International
Journal of Medical and Exercise Science
(Multidisciplinary, Peer Reviewed and Indexed Journal)

ORIGINAL ARTICLE

THE COMBINED EFFECTIVENESS OF GAZE STABILITY EXERCISE AND OTAGO EXERCISE ON BALANCE AND FALL RISK IN ELDERLY PEOPLE

Search engine:
www.ijmaes.org

SEETHAL VINCENT[1], JITTO JOSEPH[2]

Corresponding Author:
[1]MPT (Neurology)- student , Bethany Navajeevan College of Physiotherapy, Thiruvananthapuram, Kerala, India.
Mail id: sheethalvincent28@gmail.com
Co Author:
[2]Assistant Professor, Bethany Navajeevan College of Physiotherapy, Thiruvananthapuram, Kerala, India.

ABSTRACT

Background: Falls and resulting injuries have become one of the most serious health issues for elderly. Studies have shown the effectiveness of gaze stability exercise and Otago exercise program on balance and fall risk reduction respectively in elderly people. So far their combined effectiveness has not been studied. **Objective:** To find the combined effect of gaze stability exercise and Otago exercise program on improving balance and reducing fall risk in elderly people. **Method:** 30 subjects with age group 65-75 participated in this study. Subjects were divided into two equal groups with 15 samples in each. Group A performed gaze stability exercises and Otago exercise program along with conventional exercise and Group B performed conventional exercise alone. Both groups performed the exercises for two months. The outcome was measured before and after the treatment using Berg Balance Scale and Dynamic Gait Index. Statistical analysis was done using Wilcoxon and Mann- Whitney U test. **Result:** Based on the statistical analysis, the result of the present study shows that there is a statistically significant difference in balance and fall risk between pre-test and post-test in both experimental and control group($p<0.000$). Experimental group shows greater improvement in balance on BBS and reduction in fall risk on DGI than the control group in elderly people. **Conclusion:** This study provides evidence about the combined effectiveness of gaze stability exercise and Otago Exercise program in improving balance and reducing fall risk in elderly people.

Keywords: Berg Balance Scale, Dynamic Gait Index, Gaze stability exercises,Otago exercise program

Received on 10th August 2017, Revised 19th August 2017, Accepted on 28th August 2017

INTRODUCTION

Geriatrics is the branch of medicine that focuses on the health of elderly people by disease prevention, diagnosis, treatment and the problems specific to aging[1]. Elderly can be classified in to three groups: Young old (between 65 and 75 years of age), Middle old(between 75 and 85 years of age) and Old old (older than 85 years)[2].

In India, the second most populous country, the geriatric population is expected to increase from 76.6 million in 2006 to 173.1 in 2026[3]. Aging is a complex natural process where changes occur at molecular, cellular and organ levels which decreases the individual's ability to respond internal and external stressors appropriately[4]. An individual can attain balance only if there are a harmonious integration and coordination between peripheral and central factors such as vision, somatosensation, vestibular sensation, motor output, and musculature[5].

The central nervous system integrates information from various end organs and formulates appropriate responses. Afterward, it will coordinate and directs the musculoskeletal system to perform the appropriate head, eye, trunk, and limb movements to maintain posture [6]. Progressive aging results in a reduction of environmental perception and movement precision owing to impairement in vision, vestibular input and somatosensory information. On the other hand, aging impairs functional movement and balance due to reduced muscle strength and power[7,8]. The aforementioned change in balance exerts a negative impact on elderly people and results in falls.

Intervention

Gaze stability exercises: Vestibular rehabilitation is a therapeutic resource that is based on central mechanisms of neuroplasticity, known as adaptation, habituation, and substitution, which promote vestibular compensation[9]. One of the main consequences of natural aging of the vestibular system is the degeneration of vestibulo-ocular reflex that leads to a reduction in the visual-VOR gain[10]. This reduction will lead to greater retinal slip and therefore poorer visual acuity during head movement which can be retrained through gaze stability exercises[11]. Gaze stability exercises include vestibular adaptation and substitution exercises. They improve the interaction between visual and vestibular system during head movements and increase balance in conditions that produce conflicting sensory information [12].

