RESEARCH
O&G Forum 2024; 34 – 3s : 2369-2375

EFFECT OF SQUAT TRAINING TO IMPROVE STATIC STANDING BALANCE IN ELDERLY

Dr. Pramod J Palekar[1*], Muskaan Kalra[2], Dr. Tushar J Palekar[3], Dr. Soumik Basu[4]
[1,4] Associate Professor, Dr. D.Y.Patil College of Physiotherapy, Pimpri, Pune, India
[2] Intern, Dr. D.Y.Patil College of Physiotherapy, Pimpri, Pune, India
[3] Dean and Principal, Dr. D.Y.Patil College of Physiotherapy, Pimpri, Pune, India

Abstract
Introduction: Aging population with musculoskeletal impairments who are having balance-related difficulties leading to a decrease in their confidence and social withdrawal due to fear of falls. Squatting contains elements of everyday functional movements. This study will help us to know whether squat training improves balance and reduces the fear of falls.
Aim: To find out the effect of squat training to improve static standing balance in the elderly.
Materials and Methods: The experimental study was conducted at Dr. D.Y. Patil College of Physiotherapy, Pune, Maharashtra, India between August 2022 to January 2023, which included 30 healthy elderly participants of age ranging between 65 to 79 years. Subjects were trained for two weeks (five days per week) with wall squats in the first week and BOSU ball squats in the second week. Pre and post-Fall Efficacy Scale (FES)scores and weight-bearing squat test values on NeuroCom Balance master were assessed.
Results: Mean age of the study was 69.10. The weight-bearing squat value of the left side (0.011) showed significant improvement at 60^0 with the p-value <0.05. The FES scores showed significance with a p-valueof 0.0001 which is <0.05.
Conclusion: Squat training which included wall squats and BOSU ball squats showed improvement in static balance and reduced fear of falls. Hence this training can be used for elderly populations with proper precautions.
Keywords: Aging, Falling, Wall Squats, Elderly.

INTRODUCTION

The capacity or ability to gather proprioceptive and sensory information about one's position in space and to trigger the right motor response to regulate movement of the body is known as balance. When this ability deteriorates as a result of disease or the natural ageing process, the elderly is more likely to fall.[1]

Aging is a multifaceted process marked by changes at the molecular, cellular, and organ levels as a result of which the body's ability to respond correctly to external and internal stimuli alters in a systematic, predictable, and inevitable manner. Previous research has also shown that around the age of 60, the risk of falling increases by nearly 35-40% due to decreased strength, flexibility, and balance. This has an impact on the elderly's functional independence and quality of life.[2]

Balance control deteriorates with age due to changes in the vestibular, ocular, somatosensory, musculoskeletal, and central neurological systems.[3]

The capacity to maintain an erect posture and to retain the line of gravity within the confines of the base of support is known as static balance. Dynamic balance is defined as the capacity of the body to maintain stability while weight shifting and often while changing the base of support.[4]

A fundamental movement pattern, the squat demands stability in the foot, knee, and lumbar spine in addition to mobility in the hip, thoracic spine, and ankle. It has been suggested that a fair measure of overall movement quality is the capacity to execute a bodyweight squat at or below 90° of knee flexion with appropriate symmetry and coordination. In contrast, the inability to perform a bodyweight squat with symmetry and control at or below 90° of knee flexion may indicate generalized stiffness throughout the body, as well as restricted joint mobility and/or stability. [5] The squat strengthens the muscles of the lower limb and improves the ability to counteract medial or lateral knee displacement.[6]

The study tool utilized to assess Balance Master's potential for clinical use is a kinesiometric platform. The findings demonstrate the widespread use of the Neuro Com Balancer Master platform in clinical trials, particularly in the context of medical rehabilitation in sports. It is employed for a number of purposes, including estimating postural stability, tracking and assessing treatment outcomes, predicting lower limb injuries and fall risks, and comparing results with conventional balance assessment tests across all age groups.[7]

