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EVALUATION OF AGE AND GENDER-RELATED BALANCE SCORES IN NORMAL ADULTS USING MINI BALANCE EVALUATION SYSTEMS TEST

[1]Abdul Latheef K.E
[2]Thangadurai C
[*3]Shaikhji Saad Mohamed

ABSTRACT

Background: Balance is the ability to maintain body's center of mass over its base of support. Impairments of balance are common. The purpose of this study was to assess the effect of age and gender on Mini-BES Test balance score among healthy adult subjects.

Methods: A cross-sectional study was done, including240 healthy adults. Balance was assessed using Mini-BESTest and data was analyzed for the effect of age and gender on balance scores using two-way ANOVA. The comparison between male and female age groups was analyzed using Unpaired 't' test.

Result: The inferential statistics of two-way ANOVA had shown the mean ±SD of balance score was 27.85 ± 0.36, 27.5 ± 0.5,27.5 ± 0.5, 26.45 ± 0.5 for Group1,2,3 and 4 respectively with F = 2.643 ($p<0.05$). This result suggests that there was a statistically significant change in balance score between all age groups except group 2 versus 3.The mean ± SD of balance score for males was 28, 28, 27.13, 26.16 ± 0.71 with the F value = 78.97 ($p<0.05$) and for females was 27.7 ± 0.465, 27.03 ± 0.18, 27, 26 with F = 235.193 ($p<0.05$). This result suggests that there was a statistically significant change in balance score among all age groups for both genders. Inferential statistics of unpaired 't' test had shown the mean ± SD of balance score was 27.325 ± 0.927, 26.93 ± 0.657 for total male, total female subjects from all groups respectively. It suggests the difference between males and females is statistically significant ($p= 0.0002$).

Conclusion: The age and gender related balance evaluation by using mini BESTest showed that balance declines as age increases in both gender, but decrement varies differently among gender.

Keywords: Balance, mini-BESTest, age-related balance, gender-related balance.

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[1]Yenepoya Physiotherapy College,
YenepoyaUniversity, Karnataka, India.
E-mail:abdullatheefke@yahoo.in
[2]Associate Professor,
Yenepoya Physiotherapy College,
Yenepoya University, Karnataka, India.
E-mail: thangaduraic@yenepoya.edu.in

CORRESPONDING AUTHOR

[*3]**Shaikhji Saad Mohamed**

Department of Physiotherapy,
Prime Healthcare Group, Dubai,
United Arab Emirates.
E-mail: shaikhjisaad@gmail.com

INTRODUCTION

Balance is the body's ability to maintain its center of mass over the base of support. This ability relies on the integrated and coordinated functioning of person's musculoskeletal, sensory and central nervous system. The somato sensory system helps in maintaining the balance and postural stability by receiving input from articular, cutaneous, mechanoreceptors and proprioceptors which are sent to acentral nervous system where it is processed and produces are sponse to changes in the internal and external environment [1,2].

The ability to maintain balance is essential to nearly daily living all activities. Impairments of balance are common and debilitating conditions but can be a major disabling condition. People with chronic balance disorders are significantly disabled in many day-to-day functions. It is estimated that at least half of the overall population of the United States are affected by a balance or vestibular disorder sometime during life. Several groups are particularly at risk [3].

The Balance Evaluation Systems Test (BES Test) is a balance assessment tool used to assess the possible causes of imbalance. It consists of 36 items grouped intosix sections. Each section tests various components such as Biomechanical constraints, Stability limits, and verticality, Anticipatory postural adjustments, postural responses, Sensory orientation and Stability in gait. The scores across sections allow a clinician to choose treatments that will focus on the primary deficits causing the balance impairment [4].

Horak FB et al.; 2009, study results suggest that BES Test to have high inter-rater reliability and moderate concurrent validity when it was used on individuals with Parkinson's disease, vestibular dysfunction, hip arthroplasty, peripheral neuropathy, and healthy controls to check the balance dysfunctions [4].

Leddy AL et al.(2011) also concluded that BES Test was more sensitive and specific at identifying falls and had more useful in predicting falls in mixed population than the Berg Balance Scale [5].

The BES Test is a very reliable assessment tool rule out underlying postural or physiological problems underlying a balance disorder as balance is the primary risk factor in the occurrence of falls [6-8].