Adaptation exercises are based on inducing long-term changes in the neuronal response of the vestibular system to retinal slip. Exercises consist of performing head movements while keeping a target in focus and or by moving the target in the opposite direction of the head movement performed with progressively greater challenges. Substitution exercises have patients perform exercises that encourage the substitution of alternative strategies to replace the lost or compromised vestibular function. The goal of these exercises, such as performing eye and head movements between two or more targets and the remembered target exercises in which visual fixation is maintained during a head movement performed with eyes closed, is to improve gaze stability during head movement [13].

Otago exercise program

The Otago Exercise Program (Otago) is an individually tailored, home-based, balance and strength fall prevention program. The program was developed by Professors John Campbell, Clare Robertson, and Melinda M. Gardner, researchers at the University of Otago in Dunedin, New Zealand and the New- Zealand Falls Prevention Research Group, in response to the frequency and severity of fall injuries among elderly in New Zealand. Otago intervention includes almost all the components for improving balance, strength and functional capacity of elderly subjects[14]. The OEP is recognized by the Centers for Disease Control and Prevention as an evidence-based fall prevention program[15], and the National Council on Aging has categorized OEP as meeting the highest level criteria for evidence-based programs[16]. The OEP consists of 5 warm up and 17 strength and balance exercises, which are progressed over the course of the plan of care.

So the main purpose of this study was to find the combined effect of gaze stability exercise and Otago exercise program along with conventional exercise on improving balance and reduce the risk of fall in elderly people.

Need of the study: Worldwide, the number of people over 60 years is growing faster than any other age group and the main reasons for this substantial demographic change are higher life expectancy and declining birth rates. With advancing age, changes related to normal aging, and those associated with diseases and their treatments, can affect the integrity and function of the musculoskeletal, vestibular, central, and peripheral nervous systems .Gaze stability exercises are used to improve control of eye movements so vision can be clear during head movements. The Otago Exercise Programme (OEP) is a falls prevention programme which addresses the risk factors of poor balance and lower limb weakness with an individually prescribed, home based strength and balance exercise programme. So if these two exercises are coalesced and given to the elderly people, it will benefit all those factors that get declined on aging. Such an exercise protocol will be very effective for elderly people in improving balance and thereby reducing fall risk.

Objectives

- To find the combined effect of gaze stability exercise and Otago exercises in improving balance in elderly people.
- To find the combined effect of gaze stability exercise and Otago exercises in reducing fall risk in elderly people.

Alternative hypothesis

The combined application of gaze stability exercise and Otago exercise will have significant impact on balance and fall risk reduction in elderly people

Null hypothesis

The combined application of gaze stability exercise and Otago exercise will have no significant impact on balance and fall risk reduction in elderly people

METHODOLOGY

Study design: Pre Vs post test experimental study design.

Study setting: Old age homes in and around Trivandrum.

Sample size: 30 samples of the population who satisfied the inclusion and exclusion criteria were selected.

Inclusion criteria

- Age between 65 -74 yrs
- Both male and female
- Multiple history of falls
- Loss of balance during activities.
- Independent in ambulation and ADL
- Able to follow commands
- Co-operative persons

Exclusion criteria

- MMSE score <24/30
- Progressive medical issues that would affect mobility
- Presence of other neurological problems
- Diagnosed vestibular problems
- Cardiovascular ,metabolic ,degenerative (other than ageing) or neoplastic disorders which are confirm to cause balance problems

Sampling procedure: Purposive sampling method used to select the samples for the study.

Study duration: The study was conducted over a period of 9 months.

Outcome measure

- Dynamic Gait Index
- Berg Balance Scale

Data analysis

- Wilcoxon Signed rank test has been performed to compare the data within the groups.
- Mann Whitney U Test has been performed for comparing data between two groups.

Procedure: Thirty elderly subjects both males and females, ranges between 65 and 74 years of age, having loss of balance during activities, multiple history of fall ,independent in ambulation and activities of daily living were included in the study. The participants were randomly arranged through purposive sampling method into Group A(Experimental group) and Group B (Control group), with 15 subjects each. A standardized assessment was conducted prior to their inclusion in the study. Informed written consent was obtained from each participant prior to participation in the study and they were explained in detail about the nature of the study. Pre test for group A and group B using BBS for balance and DGI for measuring fall risk has been used.

After a brief demonstration of the intervention program, the experimental group was subjected to gaze stabilization exercise and Otago exercise program, followed by conventional exercises.