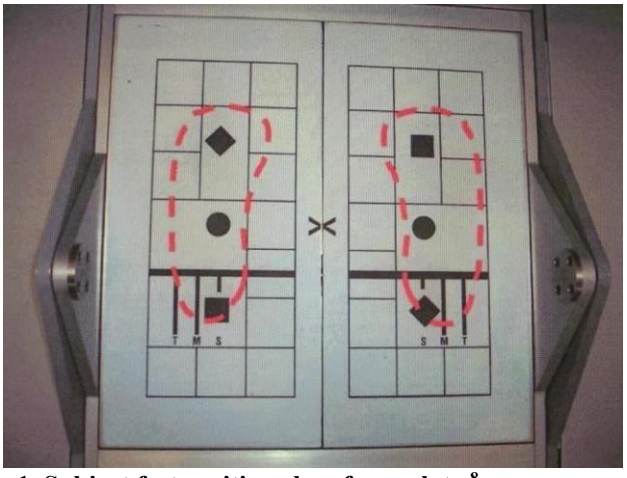


Fig 1. Subject feet positioned on force plate [8]

Impaired walking ability, balance/postural control, and lower limb muscle strength and power have all been found to be significant risk factors for falls. However, it's important to understand the difference between muscle power and strength. Muscle power, also known as force-velocity, is the product of force and speed; it's related to falling, whereas muscle strength is the maximum force a muscle can produce against a given resistance. Therefore, increasing muscle power rather than strength is probably more crucial for preventing falls.[9]

Fall prevention is aided by exercise that increases muscle strength and balance. A progressive loss of muscle strength and functional ability can contribute to fall prevention in the elderly.[10]

BOSU ball was first invented by a personal trainer, which stands for "Both Sides Up." It is crucial for maintaining balance and increasing functional fitness in the elderly population.

NEED OF STUDY

Aging population with musculoskeletal impairments who are having balance related difficulties leading to decrease in their confidence and social withdrawal due to fear of fall. The physiological changes and other reasons such as weakness, loss of muscle strength, muscle atrophy, change in muscle tone occurs due to different kinds of musculoskeletal conditions. Aging population has fear of fall due to difficulties in maintaining balance for which this study will help us to know whether the squat training improves balance and reduces fear of fall.

Squatting comprises components of everyday functional movements such as walking, ascending and descending stairs, sitting down and standing up. This study was to find out if wall squat training and squats on BOSU ball improves static standing balance which may improve stability of the patient and overcome the fear of fall.

AIMS AND OBJECTIVES

Aim: To see the effect of squat training in elderly population.

Objectives

1. To see the effect of wall squats and squats on BOSU ball in elderly people.
2. To assess the level of fear of fall.

REVIEW OF LITERATURE

1. **Zouita, s & ZOUHAL et al (2021)** conducted a study titled "Effects of Combined Balance and Strength Training on Measures of Balance and Muscle Strength in Older Women with a History of Falls" which showed that the higher positive effects of training seen in standing balance tests compared to dynamic tests suggests that balance training exercises such as lateral, forward, and backward exercises improved static balance in older women to a greater extent.
2. **D, REBECCA et al (2020)** conducted a study titled "Efficacy of Otago exercise versus Bosu ball exercise in balance-impaired elderly people" which showed that both BOSU ball exercise and OTAGO exercise were effective in improving balance among elderly people. However, BOSU ball exercise was better than OTAGO exercise in improving balance among elderly people.
3. **Andrea Biscarini (2020)** conducted a titled "Joint Torques and Tibiofemoral Joint Reaction Force in the Bodyweight Wall Squat Therapeutic Exercise" in which the study provides an in-depth biomechanical analysis of the bodyweight wall-squat exercise, which takes in consideration all the relevant exercise variants. With the results of this study, trainers and therapists might manage the wall squat exercise to finely modulate the lower-limb joint torques and to minimize the shear component of the tibiofemoral joint reaction force.
4. **Muyinat Y. Osoba(2019)** conducted a study titled "Balance and gait in the eldeíly: A contempoíaíy íeview" which showed that balance and gait distuíbances aíe common with age and have a significant impact on the wellbeing of oldeí adults. ľhe decline of sensoíy systems in eldeíly adults has been linked to theií íeduced ability to adapt to changes in theií enviíonment and maintain balance; the visual system is especially impoítant in maintaining postuíal stability.
5. **Sung-hoon Jung, Ui-jae Hwang et al (2019)** conducted a study titled "Relationship Between Lower Extremity Extensor Strength and Wall Squat Performance" in which they concluded that that hip extensor strength normalized by body weight is proportionally related with WSP. Thus, it could be concludedthat hip extensor strengthnormalized by body weight is important factor for Wall squat performance (WSP) in males and females. Therefore, it is recommended that rehabilitation programsdesignedfor improving WSP shouldfocus on strengthening hip extensor strength considering body weight.
6. **Tomohiro Osugi et al (2014)** conducted a study titled "Effect of a combination of whole- body vibration exercise and squat training on body balance, muscle power, and walking ability in the elderly" which showed that WBV exercise plus squat training was more effective for improving tandem gait step number and chair-rising time compared with WBV exercise alone. These results suggest the benefit and safety of WBV exercise plus squat training for improving physical function in terms of body balance and muscle power in the elderly.
7. **F. Yamashita, J. Iwamoto et al (2012)** conducted a study titled "Chair rising exercise is more effective than one-leg standing exercise in improving dynamic body balance" who found that for increasing walking speed and dynamic body balance, the chair-rising exercise was superior to the one-leg standing exercise.
8. **E Hinds et al (2011)** conducted a study titled "The additional effects of Swiss ball use during the wall squat exercise on lower limb muscle activity" which showed that some of the lower limb muscles are work harder when the Swiss ball is added to the wall squat workout. However, it appears that the results vary depending on the muscles targeted and the degree of knee flexion used during the exercise. The study shows that the Swiss ball does play a role in raising the muscular activity of some specific muscles, but it cannot be generalized as a way to increase lower limb muscle activity during the wall squat.

