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Effect of square stepping exercise on cognition and risk of fall in overweight and obese elderly females

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Abstract
Background: Falls in elderly are associated with a number of risk factors, of which obesity is one of the major risk factors for falls leading to disability, dependency and reduced quality of life. The Square Stepping Exercise (SSE) consists of movements similar to walking, in multiple directions composed of various elementary patterns with increasing progression. So, the aim of this study is to find whether or not the Square Stepping Exercise is effective in improving the cognitive function and reducing the risk of fall in elderly overweight and obese females.
AIM and objectives: To find the effect of Square stepping exercise on cognition and risk of fall in overweight and obese elderly females, using MMSE and TUG.
Materials and Methodology: 20 overweight and obese elderly females were included in the intervention protocol that extended over 4 weeks. Elementary pattern I and II extended for two weeks each, with 3 sessions per week. Pre and post cognitive function was evaluated using the Mini Mental State Examination. Pre and post balance was assessed by the Timed-Up and Go test and risk of fall was evaluated by it.
Results: There was a significant improvement in balance according to the Timed-Up and Go Test and a significant improvement in cognitive function according to MMSE in overweight (p=) and obese females (p=). There was a reduction in the risk of fall in obese females (%).
Conclusion: The Square Stepping Exercise effectively improves balance and cognitive function and reduces the risk of falls in overweight and obese elderly females.

Keywords: square stepping exercise, obese, overweight, elderly, cognitive function, risk of fall

Introduction

According to the U.S. Centers for disease control and prevention, falls lead to more than 2.8 million injuries that are treated in the emergency department annually, which include over 800,000 hospitalizations and over 27,000 deaths. They are also a leading cause of fatal injury and the most common cause of nonfatal trauma related hospital admissions among the older adults [1]. Also the World Confederation for Physical Therapy (WCPT) estimates that one out of three people above 65 years of age will fall each year [2]. Because women usually live longer than men, the problems of America's elders are largely the problems of women [3].

Ageing is a process that affects all our body systems and tissues [4] causing a significant change that is associated with the reduction in the components of functional capacity such as balance, coordination, agility and muscle strength which could impair mobility [5]. Deterioration of brain structures and a decline in cognitive function is also seen in the ageing process. A decline in attention and executive functioning also increases risk of postural instability, impairments, activity limitations and high risk of falls [4]. Older people become increasingly limited in their abilities to perform activities of daily living because of reduced endurance, poor balance, generalized weakness and risk of fall [3].

Balance is a complex process that includes reception and integration of sensory inputs; planning and executing a movement that requires upright posture [4, 6]. All activities we perform require us to react to gravity so that our body adjusts accordingly to maintain balance [4, 7].

Postural stability also involves rapid, automatic integration of information from the vestibular, somatosensory, visual and musculoskeletal systems in presence of cognitive functions like attention and reaction time [8]. Cognition is the act or process of knowing which includes awareness, judgment, reasoning, intuition and memory. Executive functions are also sometimes included in cognition. Executive functions include the ability to plan, manipulate information, initiate and terminate activities, recognize errors, solve problems, and think abstractly [9]. Cognitive functions also include planning, sequencing and directing goal oriented behavior [10].

Falls are associated with a number of risk factors and these falls increase with the increase in the number of risk factors. These risk factors can be classified as intrinsic and extrinsic risk factors. The intrinsic risk factors are those which are related to the individual who experiences the fall. These intrinsic risk factors can be physiological or pathological due to normal aging, diseases (chronic and acute) and medication use etc. The extrinsic risk factors are the ones related to the environmental features. These are the ones that surround the individual and include the obstacles, placement of furniture or assistive devices the individual maybe using and footware [11].

Obesity, one of the major risk factors for falls, is the accumulation of adipose tissues in the body leading to an increased body mass. Body mass distribution is gender

specific (android and gynoid type of obesity) and whether this shape has an effect on balance is still controversial [12]. When compared to healthy-weight people, the chances of suffering from a fall-related injury requiring medical treatments are 15 to 79 % higher for overweight individuals [13, 14] and injuries such as sprains, strains, and dislocations are more often due to falls [13, 15].