However, the BES Test lasts for 30 to 35 minutes and also it decreases clinical utility and feasibility as it is time-consuming. Hence to check the limitations to improve the psychometric properties, the Mini-Balance Evaluation Test (Mini-BES Test) was developed. The Mini-BES Test takes only 10 to 15 minutes to perform, and it includes 14 of the original 36 BES Test items. Mini-BES Test is an effective brief clinical rating scale for Dynamic balance with good psychometric characteristics [5,9].[5,9]

Laurie A. King et.al; 2012,Mini-BESTest may be more useful in evaluating balance disorders in patients with PD, especially in those with mild PD or more subtle balance deficits [10].

For clinicians to use balance tests effectively, test norms must be established in samples across age decades of healthy community-dwelling populations [11].

Aging plays an important role in balance disorders and can best be appreciated by studying subjects free of comorbidities [12].

There is no study determining the Age and Gender specific normative values using Mini BES Test was found. Hence, this is the unique study aimed to assess the balance ability of independent, common men and women aged 21 to 60 using Mini BES Test. The purpose of the study was to assess the effect of age and gender on mini-BES Test balance scores in healthy adult males and females.

MATERIALS AND METHODS

After obtained an ethical clearance from Center for Ethics, Yenepoya University, a total of 240 healthy adult Subjects age ranged from 21-60 years were selected from Dakshina Kannada and Kasargod districts of Karnataka and Kerala respectively. The procedure was explained, and informed-consent was obtained from each subject prior to the study. Inclusion criteria: Subjects aging 20 to 60 living in the community and could ambulate independently. Exclusion criteria: Unwillingness to participate in the study, a Substantial neurological disorder such as Stroke, Acquired brain injury, Multiple Sclerosis, Peripheral neuropathy or Vertigo, Pregnancy, Chronic Systemic illness, Subjects who had diabetes mellitus or a musculoskeletal disorder requiring active management, Congenital Musculoskeletal deformities, Amputations, Recent Fractures or Surgeries.

The subjects were groupedinto four categories with the distribution 60 (30 male and 30 female) subjects in each group based on age ranges from 21-30, 31-40, 41-50, and 51-60. The Balance was assessed using Mini-BESTest which comprises 14 tasks as follows: the subjects were tested with flat-heeled shoes or shoes and socks off.

- **Sit to Stand:** The subjects were asked to cross the arms across chest and stand up, the movement initiation and use of the hand on their thighs or thrust forward were observed.
- **Rise to Toes:** The subjects were asked to place their feet shoulder width apart and place their hands on their hips, look straight ahead,movement initiation and use of the hand on their thighs or thrust forward were observed.

- **Stand on One Leg :** The subjects were instructed to look straight, place their hands on their hips, bend one leg behind them, Then they were asked to stand on one leg as long as they can, The subjects were asked to look straight, place their hand on their hips, bend one leg behind them. The number of seconds they can hold posture up to a maximum of 30 seconds was recorded, and movements of the hands and legs were observed.
- **Compensatory stepping correction – forward:** The subjects were instructed to stand with their feet shoulder width apart and arms at their sides. They were asked to lean forward against examiner's hand beyond

their forward limits. Elicitation of a step is observed when examiner suddenly leave the hand

