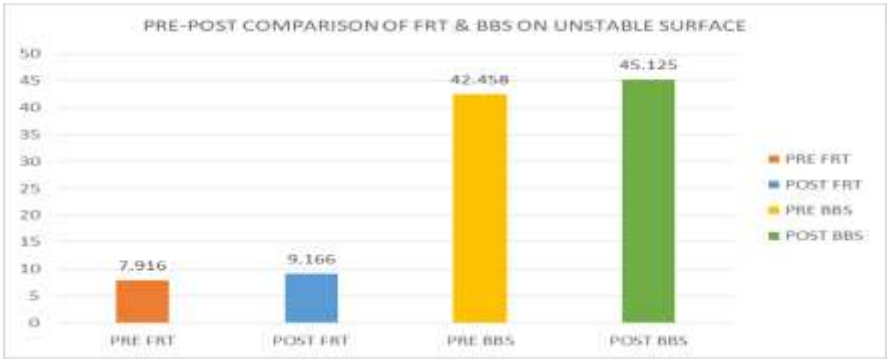


Table 6: Pre-post comparison of FRT & BBS on stable surface.

Sr. No.	Outcome variable	Mean ± SD	Mean difference	't' Value	'p' Value
1	FRT				
	PRE	6.916 ± 1.954	-2.375	6.253	< 0.0001
	POST	9.291 ± 2.896	-2.375	6.253	< 0.0001
2	BBS				
	PRE	36.291 ± 7.760	-6.375	7.400	< 0.0001
	POST	45.125 ± 7.487	-6.375	7.400	< 0.0001

Paired Sample 't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)

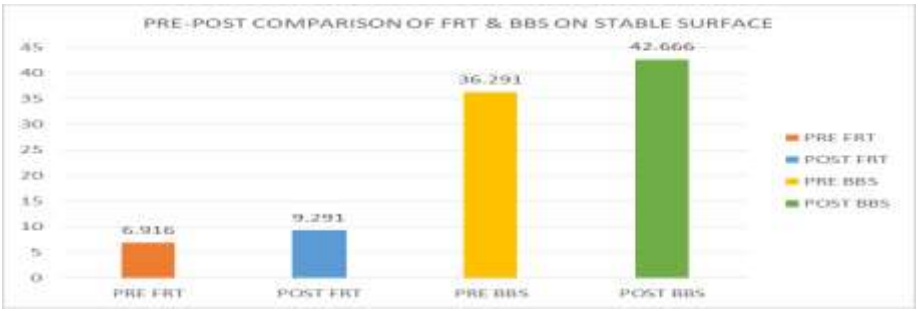


Table 7: Pre comparison of FRT & BBS on unstable & stable surface.

Site	Mean ± SD	Mean Difference	't' Value	'p' Value
FRT				
Unstable	7.916 ± 1.886	1.250	2.158	0.0362
Stable	6.916 ± 1.954	2.374	3.329	0.0017
BBS				
Unstable	42.041 ± 6.590	2.667	1.445	0.1552
Stable	36.291 ± 7.760	6.375	2.896	0.0058

Unpaired sample t test: *P<0.05 (significant), **p >0.05(not significant)

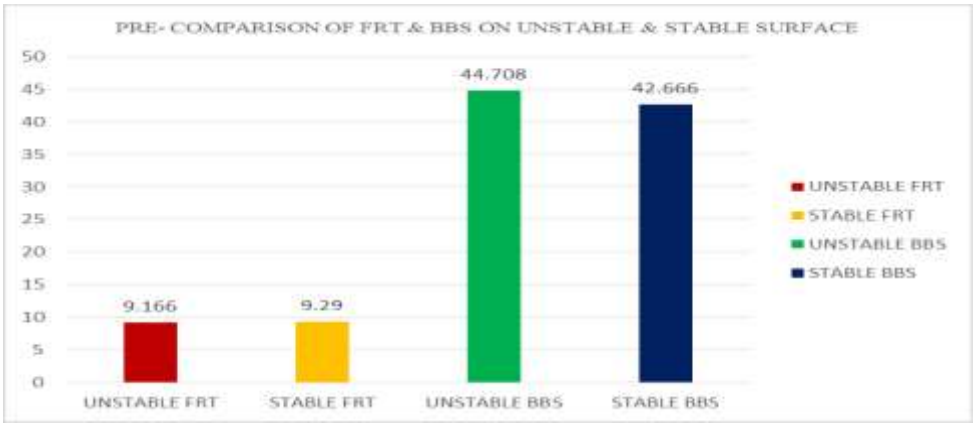


Table 8: Post comparison of FRT & BBS on unstable & stable surface.