Fear of Falling (FOF) gained recognition as a health problem of older adults in the early 1980's. It has also been said that this fear of fall is an ongoing concern which ultimately restricts the performance of the older adults in their activities of daily living [11].

Falls are a complex problem and over 70% of them occur due to multiple interacting factors [9, 15]. An injury from a fall can lead to disability, dependency and reduced quality of life. The elderly develops a fear of fall, social withdrawal, and reduced confidence to perform their activities of daily living and functional mobility. This eventually leads to adaptation of an inactive lifestyle and functional decline [4].

Walking is said to develop functional fitness and reduce the risk of fall, however, walking maybe affected in the elderly individuals due to fear of injury, disease, accident and crime. This may prevent them from walking outdoors. Taking into consideration these aspects, Shigematsu *et al.* developed a Square Stepping Exercise (SSE) in 2006 which composed of movements that are similar to walking and can easily be performed indoors. Unlike walking, Square Stepping Exercise involves varied movements in multiple directions. It is performed on a thin mat (100x250 cm) partitioned into 40 squares of 25cm each [16].

The Square Stepping Exercise seems to be a great method for preventing risk of fall and improving balance [5]. Thus, the aim of this study is to find whether or not the Square Stepping Exercise is effective in improving the cognitive function and reducing the risk of fall in elderly overweight and obese females.

Materials and Methods

This study was a pre and post experimental study in which 30 elderly females above the age 65 and not having any serious cardiovascular impairments were evaluated. Their age, height and weight were documented. Their BMI was calculated according to the Asian's Classification of BMI and only overweight and obese females were included in the study. They were asked questions according to the Mini Mental State Examination (MMSE) [17] and all their scores were above 24. Then, their risk of fall was evaluated by the Timed-up and go test [18, 19]. All scores above 14 were considered at risk of fall [10].

They then underwent the intervention of the square stepping exercise: elementary patterns 1 and 2, [16] over a period of four weeks, three sessions weekly, for duration of 30mins per session. The 30mins of session was divided as 5mins of warm up, 20mins of intervention followed by 5mins of cool down. Warm up and cool down exercises included deep breathing exercises and few upper and lower extremity range of motion exercises. Elementary pattern one extended over two weeks and elementary pattern two extended for the third and fourth weeks. After four week's duration their risk of fall and cognition was again assessed with the help of TUG and MMSE, respectively.

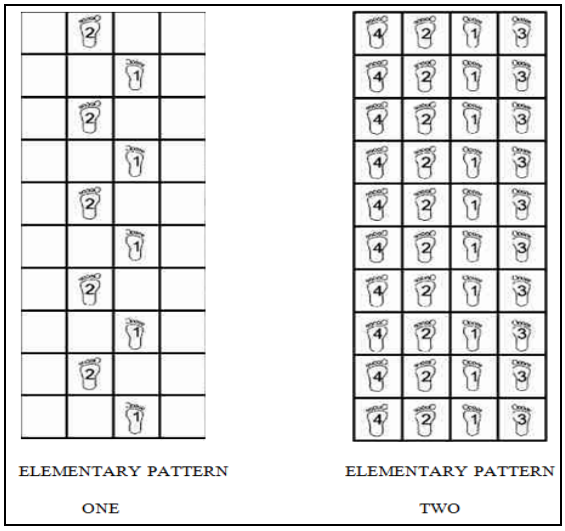

Fig 1

Results

Table 1: Classification of participants according to BMI with mean age

BMI category	Number of participants	Mean BMI	Mean Age
Overweight	4	23.725	73.5
Obesity Grade 1	11	26.33	74.64
Obesity Grade 2	5	33.28	75.6