Gaze stabilization exercise[17]

Adaptation exercises require the individual to perform rapid, active head rotations while watching a visual target with the target remaining stationary(X1 viewing). It was progressed with the target moving in the opposite direction of head movement(X2 viewing). Substitution exercises require the individual to perform eye-head movements between targets with the goal of seeing clearly during the task.

Adaptation exercises:

Horizontal and vertical X1 viewing exercise with near target, sitting.
Horizontal and vertical X1 viewing exercise with near and far target, sitting

Horizontal and vertical X1 viewing exercise with near and far target, standing.
Horizontal and vertical X2 viewing exercise, plain background, Standing.

Substitution exercises:

Horizontal and vertical X1 viewing exercise with near and far targets, sitting.
Horizontal and vertical X1 viewing exercise with near and far target, standing.
Horizontal and vertical X2 viewing exercise, plain background, standing.

The participants were instructed to perform the exercises 3 times daily over an 8 week period. After the 8th week, post intervention data was collected again to analyze the statistical difference.

Figure 1: Patient performing substitutional exercise

Otago exercises[18]

Otago exercise programme consists of a set of progressive leg muscle strengthening and balance retraining exercises and a walking plan to be individually prescribed at home. It starts with warm up, consisting of flexibility exercises for 5 minutes.

The strengthening exercises focus on major lower limb muscles:

- Knee flexors
- Knee extensors
- Hip abductors
- Ankle dorsiflexor muscles
- Ankle plantar flexor muscles

Ankle cuff weights provide resistance to the knee flexors, knee extensors, and hip abductors. The ankle dorsiflexors and plantar flexors are strengthened using body weight alone. Progression of exercises were done by increasing the duration and then intensity.

The balance retraining exercises consists of the following:

Knee bends, Backwards walking, Walking and turning around, Sideways walking, Tandem stance, Tandem walk, One-leg stand, Heel walking, Toe walking, Heel toe walking backward, Sit to stand.

Balance exercises progressed from holding on to a stable structure to performing the exercise independent of support .Subjects were advised to carry walking for at least 30 min 2 times a week ,if safe. The walking was broken into shorter sessions, for example three 10-minute sessions. The exercises (flexibility, strengthening, balance) took approximately 30 minutes to complete and done three times a week, with rest days in between.

Figure2: Patient performing Otago strengthening exercise

Control group were allotted with conventional balance exercises which include:

Sitting, knee extension with eyes closed.
Sitting, knee extension with arm crossed.
Marching in place (sitting progressed to standing).
Transferring ball from one hand to another.
Standing with eyes open on different surfaces(progress to eyes closed).
Sitting ,throwing and catching a ball (progress to standing and walking).
Standing with hands extended ,arm facing upwards.
Sitting throwing and catching a ball with counting backward(progress to standing).
Standing on a wobble board (progress to rocking in all directions).

The progression was given by conventional balance exercise on standing and different surfaces. Each exercise was performed 10 repetitions daily for 6 days per week for 8 weeks.

Post test was conducted on Group A and Group B using BBS for balance and DGI for fall risk.

RESULT

Group A		N	Mean	Std. deviation	Z value	P value
BBS	Pre	15	30.53	5.194	-3.449	0.001
	Post		40.00	5.210		
DGI	Pre		11.33	2.127	-3.499	0.000
	Post		16.33	2.257		

Table 1: Comparison of pre test and post test values of BBS and DGI in experimental group

Table 1 shows the pre and post test values of BBS and DGI of experimental group (Group A). Based on the statistical analysis the result of the study shows that there is statistically significant difference between pretest and posttest values of BBS and DGI in experimental group.

Group B		N	Mean	Std.deviation	Z value	P value
BBS	Pre	15	30.53	3.270	-3.475	0.001
	post		34.53	3.720		
DGI	Pre		9.80	1.897	-3.464	0.001
	post		11.93	2.34		

Table 2: Comparison of pre test and post test values of BBS and DGI in control group

Table 2 shows the pre and post test values of BBS and DGI of control group (Group B). Based on the statistical analysis the result of the study shows that there is statistically significant difference between pretest and posttest values of BBS and DGI in control group.