- **Compensatory stepping correction – backward:** The subjects were instructed to stand with their feet shoulder width apart and arms at their sides. They were asked to lean forward against examiner's hand beyond their backward limits. Elicitation of a step is observed when examiner suddenly leave the hand
    - **Compensatory stepping correction – lateral:** The subjects were instructed to stand with their feet together, arms at their sides and to lean against examiner's hand beyond their sidewise limits. Elicitation of a step is observed when examiner suddenly leave the hand
    - **Stance on a firm surface -EYES OPEN:** The subjects were instructed to stand on a normal ground (firm surface) with their eyes open and asked them to place their hands on hips, place their feet together. And they were instructed to look ahead and maintain balance as much as possible until the examiner asks to stop. The examiner recorded the time to a maximum of 30 seconds and movements of the legs, and swaying posture is checked.
- **Stance eyes closed-foam surface (Feet together):** The subjects were instructed to stand on a foam surface with hands on hips, they were instructed to place their feet together until almost touching. Atlast asked them to look straight ahead, Close their eyes and stay as balanced as possible until the examiner asks to stop. The time was recorded by the examiner to a maximum of 30 seconds according to the subject's performance. If the subjects were unable to stand for 30 seconds, they were allowed to repeat the trial once more, and the average was recorded. Change of position and swaying of posture is checked.
- **Incline stance – Eyes closed (Toes-up):** The examiner helped subjects to stand on an inclined ramp with their toes toward the top and asked them to place their feet shoulder width apart. And they were asked to place their hands on hips. Change of position and body movements are observed.
- **Change in Gait Speed:** Individuals were asked to walk at normal speed. Then they were instructed to walk according to the command given by the examiner when the examiner commanded fast, they walked as much fast as they can, and when commanded slow they walked very slowly. Subjects were allowed to take few steps (3 to 5) at normal speed, few steps (3 to 5) fast, followed by 3 to 5 steps slow, according to the command 'slow' and 'fast' change of speed is observed.
    - **Walk with Head Turns – Horizontal:** The subjects were instructed to walk according to the command given by the examiner. First they were asked to turn their head towards theright and look right and followed by head turns towards left and look left and asked them to keep themselves in a straight line. They were given commands to turn "Right and Left" every 3-5 steps. Alteration of body movements is observed.
    - **Walk with a pivot turn:** The subjects were instructed to walk at their normal speed and then "turn and stop" as fast as they can and face towards opposite direction and stop. Instructed to keep their feet close together after the turn. Alteration of body movements is observed.
- **Step over the obstacles:** Two shoe boxes (9" /21 cm) placed with 10 feet distance and away from where the subject would begin walking. The subjects had to walk at their normal speed; Then they were instructed to step over the obstacles, not around them and keep walking. Alteration of body movements is observed.
- **Timed get up and go with a dual task:** Individuals are given verbal instructions to stand up from a chair, walk 3 meters as quickly and safely as possible, cross a line marked on the floor, turn around, walk back, and sit down. The test includes the time the individual takes to get out of the chair after he/she is told to "go."Then the subjects were asked to perform the test with a dual task. Individuals were asked to complete the test while counting backward by threes from a randomly selected number between 20 and 100. Deviations are observed.
    - The grading is done by using 0=normal,1=moderate, and 2=severe

Materials

Temper foam (4-inch thick medium density),Chair without armrests and wheels, an inclined ramp, Stopwatch, Ruler, A box (9-inch height) and the3-metre distance measured out from the chair and marked with tape, Consent form, and Data Sheet/Subject Performa.

Statistical methods

The collected data were statistically analyzed by ANOVA and unpaired t-test. The effect of age and gender on balance scores was analyzed using two-way ANOVA. The comparison between male and female age group was analyzed using unpaired t test. Scistatcaculator software was used for analysis.

RESULT

Table 1(a) and Table 1(b) showed the Mean balancing score for all the four groups. The mean balancing score for the group one Vs group two, group one Vs group three, group one Vs group four, group two Vs group four, group three Vs group four are statistically significant. The mean balancing score for age group 2Vs group 3 is statistically not significant; it shows that there is no significant difference in balance between these age groups. The result indicates that balance score decreased as the age increased from 20 years to 60 years, the balance decreased from 30 years to 40 years but from 4o years to 50 years there was no decrement in balance, and from 50 years to 60 years the balance score showed decrement. The result indicates that balance score decreases as the age increases, but remains same from the age 30 to 50 and further decreases above the age of 50 to 60.

Table 1(a): Mean balance score of all subjects in different age groups

Sl. No.	Age Groups (Total)	Balance score	
		Mean	SD
1	Group1 (20-29) {60 subjects}	27.85	0.360
2	Group2 (30-39) {60 subjects}	27.50	0.503
3	Group3 (40-49) {60 subjects}	27.50	0.503
4	Group4 (50-59) {60 subjects}	26.45	0.501
F=2.643		p<0.05	

Table 1(b): Comparison of the level of significance among the group.

Sl. No.	Age Groups (Total)	p Value	Result
1	Group1 vs Group 2*	<0.05	0.0000*
2	Group1 vs Group 3*	<0.05	0.0000*
3	Group1 vs Group 4*	<0.05	0.0000*
4	Group2 vs Group 3	>0.05	0.152
5	Group2 vs Group 4*	<0.05	0.0000*
6	Group3 vs Group 4*	<0.05	0.0000*

Significant*

Table.2 shows gender wise comparison of all the subjects in all the four groups, Unpaired T- test was used to check mean balancing score. The mean balance score for total male subjects is 27.325, and thestandard deviation is 0.927 whereas for the total female subject is 26.93,and thestandard deviation is 0.657. A significant statisticdifference (p= 0.0002) was found between the groups, which shows that there is difference in balance between males and females.

