VISUAL CONTRIBUTION TO STATIC BALANCE OF SEDENTARY UNIVERSITY STUDENTS

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Abstract
The aim of this study was to measure the static balance of participants on both hard and soft surfaces. The study also examined the time difference on the balance measures of participants on hard and soft surfaces and with eye open and eyes closed. The participants for the study comprised undergraduate students of the Department of Physical and Health Education of the Obafemi Awolowo University, Ile-Ife. 18 participants comprising 7 females and 11 males took part in the study. This study adapted the Romberg balance test. To avoid fatigue of the legs, participants were asked to stop when they are able to maintain balance for up to 5 minutes. Participants were given 5 minutes of rest between each test. The first test was performed with eyes open and then with eyes closed on hard and soft surfaces. The mean age (Female: 26.29 ± 3.04 and Male: 25.43 ± 2.15), weight (Female: 68.29 ± 11.6 and Male: 67.86 ± 6.3) and height (Female: 163.86 ± 7.97 and Male: 177.71 ± 9.83) of the participants. The female participants had a mean static balance test EO measures of 210.43 ± 91.07 and EC measures of 61.71 ± 82.03 while the male participants had a mean static balance test EO measures of 237.14 ± 86.52 and EC measures of 76 ± 75.24 on a hard surface. The female participants had a mean static balance test EO measures of 140.29 ± 99.52 and EC measures of 50.29 ± 47.14 while the male participants had a mean static balance test EO measures of 186.71 ± 133.23 and EC measures of 67.86 ± 77.89 on a soft surface. It was concluded that participants had better static balance measures when eyes were open than when eyes were closed on both hard and soft surfaces.
Keywords: ***Balance, static balance, Motor Skills, Visual conditions***

Introduction

Vision is of utmost importance for maintaining balance in humans. This is so because information about the orientation of the body in space is collected through vision. This is evident in humans as the sway in posture is more with eyes closed than with eyes opened (Cornilleau-Pérès et al., 2005). The upright standing position of humans is made possible because the central nervous system combines visual contributions with somatosensory and vestibular data. Performance of routine functional movement, sporting activities, exercises, limb coordination and range of motion of joints are adjusted and controlled safely as a result of combined sensory information from the vestibular, visual and somatosensory systems providing guided motor responses (Hammami, Behm, Chtara, Othman, & Chaouachi, 2014).

The role of vision cannot be overemphasised in maintaining postural balance (Berthoz, 2001). Several researches have been done on postural control and orientation by examining the movement of the eyes (Crémeux & Mesure, 1994), head, body and limbs (Imai, Moore, Raphan, & Cohen, 2001) in space while executing a motor task in different environment (Chapman, Needham, Allison, Lay, & Edwards, 2008). There is substantial amount of research investigating visual role in posture among the elderly population (de Oliveira, da Silva, Dascal, & Teixeira, 2014), in children with diseases (Houghton & Guzman, 2013), in healthy normal-weight and overweight children (D'Hondt et al., 2011) and among athletes(Steinberg et al., 2016).

While postural stability is the ability to maintain the position of the body within the base of support (Salsabili, Bahrpeyma, Forogh and Rajabali, 2006 and Shumway-Cook and Woollacott, 1995). Balance, postural control or equilibrium are concepts used to describe how the body is kept in an upright position and, when necessary, adjust this position (Piirtola and Era, 2006). Postural stability is an important component in maintaining an upright position and in maintaining balance during normal daily movements and activities (Alexander, Réne and Bruce, 2010). The sensory system is very important in the maintenance of posture and plays a main role in co-coordinated movement of extremities. Central Nervous System (CNS) is responsible for integrating all sensory information to assess the position and motion of the body in space. Visual input is important to integrate the impulse of CNS via the vestibular apparatus, with the subject’s physical environment. The proprioceptive control of balance involves mechanoreceptors, muscle tendons and ligaments surrounding a joint, providing important sensory information on body position and its movement. Visual deprivation results in an increase in postural sway in studies of healthy participants (Alexander, 2011, Popa, Bonifazi, Volpe, Rossi and Mazzocchio, 2007 and Kuukkonen and Malkia, 2000).