MATERIALS AND METHODOLOGY

Research Design:

1. STUDY DESIGN: Experimental study
2. STUDY SETTING: Tertiary health care center
3. TARGET POPULATION: Patients with loss of balance and fear of fall

Sample Population:

1. SAMPLE METHOD: PURPOSIVE METHOD
2. SAMPLE SIZE: 30

Inclusion:
1. Age group above 65 years
2. Both genders population (males and females)
3. Patients with musculoskeletal conditions.
4. Patients who have history of loss of balance in past 1 year
5. Patients who have fear of fall

Exclusion:
1. Patients with visual or vestibular impairments
2. Patients with history of cardiovascular and recent surgeries
3. Patients with history of epilepsy

Outcome Measure:
Fall efficacy scale (FES) – measure of fear of falling
NeuroCom Balance Master™ – to measure the weight bearing squat component

Materials required:
1. Consent form
2. Data collection sheet
3. Stationary (pen, paper, writing pad)
4. BOSU ball

Procedure:
- Approval from the Institutional Ethical Committee was taken.
- Participants were selected according to inclusion criteria
- Patient's core strength, height, weight, BMI, knee and hip ROM, MMT and the FESscore were checked.
- Pre training values of weight bearing squat at 0°, 30^0,60^0,90^0 degrees were computed using weight bearing squat component on Neurocom balance master™.
- The patients were briefed about the technique and squat training was done for 2 weeks
- In the first week patients were given training of wall squats.
- In the second week training squats on BOSU ball was given.
- After completion of 2 weeks, post training effect of squat was checked using NeuroCom Balance master™.

Fig-2: Wall Squats

Fig-3: Bosu Ball Squats

STATISTICAL ANALYSIS

Table No. 1: Age Group Distribution

	SD	MEAN
AGE	±5.29	69.10

Diagram No 1

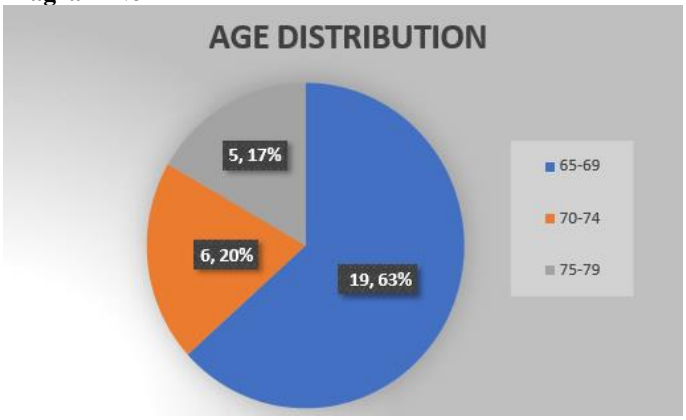
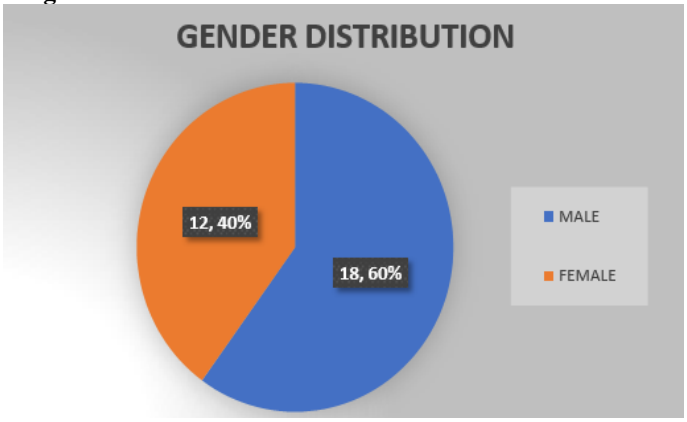


