ORIGINAL ARTICLE

IJPHY

EFFECT OF AGING ON COMPONENTS OF BALANCE EVALUATION SYSTEM TEST (BESTest)

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ABSTRACT

Background: Current available standardized clinical balance assessment tools are used for screening. BESTest helps us identify the specific system that might be responsible for balance dysfunction with aging.

Methods: An observational single point cross-sectional study. Healthy subjects (N=120) Young age group (20-40 yrs), Middle age group (41-60 yrs), Old age group (61-80yrs). Quota sampling. Total BESTest score and a Total score of each of 6 components of BESTest were compared across the three age groups.

Results: Non- parametric Kruskall Wallis test. Post hoc test study of Total BEST Score H=48.88 (p value <0.0001) showed a significant difference in young adult as compared to Middle aged adult (p value <0.001) and older adults (p value <0.001). Similar post hoc test study with a P value < 0.0001 were observed in biomechanical constraint H=32.10, Stability limits or Verticality H=25.11 and Anticipatory control score H=19.83. Post study of reactive postural response H=41.17 and Sensory Orientation H=28.14 (p value <0.0001) showed a significant difference in Older adults as compared with Young Adults and Middle age adults. Post Study of Stability in Gait H=51.00 (p value=0.0001) showed significant difference across the three age group.

Conclusion: Total BEST score and three balance components start getting impaired by middle age. Reactive postural responses and sensory orientation diminish in older adults. Stability in gait shows a steady decline with aging. Our study concludes that middle age is critical aging and changes start appearing by middle age. Future studies are needed to observe the effect of an exercise program designed to target specific component of BESTest.

Keywords: Aging, Postural control, Balance Assessment, BESTest, Young Age, Middle Age and Old Age.

Received 09th April 2017, revised 31st May 2017, accepted 05th June 2017

www.ijphy.org

10.15621/ijphy/2017/v4i3/149072

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INTRODUCTION

Aging is a fundamental process that affects all of our systems and tissues. The rate and magnitude of change in each system may differ person to person, but total body decline is an inevitable part of life for everyone. It was found by Porter Mm and et al. in 1995 that approximately half of the decline with age has a genetic basis. The remainder of age-related change is the consequence of lifestyle, primarily physical inactivity that can account for the other half of the decline with age [1]. India is the second largest country in the world, with 72 million elderly persons above 60 years of age as of 2001. According to projections, the elderly in the age group 60 and above is expected to increase from 71 million in 2001 to 179 million in 2031 [2].Postural control involves many sensory and motor systems, and studies have been done to show age-related declines in visual, vestibular, and sensory motor functions [3-11].For many elderly subjects, the aging process is inevitably accompanied by a restriction of the ability of independent movement and loss of balance [3]. Functional limitations associated with aging often lead to a vicious downward cycle with increasing levels of disability leading to greater reconditioning that further decreases functional ability. These declines lead to secondary conditions and, often, to additional new diseases. Current standardized clinical balance assessment tools are directed at screening for balance problems and predicting fall risk, particularly in elderly people. These tools identify which patients may benefit from balance retraining, but they do not help therapists decide how to treat the underlying balance problems .BEST is developed on a clinical test of balance control based on Bernstein's concept that postural control results from a set of interacting systems. BEST evaluates balance in 6 components.Since much of the decline with aging is lifestyle related, physiotherapists have ample opportunity to intervene along the way Physical therapists can be particularly instrumental in reducing the disabling effects by promoting restorative and accommodative changes that stop or reverse the vicious downward functional cycle, allowing the individual to achieve optimal aging [12]. Age 50 marks a point in middle age at which the benefits of regular physical activity can be most relevant in avoiding, minimizing, and reversing many of the physical, psychological, and social hazards which often accompany advancing age. Heidelberg guidelines suggest preventative and rehabilitative effects of regular physical activity are optimized when physical activity patterns are adopted early in life, rather than when initiated in old age [13]. These beneficial effects apply to most individuals regardless of health status and disease state. The objective of this study to see how each of the six components is affected in the three age groups as age advances. So that earliest and most affected component of BESTest can be targeted in future for early aging to promote healthy aging.