Table 2: Mean scores of Timed Up and Go (TUG) with p value and t score

BMI category	TUG (seconds)		p Value	t Score
	Pre Intervention	Post Intervention		
Overweight	21.25±6.238	15.75±4.031	0.0222 (significant)	4.371
Obesity Grade 1	23.09±6.935	16.27±4.789	<0.0001(extremely significant)	8.964
Obesity Grade 2	22.2±7.39	14.6±7.09	<0.0001(extremely significant)	31.027

Interpretation: There is significant improvement in reducing risk of fall post SSE

Table 3: Mean scores of Mini Mental State Examination (MMSE) with p value and t score

BMI category	MMSE		p Value	t Score
	Pre Intervention	Post Intervention		
Overweight	26.25±2.217	29.75±0.500	0.0436(significant)	3.363
Obesity Grade 1	25.18±1.779	29.81±0.40	<0.0001(extremely significant)	9.101
Obesity Grade 2	25.6±1.14	30±0	0.001(significant)	8.629

Interpretation: There is significant improvement in cognition post SSE

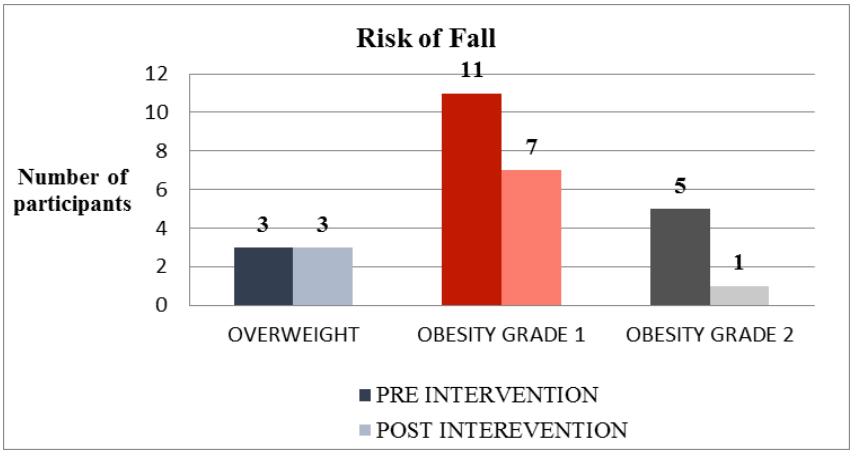

Fig 1: Number of participants at risk of fall (pre and post intervention)

Interpretation: The number of participants at risk of fall has reduced post intervention in obese females

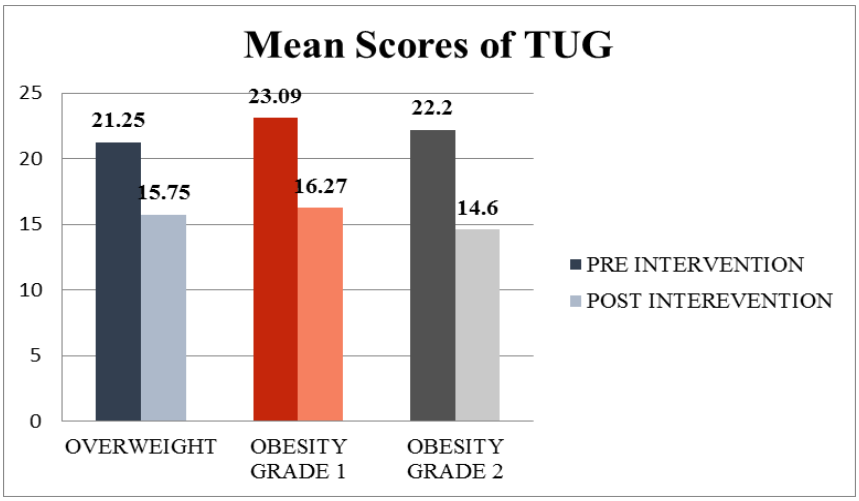

Fig 2: Mean TUG scores of participants at risk of fall (pre and post intervention)