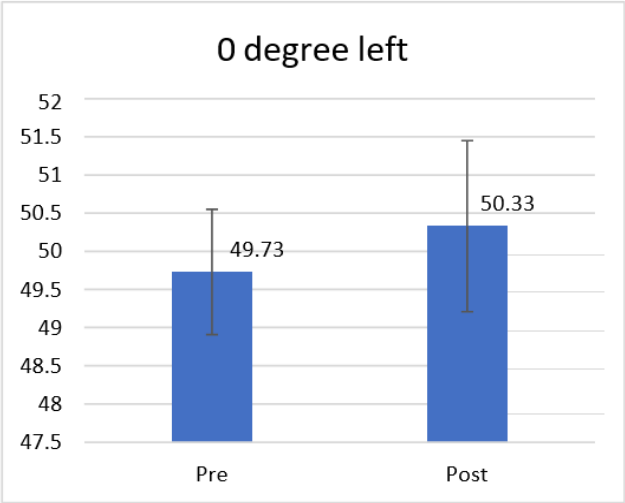
Diagram No. 2



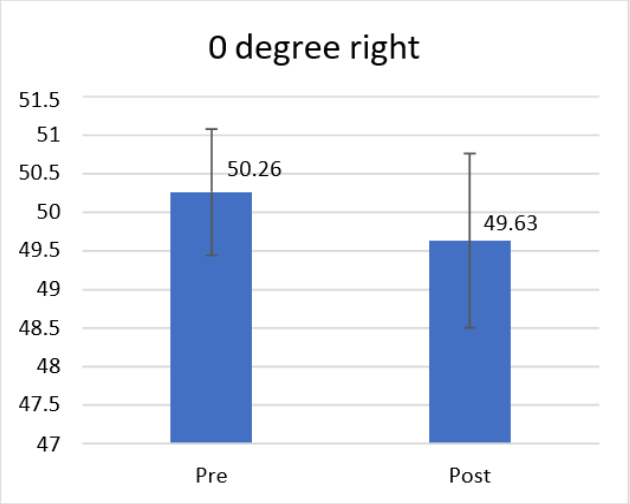
WEIGHT BEARING SQUAT ASSESSMENT

Table 2: Pre and Post Values of Weight Bearing Squats At 0^0

	Pre			Post			P value	z-value
	Mean+/-SD	Standard error	Median	Mean+/-SD	Standard error	Median		
Left 00	49.73+/-4.49	0.82	51.00	50.33+/-6.17	1.12	50.5	0.465	-0.72
Right 00	50.26+/-4.49	0.82	49.00	49.63+/-6.21	1.13	49.5	0.441	-0.77