Balance testing can be broadly divided into two static and dynamic balance tests. Static balance indicates conditions where the base of support (BOS) and body remains relatively stationary (Maki and Mcilroy, 1996). Dynamic balance indicates conditions where the body and/or its segments are in a state of motion, such as when walking, running, jumping, throwing, or lifting (Maki and Mcilroy, 1996). The most common measure of static balance is the Sharpened Romberg balance test which involves a single limb support. Other tests of static balance include the Postural Stress Test (PST), Posturography, and the Clinical Test for Sensory Interaction in Balance (CTSIB). Balance impairment is highly prevalent in patients with head injuries, peripheral neuropathy or vestibular disorders (Black, Zafonte and Milli, 2000; Geurts, Ribbers, Knoop, and van Limbeek, 1996 and Mizrahi, Groswasser, Susak and Reider-Groswasser, 1998). Balance is not only affected in those with disease processes or trauma, it has also been documented in healthy senior citizens (Vellas, Rubenstein, and Ousset, 1997; Vellas, Wayne, Romero, Baumgartner, Rubenstein, and Garry, 1997 and Hurvitz, Richardson, Werner, Ruhl, and Dixon, 2000).

The aim of this study was to measure the static balance of participants on both hard and soft surfaces. The study also examined the time difference on the balance measures of participants on hard and soft surfaces and with eye open and eyes closed.

Method and materials

The participants for the study comprised third year students of the Department of Physical and Health Education of the Obafemi Awolowo University, Ile-Ife. Eighteen participants comprising 7 females and 11 males took part in the study. The procedure was explained to them and informed consents were obtained from all the students. This study adapted the Romberg balance test. The Romberg test requires a person to stand on one leg, with arms folded across his/her chest for as long as possible, up to five minutes for this study, with the eyes opened and then with the eyes closed. The participant stood on one leg (most preferred leg). The participants were given 20 seconds to practice the balancing test before starting the test. The timing stops when the elevated foot touches the ground or the person hops or otherwise loses the balance position. To avoid fatigue of the legs, participants were asked to stop when they are able to maintain balance for up to 5 minutes. Participants were given 5 minutes (300 seconds) of rest between each trial. The first trial of the balance test was performed with eyes open and the second with eyes closed on a hard surface and then on a soft surface. The balance measures were recorded in seconds.

The instruments used for the study were a flat hard and non-slip surface, a form and a stop watch. Data from the study was analysed using descriptive statistics of mean and standard deviation. A two factor analysis of variance (ANOVA) was used to determine if there was any significant difference between the surfaces (hard and soft) and the visual condition (eyes open and eyes closed) measures of participants. Data was analysed with Microsoft Excel and statistical significance was set at $p < 0.05$.

Results

Table 1 shows the mean age (Female: 26.29 ± 3.04 and Male: 25.43 ± 2.15), weight (Female: 68.29 ± 11.6 and Male: 67.86 ± 6.3) and height (Female: 163.86 ± 7.97 and Male: 177.71 ± 9.83) of the participants.

Table 1: Summary of physical attributes of participants

	Age (yrs) Mean ± SD	Weight (kg) Mean ± SD	Height (cm) Mean ± SD
Female	26.29 ± 3.04	68.29 ± 11.6	163.86 ± 7.97
Male	25.43 ± 2.15	67.86 ± 6.3	177.71 ± 9.83
Group mean	25.61 ± 2.43	68.11 ± 8.53	169.89 ± 11.08

Table 1 shows the mean age (Female: 26.29 ± 3.04 and Male: 25.43 ± 2.15), weight (Female: 68.29 ± 11.6 and Male: 67.86 ± 6.3) and height (Female: 163.86 ± 7.97 and Male: 177.71 ± 9.83) of the participants.

Table 2 shows the summary of the means for static balance test measures of male and female participants with eyes opened (EO) and eyes closed (EC).

Table 2: Summary mean score of the participants balance test measures (seconds).

	Hard Surface		Soft Surface	
	EO (Sec)	EC (Sec)	EO (Sec)	EC (Sec)
Female	210.43 ± 91.07	61.71 ± 82.03	140.29 ± 99.52	50.29 ± 47.14
Male	237.14 ± 86.52	76 ± 75.24	186.71 ± 133.23	67.86 ± 77.89
Group mean	240.77 ± 82.33	105.11 ± 103.79	193.83 ± 116.68	79.17 ± 80.77

In table 2, the female participants had a mean static balance test EO measures of 210.43 ± 91.07 seconds and EC measures of 61.71 ± 82.03 seconds while the male participants had a mean static balance test EO measures of 237.14 ± 86.52 seconds and EC measures of 76 ± 75.24 seconds on a hard surface. Table 2 also shows that the female participants had a mean static balance test EO measures of 140.29 ± 99.52 seconds and EC measures of 50.29 ± 47.14 seconds while the male participants had a mean static balance test EO measures of 186.71 ± 133.23 seconds and EC measures of 67.86 ± 77.89 seconds on a soft surface respectively.