Outcome measures	Group	N	Mean rank	Sum of ranks	Mann Whitney U Value	Significance P value
BBS	A	15	20.57	308.50	36.500	0.002
	B	15	10.43	156.50		
DGI	A	15	21.87	328.00	17.00	0.000
	B	15	9.13	137.00		

Table 3: Comparison of effect of post BBS and DGI between groups

Table 3 shows the post test mean rank and post test sum of rank of Group A and Group B, Mann Whiteny U test value and p value of BBS and DGI .Based on the statistical analysis the result of the study shows that there is a statistically significant difference between the post test mean rank of BBS and DGI in Group A and Group B. The post test mean rank of BBS and DGI shows that Experimental Group (Group A) shows significant improvement in balance and fall risk reduction than Control Group (Group B).

DISCUSSION

Aging can be defined as "a persistent decline in the age-specific fitness components of an organism due to internal physiological deterioration". On aging there will be physiological degeneration of proprioception and vestibular system and thereby muscle mass decreases and postural sway increases, so the reaction time of the motor nerve becomes slower until changes ultimately occur in balance control, which increases the frequency of falls [19].

30 subjects fulfilling the inclusion and exclusion criteria were included in the study and they were divided into two groups i.e., Group A and Group B with 15 subjects each. Each subject has well explained the procedure of the intervention and the possible risks involved. A written informed consent from each subject was obtained. Group A received GSE and OEP in addition to Conventional Exercises. Group B received conventional exercises only. All subjects were well tolerated with the interventions given and no one was dropped out of the study.

Berg Balance Scale was used to measure the balance and Dynamic Gait Index was used to measure fall risk. Both outcome measures were collected before and after the intervention protocol. In both groups, Wilcoxon test was used to compare pre and post test values. The post test scores of both groups were analyzed using Mann Whitney U test. The statistical analysis was done using SPSS 16 software. The result showed that there was a significant improvement in balance and reduction in fall risk after giving GSE in combination with OEP for two months.

Although falls are common among the elderly population, recent research conducted in Kerala has found a greater increase in falls in elderly women residing in long-term care homes compared with women living in the community .So present study tries to develop an intervention protocol, which can be performed in home settings that will improve all domains of balance affected by aging[20].

Numerous studies have investigated on most likely causes of falls, with varying results. Risk factors for falls have been classified as intrinsic and extrinsic. Among the intrinsic factors, researchers have identified decreased balance and mobility skills as very strong predictors of the likelihood for falls. P.Dhargave and R.Sendhilkumar in their study found that history of falling, poor vision, use of multiple medications, chronic diseases, use of walking aids, vertigo and balance problems were risk factors associated with falling among elderly people living in long term care homes and also women had a higher risk of falls than men[21].

R.Peters in his review on 'ageing and brain' says that aging causes changes to the brain size, vasculature, and cognition[22]. He reports that the brain shrinks with increasing age and there are changes at all levels from molecules to morphology. He concluded that healthy life both physically and mentally may be the best defense against the changes of an aging brain.

Yogendra Singh Chauhan in his review states that fall and resulting injuries have become one of the most serious health issues for the elderly[23].A definite pattern is seen to falls in the elderly as 'post fall syndrome.

In many studies, it has been shown that there is a relationship between balance impairment and a history of falls among the elderly [24,25,26]. U.B Aslan in his study indicated that aging affects the balance performance year by year[27]. Matsumura and Ambrose in their article had described the impairments in the sensory, musculoskeletal, and central and peripheral nervous system commonly seen in elderly which adversely affect the balance[28].

Foram Dhebar in his review article says that the most effective interventions to manage falls risk are to incorporate exercise[29]. The objective of their study was to determine interventions that are most effective in increasing balance & confidence in older adults. He concluded that for optimal results, the exercise program needs to be structured, progressed, and must achieve the minimum dose of exercise. Exercise including strength training, balance and coordination exercise, dual-task training, hydrotherapy & allied therapeutics like yoga & tai chi have beneficiary effects.

Another study conducted by C.D.Hall on elderly people in 2010 is in relation to present study where gaze stability exercising group showed a reduction in fall risk (indicated by significant improvement on DGI score) as compared with control group[30]. This improvement was attributed to the adaptation of the vestibulo-ocular reflex through the performance of specific vestibular exercises and the second possibility was that participants in the Gaze Stability (GS) group became more accustomed to head movements, one of the elements in the DGI test. In another study conducted by Badke et al. on the effect of vestibular rehabilitation and balance exercises on adults of age, more than 65 having central or peripheral vestibular dysfunction was seen and found that both types of patients improved on DGI score indicating the effectiveness of vestibular rehabilitation in these patients[31]. Diandra Caroline Martins e Silva et al in their systemic review conducted in 2015 concluded that vestibular rehabilitation has shown efficacy in the treatment of elderly patients who suffer from vestibular disorders[32].