Interpretation: The TUG shows significant improvement post intervention

Discussion

This study showed the effectiveness of the Square Stepping Exercise on balance, risk of fall and cognitive function in overweight and obese elderly females. Overweight elderly females showed significant improvement in balance ($p=0.0222$) and cognition ($p=0.0436$). Participants with obesity grade 1 showed extremely significant improvement in balance ($p<0.0001$) and cognition ($p<0.0001$). Also the number of participants at risk of fall reduced from 11 to 7, post intervention. Participants with obesity grade 2 also showed significant improvement in balance ($p<0.0001$) and cognition ($p=0.001$). The number of participants at risk of fall also reduced from 5 to 1, post intervention.

Walking is a widely accepted exercise and is used to develop functional fitness in fall prevention. SSE also composed of similar movements as that of walking, the difference being that SSE consists of multidirectional steps- forward, backward, lateral and oblique movements. These multidirectional movements lead to better activation of the synergist and agonist leg muscles [16]. Orr and colleagues in their study had explained how continuous activation of the muscles in their concentric phase increases the muscles strength of the leg muscles and so improving balance [16, 20].

Also, Jessica *et al.* in their study discussed that the activation of synergists and agonists of muscles of locomotion seems to improve specific components of functional mobility which in turn have an effect on mobility improvement. They also suggest that SSE is a low intensity exercise that targets functional mobility and so reduce the risk of fall. This makes SSE a more feasible alternative for older people mainly for the ones having a fragile health condition [5].

Van Schoor NM *et al.* [10, 21] and Hauer K *et al.* [10, 22] at in their study suggest that maintaining balance and preventing falls requires cognitive process. They also say that executive control functions are independent predictor of falls, balance and walking speed. Coppin AK *et al.* [10, 23] and Sheridan PL *et al.* [10, 24] suggest that performance in dual task activities rely on executive functions and processing speed abilities and Silsupadol *et al.* suggests that this ability of dual task performance can be improved by targeting executive function [10, 25]. SSE also focuses on dual task performances. Looking for the proper sequence of numbers, judging the size of the box, placing the leg in the box and walking are almost done simultaneously. This could be a reason that SSE challenges the executive functions and improves the balance cognition of the elderly.

Tiffany *et al.* in their study also have suggested that

participation in a multicomponent exercise program that includes aerobic training with a focus on improving balance skills have a positive impact on the cognitive function [10]. The intervention protocol in our study was focused on balance training. Along with this our intervention for conducted for 30 minutes including warm up and cool down which would have an effect on aerobic conditioning of the participant. This might be a reason of the significant improvement on cognitive function of the participants.

Conclusion

The Square Stepping Exercise effectively improves cognitive function and reduces risk of fall in overweight and obese elderly females.