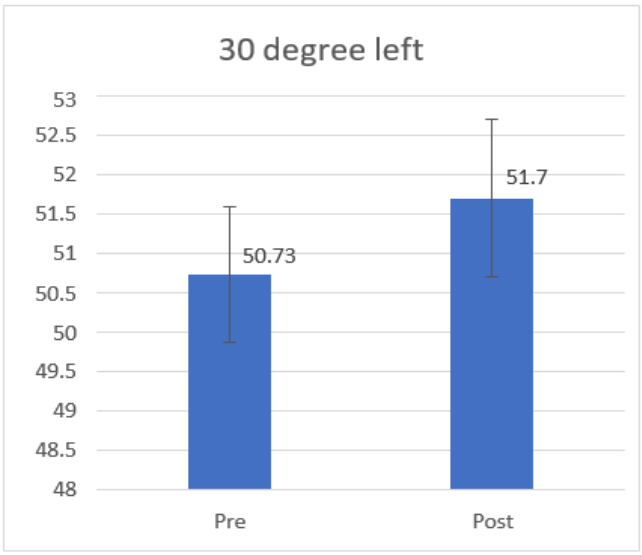
Graph 1.1



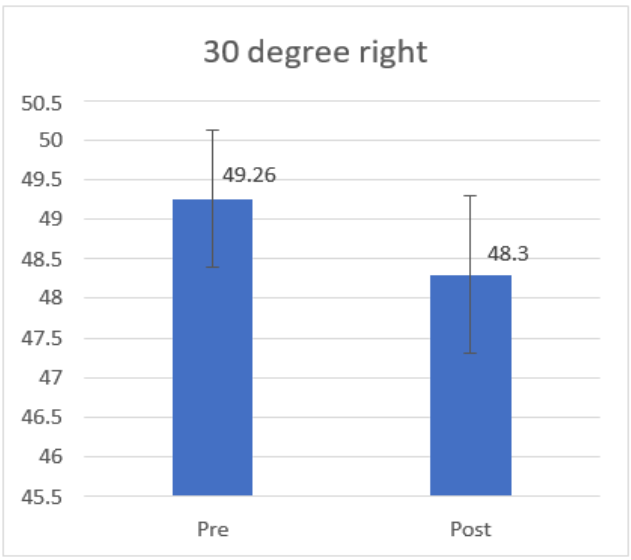
Graph 1.2

Table 3: Pre and Post Values of Weight Bearing Squats At 30^0

	Pre			Post			P value	z-value
	Mean+/-SD	Standard error	Median	Mean+/-SD	Standard error	Median		
Left 30^0	50.73+/-4.77	0.87	51.00	51.70+/-5.47	1.00	52.5	0.238	-1.17
Right 30^0	49.26+/-4.77	0.87	49.00	48.30+/-5.47	1.00	47.5	0.341	-0.94



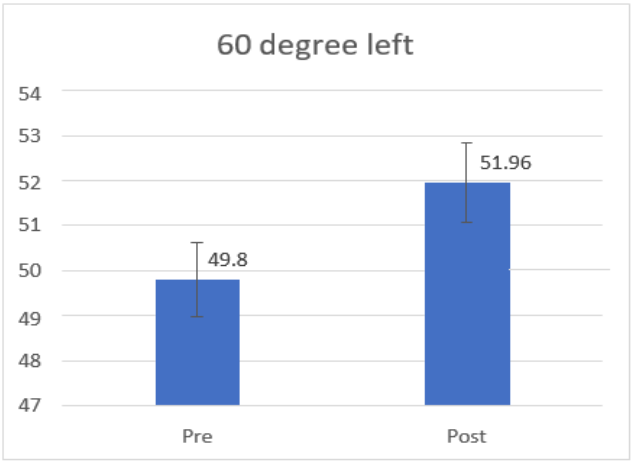
Graph 2.1



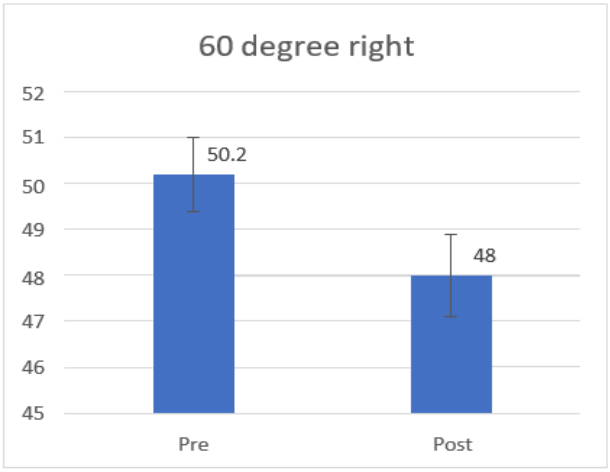
Graph 2.2

Table 4: Pre and Post Values of Weight Bearing Squats At 60^0

	Pre			Post			P value	Z-value
	Mean+/-SD	Standard error	Median	Mean+/-SD	Standard error	Median		
Left 60^0	49.80+/-4.48	0.81	49.00	51.96+/-4.85	0.88	52.5	0.011*	-2.53
Right 60^0	50.20+/-4.48	0.81	51.00	48.00+/-4.87	0.89	47.5	0.009	-2.57