A lower-extremity weakness has also been reported as an important intrinsic factor found among older adults who have fallen. OEP developed by Gardner et al had already proven

its effectiveness in reducing fall risk by improving lower limb strength and balance. The current thought is that these types of exercises reduce falls by improving physiological functions and cognitive functions, specifically executive functioning, by improving balance and strength[33].

From all these findings the study came to a hypothesis that we can improve balance and reduce fall risk by combining GSE and OEP together since they act on sensory and motor components of balance.

BBS and DGI were the outcome measures we used in our study. Berg Balance Scale was used to measure the balance and Dynamic Gait Index was used to measure fall risk. Katherine Berg and her colleagues developed BBS as a measure of balance appropriate for elderly individuals in 1989[34]. The BBS can be easily administered in community settings, and its application to the assessment of balance performance in community-dwelling older adults has been suggested. Its reliability, validity and psychometric properties have been shown to be satisfactory in geriatric patients. It's Intra rater reliability had been proven by Mia Conradsson among elderly people living in residential care facilities[35].

Based on the statistical analysis in experimental group, the pre test mean value with standard deviation of BBS was 30.53±5.194 with minimum value of 20 and maximum value of 39 and the post test mean value with standard deviation of BBS was 40.00±5.210 with minimum value of 31 and maximum value of 48, the mean difference was 9.47, z value was -3.449 and p value was 0.001. The result of the study shows that there was a statistically significant difference between pre test and post test values of BBS in the experimental group. Based on the statistical analysis in Control group (Group B), the pretest mean value with standard deviation of BBS was 30.53±3.270 with minimum value of 25 and maximum value of 38 and the post test mean value with standard deviation of BBS was 34.53±3.720 with minimum value of 29 and maximum value of 44, mean difference was 4, z value was -3.475 and p value was 0.001. The result of the study shows that there was a statistically significant difference between pre test and post test values of BBS in Control group (Group B). Based on the statistical analysis, the mean rank for group A was 20.57 and for group B was 10.43.The sum of rank for group A was 308.50 and for group B was 156.50, Man Whitney U value was 36.500, the P value was 0.002. The result of the study shows that there was a statistically significant difference between the post test mean rank of BBS in Group A and Group B. The post test mean rank of BBS shows that Experimental Group (Group A) shows significant improvement in balance than Control Group (Group B). Therefore the study rejects the null hypothesis and accepts the alternate hypothesis.

Susan. W. Muir et al in 2008 investigated that the use of the BBS as a dichotomous scale to identify people at high risk for falling should be discouraged because it fails to identify the majority of such people[36]. Ann Shumway Cook developed DGI in 1993 as a way to assess and document a patient's ability to respond to changing task demands during walking[37]. Whitney SL et al showed that the DGI appears to be a good indicator of fall status in persons with vestibular disorders, regardless of age. The developers report inter-rater reliability for the total DGI score of 0.96– 1.00[38].

Based on the statistical analysis in experimental group (Group A), the pretest mean value with standard deviation of DGI was 11.33±2.127 with minimum value of 8 and maximum value of 16 and the posttest mean value with standard deviation of DGI was 16.33±2.257 with minimum value of 13 and maximum value of 21, the mean difference was 5, z value was -3.499 and p value was 0.000. The result of the study shows that there was a statistically significant difference between pretest and post-test values of DGI in the experimental group. Based on the statistical analysis in Control group (Group B), the pretest mean value with standard deviation of DGI was 9.80±1.897 with minimum value of 6 and maximum value of 13 and the posttest mean value with standard deviation of DGI was 11.93 ±2.34 with minimum value of 8 and maximum value of 16, mean difference was 2.13, z value was -3.464 and p value was 0.001. The result of the study shows that there was a statistically significant difference between pretest and post-test values of DGI in Control group (Group B). Based on the statistical analysis, the mean rank for group A was 21.87 and for group B was 9.13.The sum of rank for group A was 328.00 and for group B was 137, Man Whitney U value was 17, the P value was 0.000. The result of the study shows that there was a statistically significant difference between the posttest mean rank of DGI in Group A and Group B. The post test mean rank of DGI shows that Experimental Group (Group A) shows a significant reduction in fall risk than Control Group (Group B). Therefore the study rejects the null hypothesis and accepts the alternate hypothesis.