Table 2: Comparison of mean balance score for total male and female from all the groups

Sl. No.	Age group	Mean	SD	Overall SD	p Value
1	Male n=120	27.325	0.927	0.803	0.0002*
2	Female n=120	26.93	0.657		

Significant*

Table 3 shows gender wise comparison of all groups. It shows there is a significant difference between Groups 1 and 2, whereas between Groups 3and Group 4 it is not statistically significant. This result shows that there is a significant difference in the balance within the groups between males and females for group 1 and 2. But, there is no significant difference within the groups for group 3 and 4.

Table 3: Gender wise comparison for mean balance score within all the four age groups

Sl. No.	Age Group	Gender	Mean	SD	Overall SD	p value
1	Group1 (20-29)	Male	28	0	0.32	0.0008*
		Female	27.7	0.46		
2	Group2 (30-39)	Male	28	0	0.129	0.000*
		Female	27.033	0.182		
3	Group3 (40-49)	Male	27.13	0.73	0.516	0.321
		Female	27	0.000		
4	Group4 (50-59)	Male	26.1	0.791	0.559	0.253
		Female	26	0.000		

Significant*

DISCUSSION

The study was designed to assess the effect of age and gender on mini-BES Test balance scores in healthy adult males and females. 240 healthy adult males and females were selected and evaluated by using Mini-Balance Evaluation Systems Test. We found that subjects were able to perform simple tasks easily whereas the majority of them faced difficulty in performing challenging tasks. Among all the 14 items of mini-BES Test, most of the subjects failed in performing the third item (standing on one leg with eyes closed) and 14th item (dual task) and almost all the subjects were performing the anticipatory task sitting to standing and none of the subjects have failed in stepping strategies (forward, backward and lateral).Our results are concordant to Marco Godi et al. (2013) who found that mini-BESTests has lower ceiling affect and higher reliability and greater accuracy which represents a more comprehensive measure of balance, with items (e.g., compensatory steps, walking with dual task) that can challenge patients with even minimal impairment in balance function [13].

The study result showed that there is the statistically significant difference in mean balance scores between all four groups of male and female subjects except for males in group 1 and 2. It implies that the decline in balance scores of both males and females in all four groups was similar and hence balances declines in both the sexes as the age increases. Teresa M Steffen et al.(2002)study also showed a similar trend with age-related decline in balance for both male and female subjects [14].

Gender wise comparison between male and female in each age group for the mean balance score was done by using unpaired t-test. This result shows that there is the difference in the balance between males and females within the groups for group 1 and 2 where males had higher balance scores and females had lesser scores.This implies that females experience more decline in balance than males and females are more prone to falls. This difference can be because of more age-related degenerative changes in females. This result in concordance with Wei-LI Hsu et al.(2014) who suggested that women experience more falls than men, as women have more osteoporotic changes, there is a

more cortical bone loss in women than in men [15].

The study found that there was no significant difference between males and females in mean balance score for group 3 and group 4. The results were nearly similar for both the genders. The study also found that mean balance score for both males and females decrease more from 2nd decade to 3rd decade and furthermore reduces from 3rd decade to 4th decade and more reduction in a5th decade. This implies that balance in both males and females declines as they increase in age. Our results are in agreement with Teresa M Steffen et al. (2002) a study which also showed that the mean balance score declined for both male and female subjects as they age [14].

CONCLUSION

The study concluded that age and gender do have an effect on balance scores when assessed using the BES Test. In males, there is no decrease in balance from 20 years of age to 40 years. It declines gradually from 40 years of age to 60 years. Whereas in females the balance starts to decline from 20 years of age until 40 years, but the balance remains the same from 40 years to 50 years of age, and then there is a further decline from 50 years to 60 years. So Gender wise male and females both show a decrease in balance, but the effect is different among both.

The present study concludes that Age wise males and females both present a decline of balance. So as we age the risks of fall increases due to a decreasein balance.

Our study was limited to assessing the effect only and did not include any educational measures on how to prevent falls and related exercises; future studies can include educational measures and exercise prescription.

In the presentstudy, the subject age group selected was above 20 years, and below 60 years, future studies can include subjects above 60 years of age where falls are more common, to increase the generalizability of the data.

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