METHODS

Study was conducted in tertiary healthcare centre (Topiwala National Medical College, BYL Nair Charitable Hospital, and Mumbai) with community-based sample. The study was started in 2013 and completed by 2015. Institutional Ethics Committee Review Board of B.Y.L Nair Charitable Hospital, Mumbai. (Registration No.: ECR/22/Inst/Maha/2013/RR-16) approval was obtained before commencing the study

Inclusion criteria for the study were healthy community dwellers. Exclusion criteria were 1) Subjects with neurological disease. 2) Uncorrected visual problems. 3) Orthopedic alterations such as amputations, fractures, history of ankle sprain in the last six months, inability to remain standing upright without the use of walking support device. 4) Pain on abduction or flexion of the shoulders, less than 90° of shoulder abduction or reduced range of motion of the elbows. 5) Any known cause of balance impairment. 6) Subjects undergoing sports training or involved with physical training. 7) Subjects with diabetic neuropathy. 8) A score below 18 points in the Mini-Mental State Examination (MMSE). Official Consent was obtained from 2 housing society secretary. Subjects those who fulfilled the inclusion and exclusion criteria and signed an official consent were taken. Out of 289 subjects screened from the community, 150 were eligible, so 120 were selected. 120 Subjects were assigned to 3 groups according to age. Healthy subjects (N=120) Young age group (20-40 yrs), Middle age group (41-60 yrs), Old age group (61-80yrs).Male, female ratio was maintained1:1 in each group to prevent gender bias. 40 subjects were present in each group. Minimum of 30 subjects is needed in each group to evoke central limit theorem. It was an observational single point cross-sectional study. Quota Sampling was done.The synopsis was reviewed and approved by Nair Ethic's Board. Subjects were tested with shoes and socks off. Patients were assessed on Balance Evaluation Systems Test (BESTest).The standard procedure explained with the scale was followed. It includes balance assessment test such as standing with normal stance for assessing base of supportand centre of body mass, raising on toes, lifting leg to the side of the floor and hold, sitting on floor and standing up, sitting on armless chair and leaning towards each side with eyes closed, reaching forward and laterally with outreached hand in standing position, sit to stand, rise to toes and holding for 3 sec, standing on 1 leg, alternate stair touching -8times, lifting 2.5kg at shoulder level using both hand, lightly push the patient backward in normal posture and suddenly let go, stand behind patient placing hand on each scapula and isometrically hold against subject's backward push and suddenly let go, Stand in front of patient and let them lean forward on your hand and suddenly let go (be prepared to catch), stand in back of patient and let them lean backward on your hand and suddenly let go (be prepared to catch), stand behind the patient , place one hand on the either side of the pelvis and ask them to lean sideways and let it go, standing with feet together eyes open and closed on floor and foam for 30 sec, standing on inclined ramp for 30 sec, walking 6 meter in normal speed, changing speed of gait fast and slow on verbal command, walking with head turns (right or left) on verbal commands, walking with pivot turn (turn and stop), walking over obstacle of 22.9cm, timed get up and go – stand up from the chair walk 3 meter- turn around and sit,

timed get up and go- similar task with backward counting. The protocol is in accordance with the ethical standards of the institutional review board. Mean of the Total Best score, Component 1, component 2, component 3, Component 4, Component 5, and Component 6 are measured in each age group. Post evaluation data were collected and statistically analyzed. No data was missing in the study. Mean, median and standard deviation were calculated.

RESULT

Data was collected and statistically analyzed using the GraphPad Prism 6 and GraphPadI nstat. The data was tested for normality using the kolmogorov's- smirnov test. The data was not passing the normality. Hencenon- parametric Kruskall Wallis test was used for comparison of Total best score and component score across the three age groups. Means of each component within the group was plotted using frequency distribution in each age group. The level of significance was set as 5%. Distributions of age in 3 age groups were[mean(SD: min to max)]. In young age group mean age was 29.95 (5.47: 21 to 39). In middle age group mean age was 49.77 (5.87: 41 to 60). In old age group mean age was 67.45 (4.95: 61 to 80). Among the young age group, lowest mean was for component 4 (89.43) and highest mean for component 5 (97.75). Among the middle age group, the lowest mean was for component 4 (85.75) and highest mean for component 5 (92.85). Among the middle age group, the lowest mean was for component 4 (85.75) and highest mean for component 5 (92.85). Among the old age group lowest mean was for component 4 is (76.63) and highest mean was for component 1(85.10).