The results of the statistical analysis are in accordance with the study. From all these studies and result of statistical analysis, came to a conclusion that the combined GSE an OEP is effective in improving balance and fall risk reduction. Limitation of the study: The sample size was minimal. Long term effect was not considered. The components of Otago exercise program were progressed to next level without assessing according to their protocol. Psychological factors, hereditary factors, diet and socioeconomic factors were not considered. Recommendations for further study: Future study can be done with large number of samples. Long term effect can be studied. Comparison of effectiveness of these exercise programs in male and female can be done.

CONCLUSION

Based on the statistical analysis, the result of the present study shows that there is a statistically significant difference in balance and fall risk between pre-test and post-test in both experimental and control group. Experimental group shows greater improvement in balance using BBS scale and reduction in fall risk on control group in subjects with balance and fall risk.

After analyzing this study arrived at a conclusion that Gaze stability exercises and Otago exercise program when combined are effective in improving balance and reducing fall risk in elderly people.

REFERENCES

1. Medicine Net.com. Medical definition of geriatric medicine. http://www.medterms.com/script/main/art.asp?articlekey=18390.
2. Shilpa Amarya , Kalyani Singh, Manisha Sabharwal, (2015)Changes during aging and their association with malnutrition. Journal of Clinical Gerontology & Geriatrics 6.78-84.

3. india.gov.in(2007).Senior Citizen Act [prevalence of geriatricpopulation].
4. Chodzko-Zajko, W. J., & Ringel, R. L. (1987). Physiological aspects of aging. Journal of Voice, 1(1) : 18-26.
5. C.J. Knerl, P.B. Schuler, L.W. Taylor, L.M. Cosio-Lima, and K.A. Caillouet,(2009) The effects of six weeks of balance and strength training on measures of dynamic balance of older adults. Californian Journal of Health Promotion, 7(2) : 111-22.
6. Horst R. Konrad, MD, Marian Girardi, MA, Robert Helfert, PhD (1999).Balance and ageing. Laryngoscope.109:1454-1460.
7. Fabio Marco Alfieri et al. (2010). Functionalmobility and balance in community-dwelling elderly submitted to multisensory versus strength exercises. Clinical Interventions in Aging. 5: 181-185.
8. Takshashila S More, Keerthi Rao, Dheeraj Shete, Deepali Hande, (2012) effectiveness of ten weeks of balance and strength training on dynamic balance of older adults. Romanian J. of physical therapy . 18(30): 48-55.
9. Ricci N A, et al (2010). A system. review about the effects of the vestibular rehab. In middle-age and older adults. Braz J Phys Ther 14:361–371.
10. Zee DS. (2000) Vestibular Rehab., F. A Davis Company; pp 77-86.
11. C.A. McGibbon, D.E. Krebs, S.L. Wolf, P.M. Wayne, D.M. Scarborough, and S.W. Parker,(2004) .Tai Chi and vestibular rehabilitation effects on gaze and whole-body stability. Journal of Vestibular Research. 14: 467–78.
12. J. Massion, Postural control systems in developmental perspective, Neurosci Biobehav Rev, 22(4), 1998, 465-72.
13. Susan. J. Herdman, (2013). Vestibular rehabilitation. Curr Opin Neurol.26:96-101.
14. Dr.Deepti Wadhwa & Dr. Deepali Hande(2016).Effectiveness of Otago Exercise Program on Reducing the Fall Risk in Elderly: Single Case Report. Imperial Journal of Interdisciplinary Research (IJIR) .2(6): 614-618.
15. Stevens J. A CDC Compendium of Effective Fall Inteventions: What Works for Community-Dwelling Older Adults. 2nd ed Atlanta: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; (2010).
16. National Council On Aging (2016). III D Highest Tier Evidence-Based Health Promotion / Disease Prevention programs. Washington, DC:p.no 16.
17. Tanu Khanna, Sandeep Singh (2014).Effect of Gaze Stability Exercises on Balance in Elderly.Journal of Dental and Medical Sciences .13(9) PP 41-48.
18. Nancy N Patel(2015) .The effect of tago exercise program for fall prevention in elderly people.International journal of Physiotherapy 2(4), 633-639.
19. Ha-na Yoo, EunJung CHung, PT, PhD, BYoung-HEE LEE, (2013) . The Effects of Augmented Reality-based Otago Exercise on Balance, Gait, and Falls Efficacy of Elderly Women .J. Phys. Ther. Sci. 25: 797–80.
20. Johnson SJ.(2006) Frequency and nature of falls among older women in India. Asia Pac J Public Health .18(1):56-61.
21. Pradnya Dhargave, Ragupathy, et al., (2016). Prevalence of risk factors for falls among elderly people living in long-term care homes. Journal of Clinical Gerontology and Geriatrics. 7(3) :99–103.
22. R.Peters (2006) Aging and the brain. Postgrad Med J . 82:84–88.
23. Chauhan YS.(2013) Imbalance and falls in elderly: Review of Literature. Int. J. Otorhinolaryngol Clin 5(3):139-141.
24. Tinetti ME, Speechley M, Ginter SF.(1988) Risk factors for falls among elderly persons