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References

1. www.ncoa.org
2. Falls among older adults: an overview. Center for Disease control and Prevention. http://www.cdc.gov/ homeandrecreationalsafety/falls/adultfalls.html.10/6/2009 Accessed 7/27/2010.
3. Geriatric Physical Therapy. Edited by Andrew A. Guccione, PT, PhD, FAPTA. Second Edition.
4. Harshika Bhanushali, *et al.* Comparative Study on the Effect of Square Stepping Exercises versus Balance Training Exercises on Fear of fall and Balance in Elderly. International journal of Physiotherapy and Research. 4(1):1352-59.
5. Jessica Pereria, *et al.* Effects of Square Stepping Exercises on Balance and Depressive Symptoms in older adults. Motriz, Rio Claro. 2014; 20(4):454-460.
6. Darcy A Umphred. Neurological Rehabilitation, 5th Edition, Mosby; Leslie Allison, Kenda Fuller; Chapter 23 Balance and Vestibular Disorders. 732-734.
7. Patricia M Davies. Steps to follow: The comprehensive treatment of patients with hemiplegia, 2nd Edition, New Delhi, Jaypee Brothers Medical Publishers (P) Ltd., Chapt. 2003; 2:235-276.
8. Susan W. Muir. *et al.* Balance Impairment as a risk factor for falls in community dwelling Older adults who are high functioning: A prospective Study. Journal of the American Physical Therapy Association. 2010, 90(3).
9. Physical Rehabilitation, Susan BO, Sullaivan PT, EdD, Fifth Edition.
10. Tiffany E Shubert. *et al.* The effect of an exercise based balance intervention on Physical and Cognitive performance for older adults: A Pilot Study. Journal of Geriatric Physical Therapy. 2010, 33(4).
11. Archana Sharma, Sebestina A. D'souza. Developing a scale to assess balance confidence in Indian community dwelling older adults. The Indian Journal of Occupational Therapy. 2008, XL(2).
12. Francesco Menegoni, *et al.* Gender-specific Effect of Obesity on Balance. Received 29 July 2008; accepted 2 March 2009; advance online publication, 2009. doi:10.1038/oby.2009.82.
13. Normand Teasdale, Grant Handrigan. Obesity Alters Balance and Movement Control. Curr Obes Rep. 2013; 2:235-240. DOI 10.1007/s13679-013-0057-8.
14. Finkelstein EA, Chen H, Prabhu M, Trogdon JG, Corso PS. The relationship between obesity and injuries among U.S. adults. Am J Health Promot. 2007; 21(5):460-8.
15. Matter KC, Sinclair SA, Hostetler SG, Xiang H. A comparison of the characteristics of injuries between obese and non-obese inpatients. Obesity. 2007; 15(10):2384-90.
16. Campbell AJ, Robertson MC. Implementation of multifactorial interventions for fall and fracture prevention. Age Ageing. 2006; 35:ii60-ii64.
17. Ryosuke Shigematsu, *et al.* Square Stepping Exercise and Fall Risk Factors in Older Adults: A Single-Blind, Randomized Controlled Trail. Journal of Gerontology: Medical Sciences. 2008; 63A(1):76-82.
18. Shumway-Cook A, *et al.* Predicting the probability for falls in community dwelling older adults using the Timed Up and Go Test. Phys Ther. 2000; 80(9):896-903.
19. Shumway-Cook A, *et al.* Predicting the probability for falls in community dwelling older adults using the Timed Up and Go Test. Phys Ther. 2000; 80(9):896-903.
20. Whitney SL, *et al.* the reliability and validity of the Four Square Step Test for people with Balance Deficits secondary to a vestibular disorder. Arch Phys Med Rehabil. 2007; 88(1):99-104.
21. Orr R, de Vos NJ, Singh NA, Ross DA, Stavrinos TM, Fiatarone-Singh MA. Power training improves balance in healthy older adults. J Gerontol A Biol Sci Med Sci. 2006; 61A:78-85.
22. Van Schoor NM, Smit JH, Pluijm SM, Jonker C, Lips P. Different cognitive functions in relation to falls among older persons. Immediate memory as an independent risk factor for falls. J Clin Epidemiol. 2002; 55:855-862.
23. Hauer K, Pfisterer M, Weber C, Wezler N, Kliegel M, Oster P. Cognitive impairment decreases postural control during dual tasks in geriatric patients with a history of severe falls. J Am Geriatr Soc. 2003; 51:1638-1644.
24. Coppin AK, Shumway-Cook A, Saczynski JS, *et al.* Association of executive function and performance of dual-task physical tests among older adults: analyses from the InChianti study. Age Ageing. 2006; 35:619-624.
25. Sheridan PL, Solomont J, Kowall N, Hausdorff JM. Influence of executive function on locomotor function: divided attention increases gait variability in Alzheimer's disease. J Am Geriatr Soc. 2003; 51:1633-1637.
26. Silsupadol P, Shumway-Cook A, Lugade V, *et al.* Effects of single-task versus dual-task training on balance performance in older adults: a double-blind, randomized controlled trial. Arch Phys Med Rehabil. 2009; 90:381-387.