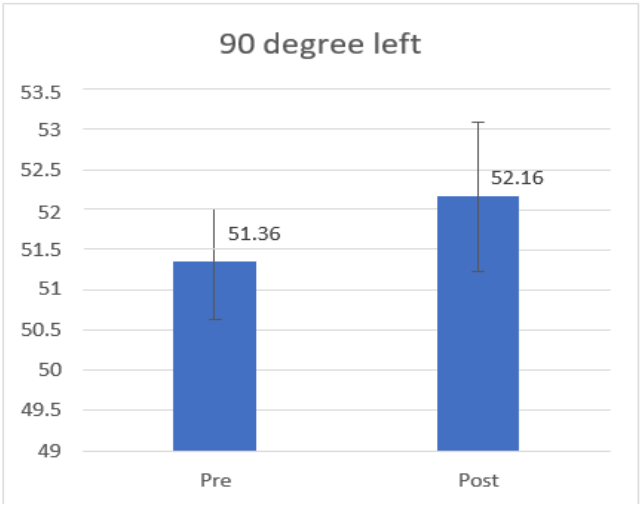
Graph 3.1



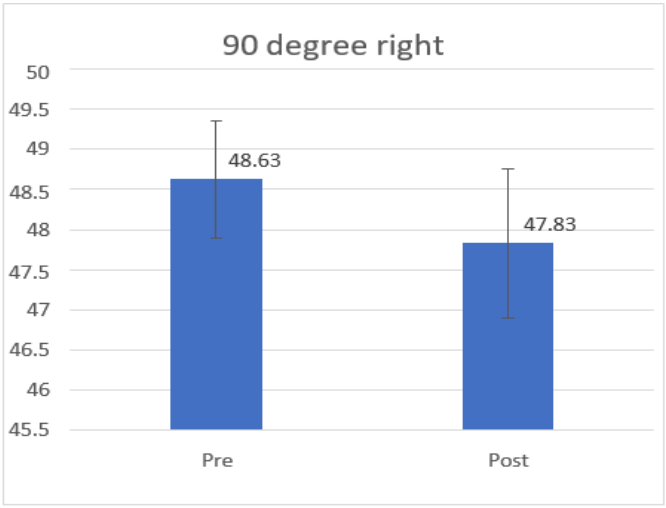
Graph 3.2

Table 5: Pre and Post Values of Weight Bearing Squats At 90^0

	Pre			Post			P value	z-value
	Mean+/-SD	Standard error	Median	Mean+/-SD	Standard error	Median		
Left 90^0	51.36+/-4.02	0.73	51.00	52.16+/-5.13	0.93	52.00	0.352	-0.93
Right 90^0	48.63+/-4.02	0.73	49.00	47.83+/-5.13	0.93	48.00	0.352	-0.93



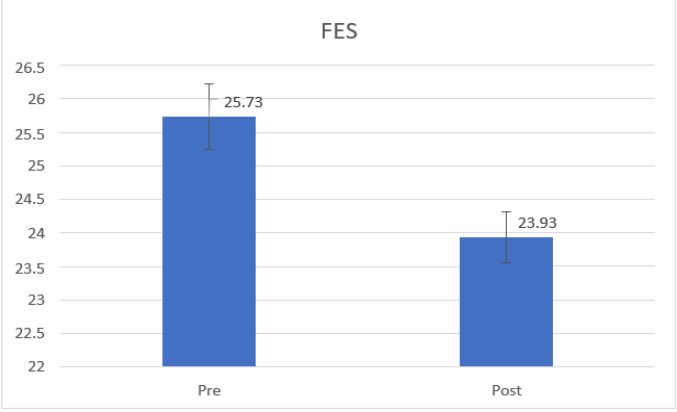
Graph 4.1



Graph 4.2

Table 5: Pre and Post Values of Fes

	Pre			**Post**			**P value**	**z-value**
	Mean+/-SD	**Standard error**	**Median**	**Mean+/-SD**	**Standard error**	**Median**		
FES Score	25.73+/-2.71	0.49	25.00	23.93+/-2.13	0.38	24.00	<0.0001*	-4.19



Graph 5

RESULTS

Table 1 shows age distribution in which the mean age is 69.10. In the diagram no 2 it shows that out of 30 participants there were 19 participants in the age group between (65-69), 6 participants between the age group of (70-74) and 5 participants between the age group of (75-79).

Diagram 2 shows the gender distribution in which out of 30 participants 12 participants (40%) are females and 18 participants (60%) are male.

Table 2 and graph 1.1 & 1.2 shows pre and post values of left and right weight bearing squat at 0^0 angle. In this the values of weight bearing squats of both left and right side 0.465 and 0.441 are statistically not significant with p value not <0.05.

Table 3 and graph 2.1 & 2.2 shows pre and post values of left and right weight bearing squat at 30^0 angles. In this the values of weight bearing squats of both left and right side 0.238 and 0.341 respectively are statistically not significant with p value <0.05.
Table 4 and graph 3.1 & 3.2 shows pre and post values of left and right weight bearing squat at 60^0 angles. In this the values of weight bearing squats of left side pre and post are statistically significant with p value 0.011 and that of right side with p value 0.009 which is not <0.05.
Table 5 and graph 4.1 & 4.2 shows pre and post values of left and right weight bearing squat at 90^0 angles. In this the values of weight bearing squats of both left and right side 0.352 and 0.352 respectively are statistically not significant with p value not <0.05.
Table 6 and graph 5 shows pre and post FES scale score. In which both pre and post values are statistically significant with p value 0.0001 which is <0.05.