Site	Mean ± SD	Mean Difference	't' Value	'p' Value
FRT				
Unstable	9.166 ± 2.120	1.250	2.158	0.0362
Stable	9.29 ± 2.896	2.374	3.329	0.0017
BBS				
Unstable	44.608 ± 6.189	2.667	1.445	0.1552
Stable	42.66 ± 7.487	6.375	2.896	0.0058

Unpaired sample t test: *P<0.05 (significant),p >0.05(not significant)**

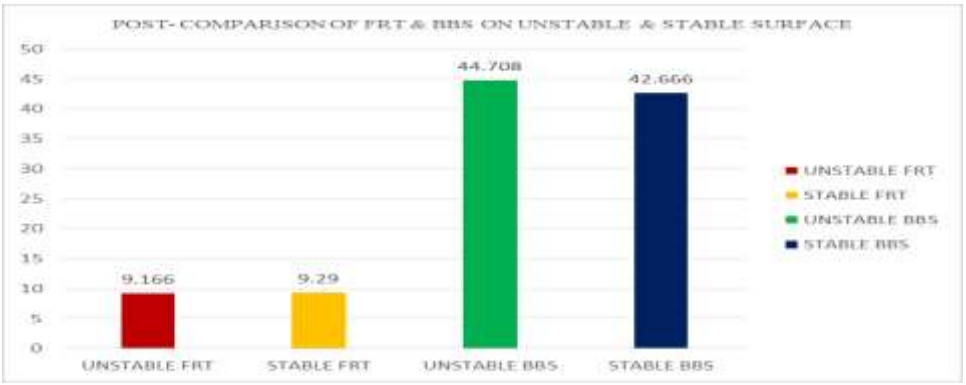
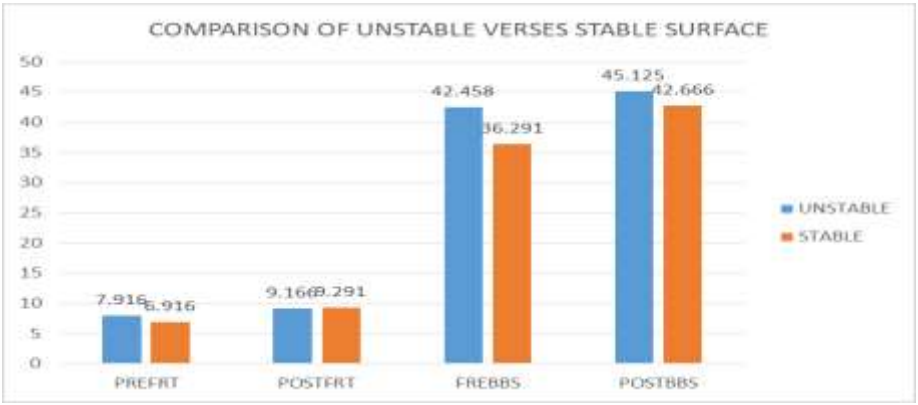


Table 9: Pre post comparison of FRT & BBS on unstable verses stable surface

Site	Pre-mean ± SD	Post-mean± SD	Mean Difference	"t" value	"p" Value
FRT					
UNSTABLE	7.916 ± 1.886	9.166 ± 2.120	-1.250	6.191	<0.0001
STABLE	6.916 ± 1.954	9.291 ± 2.896	-2.375	6.253	<0.0001
BBS					
UNSTABLE	42.458 ± 6.372	45.125 ± 5.980	-2.667	10.540	<0.0001
STABLE	36.291 ± 7.760	42.666 ± 4.487	-6.375	7.400	<0.0001

Paired Sample 't' Test: *P < 0.05(Significant), **P > 0.05 (Not Significant)



DISCUSSION

In the course of ageing, physical abilities decline, and consequently, there is an increase in risk of falling and fall incidents [1]. Fall in India showed annual fall rate for older adult of between 14 and 51 %[2]. The increase the occurrence of falls among the elderly, can lead to impairment in elderly health and negative impact on the quality of life, in addition to fear of further falls [9]. This study was conducted to compare and to check the effects of lower extremity resistance training on unstable v/s stable surface to prevent fall in healthy older adults. The result of the current study revealed that the effects of lower extremity resistance training on unstable surface is more effective than lower extremity resistance training on stable surface.