Figure no. (1) Gives a graphical presentation of Comparison of Total BEST scores among the three age groups. Age group was plotted on the Xaxis, and BESTest scores plotted on the Y axis. Mean of three age group are 102.7(SD+-3.82), 95.75(SD+-5.26), 84.53(SD+-17.10). There was a significant difference among three age groups. In the post hoc study results showed a significant difference in young as compared middle and old. There was no significant difference between middle and old. Table no. (1) Shows comparison of Total BEST score and components in three age groups (Young, Middle and old age). Table shows mean, standard deviation, comparison by kruskal Wallis test of Total BESTest score and six components among the young, middle and old age group. It shows Kruskall Wallis value along with the level of significance. Table no. (2) Shows Post hoc study between different age group in total score and each component.

By table (1) and (2) it is observed that old age group had a significant difference in total BESTest Score, biomechanical constraint, Stability limits or Verticality and Anticipatory control score compared to middle and young age groups. There was no significant difference between middle and old age group Reactive postural responses and sensory orientation score were found to significantly decrease in Old age group compared to young and middle age group. There was no significant difference between young and middle age groups. Stability in gait score showed a significant difference in three age groups. The level of significance was more when young was compared with Middle and Old. Also, Sensory Orientation Score found to be a least affected component in each age group, and Reactive Postural Responses was found to be a most affected component in each age group.

DISCUSSION

Component 4 Reactive postural responses was the most affected component in all the three groups. In middle and old age group, there is a steady decline in mean suggesting postural reactive strategy starts affecting early. similarly, Liaw MY, Chen CL et al. in 2009 while studying static and dynamic balance concluded that elderly uses hip strategy to maintain postural balance in standing [14].

Comparison of total BEST score shows that the Young group had significantly good balance than Middle and Old group. The Old group did not show difference scores significantly compared to Middle age group. In our study, it suggests balance starts declining by middle age. Kang hee cho in 2012 found that non-faller elderly has good balance; hence in our study , it could be seen that there was no significant difference between middle and old age group [15]. Middle age is an ideal age to start exercise to prevent fall associated with poor balance in old age. Indian population has a sedentary lifestyle with less interest in competitive sports. This could lead to poor strength and reaction time even in middle age. Similar results were seen with biomechanical constraint, Stability limits or Verticality, and Anticipatory control score. Exercise program for this component needs to be trained from middle age group. Reactive postural responses and sensory orientation score were found to be significantly reduced in Old age group compared to young and middle age group. Tsai YC in 2014 found that older adults have similar patterns of joint movement and COM excursion as the young adults during the balance reactive-recovery. However, the elderly group has larger proximal joint rotation inducing larger COM sway to envelop and it leads to loss of compensatory strategy of posture recovery [16]. Weinstin in 1991 found that elderly appear to use a hip strategy more than an ankle strategy, in contrast to younger adults [17]. Also, Fay Horak in 1997 showed that elderly increased body stiffness and prolonged onset latency leads to poor compensatory postural strategy [18]. Wollacot M and et al. in 1986 found that resolution of sensory conflicts becomes challenging in the old age group with a decline in the integrity of many postural regulating systems, including musculoskeletal and sensory systems, as well as neural processing and conduction of information [19]. Because of involvement of multiple system and loss of compensatory strategy with aging, there is a significant decrease in reactive postural strategy and sensory orientation score in old age group.

Stability in gait scores shows a steady decline across the three age groups. Old age group subjects had a significant decrease in score suggesting altered gait parameters. In this study, old subjects showed decreased walking speeds. Slower walking is considered less destabilizing. As found by Osama Baradh et. al in 2006 [20] regarding gait characteristics of elderly subjects, there was a significant increase

in step width, walk end sway, turn sway, and decrease in step length and speed of walk when compared to young adults. Moreover, there was significant prolongation in latencies of all responses elicited by both the gastrocnemius muscle (SLR, MLR) and tibialis anterior muscle (LLR) in the posture evoked aresponse of elderly individuals. Also, Jennifer Byrne et.al [21] in 2002 noted that with aging there occurs a change in intralimb coordination with asymmetrical weighting in lower limb during walking. Elderly subjects have reduced stability limits, delayed reaction time and decreased rate of torque generation. This section also includes the Timed "Get Up and Go" Test without and with a secondary cognitive task to challenge the patient's attention. Lack of sensory inputs, inefficient reactive strategies make gait much more cognitively controlled resulting in increased attentional demands on gait. As found by Dubost et. at in 2006 [22]authors that the rhythmic stepping mechanism of walking in healthy older adults requires some attention. Hence when an additional cognitive task is added, there is a further decrease in walking speed. So, there is a steady decline in scores of stability in gait. As using force platforms and accelerometers is expensive and not always feasible in our Indian set up, a simple, inexpensive tool like BESTest may be used to assess different component of postural stability.