DISCUSSION

The study was conducted to study the effect of squats on the elderly population for improving their static standing balance. This experimental study was done on 30 elderly participants above the age of 65 years who were selected according to the inclusion criteria. 60% population was male and 40% of the population was female. The participants were assessed before and after the training period of 2 weeks (6 days per week).
The aging process affects all factors involved in balance, which leads to falling (Barzegari et al., 2019). Reduced sensitivity of sensory receptors that track the body's direction has been associated with falling. (Goble et al., 2009). Reduced strength in the lower limbs is linked to a higher chance of falling. (de Souza Vale et al., 2009).
Mujina Y. Osoba, BA et al conducted a previous study “Balance and gait in the elderly: A contemporary review” which showed that Elderly people have greater gait variability, age-related deficits in balance and gait, and an increased risk of falling.[11]
All the participants were assessed before the training for range of motion, manual muscle testing, core strength, FES score was computed. The above parameters were computed after the training period.
Loss of independence, deconditioning from activity limitation, increased risk of further falls, decreased social activity, and a lower quality of life are among the effects of FOF on the elderly.[12]
The fall efficacy scale was used to assess the level of fear of falls which has a total score of 64 which is the maximum (very less concerned) and least score of 16 (very concerned) showing improvement in the participants. During the exercise program, no serious adverse events such as risk of falls or adverse cardiovascular effects were observed in any of the subjects.[9]
Poor weight-shifting abilities (Robinovitch et al., 2013) and deterioration in musculoskeletal and sensory systems with aging mean increased difficulties for older women in controlling standing symmetry (de Vries et al., 2014).[13]
In older persons, squat tests put more strain on the plantar fascia of the ankle and the knee extensors. When recommending exercise regimens for older persons, clinicians may utilize this discriminating result to more selectively target certain lower-extremity muscle groups.[13]
Jordan Larsen-Merrill et al (2008) concluded in their study that the Balance Master training protocols were used to achieve a variety of task goals that required propulsive movements of the body's center of gravity, a narrowed base of support, and high-velocity movements on shaky terrain. The patient's balance, transfers, and gait improved as a result of the protocols' use.[14]
The wall squat is an effective and important exercise for increasing hip and knee extensor strength. However, it is unknown which hip and knee extensor strengths are linked to wall squat performance.[15]
When performed correctly, the bodyweight wall squat can be a useful exercise for developing the extensor muscles of the hips and lumbar spine, with little to no impact on the knee muscles.[14]
A prior study demonstrated that squat training contributed to the improvement of strength and lower limb muscle strength, which helps with body balance.[9]
One bodyweight closed-kinetic-chain (CKC) exercise that may help effectively strengthen the ankle dorsiflexor muscles is the wall squat. Weight-bearing CKC exercises are commonly utilized in rehabilitation because they stabilize joints and shield ligaments.[15]
Previous studies of lower extremity strength during weight-bearing exercise (Claiborne et al, 2006; Kim et al, 2015) used strength normalized by body weight. Because the wall squat is a weight-bearing exercise, body weight should be taken into account in wall squat research.[16]
Behm et al. in their study stated that a training program with the physio ball (BOSU) should not be to gain strength but to gain stability, improve balance, and improve proprioceptive capabilities.[17] The Fear of Fall values on pre- post-test showed a mean SD of 25.93 and a post-test mean SD of 23.73 on the FES with a significant improvement in overcoming the Fear of fall with p-value of < 0.05
This study aimed to improve static standing balance in the elderly population as a precaution of fear of falling during activities of daily living which tends to limit social interaction. The wall squat exercises helped to strengthen the lower extremity muscles and BOSU ball squats improved stability which facilitated static balance as observed in the post-test values.

CONCLUSION

The study concludes that there is improvement of static standing balance in elderly and showed improvement in muscle power of lower extremities which was reflected in muscle strength after wall squats and BOSU ball squat training which helped in reduction in the fear of falls.

LIMITATIONS

The limitation of the present study is that the period of study was short.
There would have been comparatively more static and dynamic balance effects in elderly population if the training sessions would have been prolonged and could have shown more significant results with a greater number of participants.