living in the community. N Engl J Med. 319:1701-1707.

25. Wallmann,H.W.(2001).Comparison of elderly non fallers and fallers on performance measures of functional reach, sensory organization, and limits of stability. J. Gerontol. A Biol. Sci. Med. Sci. 56(9), 580–583.
26. Takahashi, T et al, (2006). Modification of the functional reach test: analysis of lateral and anterior functional reach in community-dwelling older people. Arch. Gerontol. Geriatr. 42, 167–173.
27. Bass Aslan U., U. Cavlak, N. Yagci**,** and B. Akdag(2008). Balance Performance, Aging and Falling: A Comparative Study on a Turkish Sample. Archives of Gerontology and Geriatrics. 46 (3): 283 -292.
28. B.A.Matsumura, A. F. Ambrose, (2006):Balance in the Elderly. Clinics in Geriatr Med. 22 (2) 395-412.
29. Foram Dhebar (2014). Interventions For Increasing Balance & Confidence In Older Adults: A Review. Int J Physiother Res . 2(4):631-36.
30. C. D. Hall, Lisa Heusel-Gillig, Ronald J. Tusa, Susan J. Herdman, (2010).Efficacy of Gaze Stability Exercises in Older Adults With Dizziness. JNPT.34: 64–69.
31. Badke MB, Shea TA, Miedaner JA, Grove CR.(2004) Outcomes after rehabilitation for adults with balance dysfunction. Arch Phys Med Rehabil; 85: 227-33.
32. Diandra Caroline Martins e Silva,(2015) Effects of vestibular rehabilitation in the elderly: a systematic review. Aging Clin Exp Res.28(4): pp 599–606.
33. T.Liu-Ambrose(2008). Otago Home-Based Strength and Balance Retraining Improves Executive Functioning in Older Fallers: A Randomized Controlled Trial. J Am Geriatr Soc 56:1821–1830.
34. Berg K , Wood-Dauphinee SL, Williams JI, Gayton D. 1989. Measuring balance in the elderly: preliminary development of an instrument. Physiother Can 41:304-311.
35. Mia Conradsson et al, (2007) Berg Balance Scale: Intrarater Test-Retest Reliability Among Older People Dependent in Activities of Daily Living and Living in Residential Care Facilities, Physical Therapy, 87(9), 1155–1163.
36. Muir SW, Berg K, Chesworth B, Speechley M. Use of the Berg Balance Scale for predicting multiple falls in community-dwelling elderly people: a prospective study. Phys Ther. 2008, 88: 449-459.
37. Shumway-Cook A, Woollacott M.(1995) Motor control: theory and practical applications. Baltimore: Williams & Wilkins; 3rd ed.
38. Whitney SL, Hudak MT, Marchetti GF(2000) The dynamic gait index relates to self-reported fall history in individuals with vestibular dysfunction. J Vestib Res. 10(2): 99-105.

Citation:
Seethal Vincent, Jitto Joseph. The combined effectiveness of gaze stability exercise and otago exercise on balance and fall risk in elderly people , IJMAES, 2017; 3 (3), 390-401.