Limitations

1) The study was conducted at one area, and the results cannot be generalized to the general population. 2) The study had a Small sample size. 3) The activity level was not compared in across three age groups. Future Suggestions: 1) A large multicentre study should be conducted so that the results can generalized to the general population. 2) An interventional study can be undertaken to see the effect of a balanced program planned as per the components of balance affected in this study.

CONCLUSION

Total BEST score, Biomechanical constraint, stability limit and anticipatory control components start getting impaired by middle age. Reactive postural responses and sensory orientation diminish in older adults. Stability in gait shows a steady decline with aging. Our study concludes that middle age is critical aging and changes start appearing by middle age. Future studies are needed to observe the effect of an exercise program designed to target specific component of BESTest.

Tables and Graph

Figure 1: Comparison of Total BEST scores among the three age groups chart.

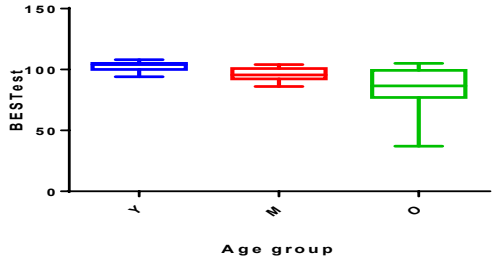

Table 1: Comparison of Total BEST score and components in three age groups (Young, Middle and old age).

	TBS (SD)	C1 (SD)	C2 (SD)	C3 (SD)	C4 (SD)	C5 (SD)	C6 (SD)
Young (Y)	102.7 (3.82)	14.35 (0.66)	16 (1.67)	17.38 (1.2)	16.3 (1.68)	14.68 (0.52)	20.15 (0.52)
Middle (M)	95.75 (5.26)	13.08 (1.38)	16 (1.30)	16.25 (1.4)	15.45 (1.88)	14.15 (1.12)	18.30 (1.38)
Old- (O)	84.53 (17.10)	11.48 (2.97)	8 (3.19)	15.08 (3.3)	12.70 (2.99)	12.78 (2.37)	15.85 (2.97)
Kruskal walis test	48.88***	32.10***	25.11***	19.83***	41.17***	28.41***	51.00**

(P value <0.0001)***, (P value < 0.001)**, TBS=Total BEST Score,C1=Component 1(Biomechanical Constraint), C2=Component 2(Stability Limitsor Verticality), C3 =Component 3 (Anticipatory Limits), C4=Component 4 (Reactive postural strategy), C5=Component 5(Sensory Orientation), C6= Component 6(Stability in Gait).

Table 2: Post hoc study (Post Kruskal Wallis) of the total BESTest score and different components among three age groups (P value showing level of significance between groups).

Post Hoc Study	Middle Vs old age group	Young Vs Middle age group	Young Vs old age group
Total BEStest Score	>0.05	< 0.001	< 0.001
Component 1	>0.05	< 0.001	< 0.001
Component 2	>0.05	< 0.01	< 0.001
Component 3	>0.05	< 0.01	< 0.001
Component 4	< 0.001	>0.05	< 0.001
Component 5	< 0.01	>0.05	< 0.001
Component 6	0.0362	< 0.001	< 0.001

Abbreviations: BESTest = Balance Evaluation System Test

Acknowledgment

I would like to thank Kedar Mate, Shilpa Gaikwad, Narendra Soni and Chandresh Soni for critically reading the manuscript and helpful discussion.

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Citation
Soni, V., & Writer, H. (2017). EFFECT OF AGING ON COMPONENTS OF BALANCE EVALUATION SYSTEM TEST (BESTest). *International Journal of Physiotherapy,* 4(3), 191-195.