Manal Anthikat (2021) conducted an exercise on wobble board and bosu ball among older adults. The study concludes that BOSU ball exercise is more effective in improving balance, fear of fall and has a positive effect on the quality of life than wobble board exercise in geriatric population. The results were found to be statistically highly significant within the groups ($p<0.001$) for all parameters in improving balance, fear of fall and has a positive effect on the quality of life [3].

Monika Btaszczyszyn (2019) the study was conducted for Analysis of Ankle sEMG on Both Stable and Unstable Surfaces for Elderly and Young Women. This study concludes that, Ankle strategy training can be useful for the elderly population to improve the function of their lower limb muscles, thereby increasing their ability to keep their balance [17].

Hirase, Tatsuya PT (2015) in this study give Balance Training Program Using a Foam Rubber Pad in Community-Based Older Adults. This study concludes that balance training in older adults performed using a foam rubber pad is effective for improving balance ability, and that this improvement occurs 2 months earlier compared with balance training performed on a stable surface. The results were found to be statistically highly significant ($p<0.001$) for all parameters in improving balance, fear of fall [23].

Nicole Kahle et al. (2014) Core muscle strengthening's conducted for improvement of balance performance in community-dwelling older adults and the study conclude that core strengthening should be part of a comprehensive balance-training program for older adults[28].

Yves J Gschwind et al. (2013) The study practice fall prevention exercise program to improve balance, strength / power, and psychosocial health in older adults and this study conclude that particularly the supervised combination of balance and strength / power training will improve performance in variables of balance, strength / power, body composition, cognitive function, psychosocial well-being, and falls self-efficacy of older adults [7].

Martínez-Amat (2013). This study conducted to check the effects of 12-Week Proprioception Training Program on Postural Stability, Gait, and Balance in Older Adults and the study conclude that 12 weeks proprioception training program in older adults is effective in postural stability, static, and dynamic balance and could lead to an improvement in gait and balance capacity, and to a decrease in the risk of falling in adults aged 65 years and older [20].

Michael Drey et al. (2012) to study the effects of strength training versus power training on physical performance in prefrail community-dwelling older adults. Strength training and power training given to the older people and this study conclude that Power training is not superior to Strength training, although both training modes resulted in significant improvements in physical performance [27].

Anne-Gabrielle Mittaz Hager (2019). In this study to check the effects of three home-based exercise programmes regarding falls, quality of life and exercise-adherence in older adults at risk of falling. And this study conclude that home-based exercises programmes show positive effects in fall prevention in elderly persons [26].

André Lacroix et al. (2016) this study is to check the effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults. And this study conclude that supervised as compared to unsupervised balance and strength training was more effective [15].

Nils Eckardt (2016). This study conducted in community dwelling older adults to improve Lower-extremity resistance training on unstable surfaces improves proxies of muscle strength, power and balance in healthy older adults. This study concludes that, Free weight - unstable resistance training seems an effective and safe alternative training program to mitigate intrinsic fall risk factors in older adults [1].

There are currently no studies available that evaluated the effects of resistance training on stable versus unstable surfaces, on measures of lower-extremity muscle strength, power and balance in older adults [1].

Some studies that examined the effect of unstable resistance training in older adults found meaningful improvement in majors of strength, power and balance. Other study used an unstable device to strengthen lower extremities. None of these studies compared the effect of unstable resistance training to stable resistance training. Some recent studies, comparing unstable resistance training and stable resistance training where found for young adults, but not for older adults. so, in the study we can compare and check the adherence of lower extremity resistance training on unstable surface versus stable surface to prevent fall in healthy older adults.

Exercise is fundamental intervention tool in improving functional ability and quality of life. The recommended exercise program for older adults includes aerobic, balance and strength exercises with main objective of promoting functional abilities and preventing chronic diseases and falls.

CONCLUSION

The study concludes that lower extremity resistance training on unstable surface is more effective than lower extremity resistance training on stable surface to prevent fall in healthy older adults.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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