FUTURE SCOPE

The study can be done on other medical, surgical, neurological, cardiac conditions. Dynamic balance and functional activity training parameters can be included.
Aerobics with strength training can also be included in the study.

References

1. *Değer TB, Saraç ZF, Savaş ES, Akçiçek SF. The relationship of balance disorders with falling, the effect of health problems, and social life on postural balance in the elderly living in a district in Turkey. Geriatrics. 2019 May 17;4(2):37.*

2. *(Hornbrook MC, Stevens VJ, Wingfield DJ, Hollis JF, Greenlick MR, Ory MG. Preventing falls among community-dwelling older persons: Results from a randomized trial. Gerontologist. 1994;34(1):16-23.)*
3. *da Silva Borges E. G., de Souza Vale R. G., Cader S. A., et al. Postural balance and falls in elderly nursing home residents enrolled in a ballroom dancing program. Archives of Gerontology and Geriatrics. 2014;59(2):312–316. doi: 10.1016/j.archger.2014.03.013. [PubMed] [CrossRef] [Google Scholar])*
4. *(Rival C., Ceyte H., Olivier I. Developmental changes of static standing balance in children. Neuroscience Letters. 2005;376(2):133–136. doi: 10.1016/j.neulet.2004.11.042. [PubMed] [CrossRef] [Google Scholar]*
5. *Kritz M, Cronin J, Hume P. The bodyweight squat: A movement screen for the squat pattern. Strength & Conditioning Journal. 2009 Feb 1;31(1):76-85.*
6. *Lorenzetti S, Ostermann M, Zeidler F, Zimmer P, Jentsch L, List R, Taylor WR, Schellenberg F. How to squat? Effects of various stance widths, foot placement angles and level of experience on knee, hip and trunk motion and loading. BMC Sports Science, Medicine and Rehabilitation. 2018 Dec;10(1):1-1.*
7. *Trajkov M, Jovanović S, Kljajić D. Examination postural stability with neuro com Balance Master Platform. Zdravstvena zaštita. 2015;44(5):53-9.*
8. *McGuirk TE. The Use of Computerized Dynamic Posturography to Assess the Balance in Individuals with Parkinson's Disease.*
9. *Osugi T, Iwamoto J, Yamazaki M, Takakuwa M. Effect of a combination of whole-body vibration exercise and squat training on body balance, muscle power, and walking ability in the elderly. Ther Clin Risk Manag. 2014 Feb 20; 10:131-8. doi: 10.2147/TCRM.S57806. PMID: 24591837; PMCID: PMC3934664.*
10. *Sun M, Min L, Xu N, Huang L, Li X. The effect of exercise intervention on reducing the fall risk in older adults: a meta-analysis of randomized controlled trials. International journal of environmental research and public health. 2021 Nov 29;18(23):12562.*
11. *Osoba MY, Rao AK, Agrawal SK, Lalwani AK. Balance and gait in the elderly: A contemporary review. Laryngoscope investigative otolaryngology. 2019 Feb;4(1):143-53.*
12. *Schoene D, Heller C, Aung YN, Sieber CC, Kemmler W, Freiberger E. A systematic review on the influence of fear of falling on quality of life in older people: is there a role for falls?. Clinical interventions in aging. 2019;14:701.*
13. *Zouita S, Zouhal H, Ferchichi H, Paillard T, Dziri C, Hackney AC, Laher I, Granacher U, Ben Moussa Zouita A. Effects of combined balance and strength training on measures of balance and muscle strength in older women with a history of falls. Frontiers in physiology. 2020 Dec 23;11:619016.*
14. *Larsen-Merrill J, Lazaro R. Use of the Neuro Com Balance Master Training Protocol to Improve Functional Performance in a Person with Multiple Sclerosis. J Student Physical Ther Research 2008 1 (1): 12. 2008;27.*
15. *Biscarini A, Contemori S, Dieni CV, Panichi R. Joint torques and tibiofemoral joint reaction force in the bodyweight "Wall Squat" therapeutic exercise. Applied Sciences. 2020 Apr 26;10(9):3019.*
16. *Jung SH, Hwang UJ, Kim JH, Jeon IC, Kwon OY. Relationship Between Lower Extremity Extensor Strength and Wall Squat Performance. Physical Therapy Korea. 2019 Dec 31;26(4):20-8.*
17. *Accardo P. The effect of an exercise and balance training intervention program on balance and mobility in community-dwelling older adults.*