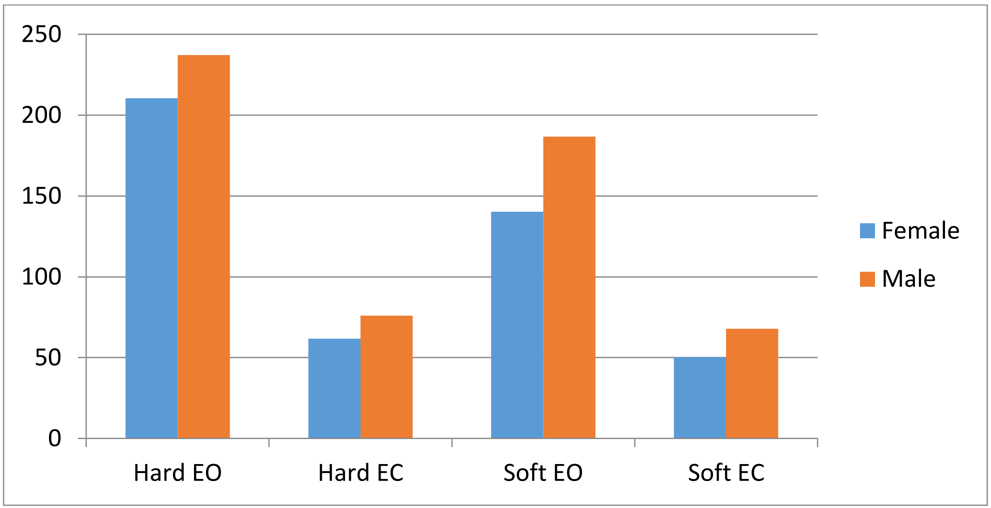

Figure 1: Bar chart of the static balance measurement of both male and female participant on hard and soft surfaces with eyes closed and opened.

From the bar chart in figure 1, mean static balance measures of the participants show that the male participants had a higher balance measures than the female participants in both hard and soft surfaces and with eyes closed and eyes opened.

Table 3 shows a two factor analysis of variance comparison of the female participants. The static balance measures on surface type (hard and soft surfaces) and visual conditions (eyes opened (EO) and eyes closed (EC).

Table 3: Two factor ANOVA for the female participants balance measures on surface types and visual conditions

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	11644.32	1	11644.32	1.715617	0.202658	4.259677
Columns	99722.89	1	99722.89	14.69268	0.000802	4.259677
Interaction	6032.893	1	6032.893	0.888857	0.355182	4.259677
Within	162894	24	6787.25			
Total	280294.1	27				

A two factor ANOVA was done for the female participants' measures as shown in table 3. Results showed that there was no statistical significant difference between the hard and soft surfaces in terms of static balance (F (1, 24) = 4.25, $p > 0.05$). There was however a significant difference between the EO and EC conditions of static balance (F (1, 24) = 4.25, $p < 0.05$). The participants had a better static balance in EO condition than the EC condition. Result further shows that there was no significant interaction of the surface type and visual condition (F (1, 24) = 4.25, $p > 0.05$).

Table 4 shows a two factor analysis of variance of male participants. The static balance measures on surface types (hard and soft) and visual conditions (eyes opened and eyes closed).

Table 4: Two factor ANOVA for the male participants balance measures on surface types and visual conditions

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Surfaces	12445.45	1	12445.45	1.234363	0.273194	4.084746
Conditions	182535.4	1	182535.4	18.10419	0.000122	4.084746*
Interaction	26.27273	1	26.27273	0.002606	0.959542	4.084746
Within	403299.8	40	10082.5			
Total	598306.9	43				

*p<0.05

Results in table 4 showed that there was no statistical significant different between the hard and soft surfaces in terms of static balance (F (1, 40) = 4.08, p>0.05). There was however a significant difference between the EO and EC conditions of static balance (F (1, 40) = 4.08, $p < 0.05$). The male participants had a better static balance measure under the EO condition than the EC condition. Result further showed that there was no significant interaction effect between surface types and visual conditions (F (1, 40) = 4.08, $p > 0.05$).

Table 5 shows a two factor analysis of variance of the participants (male and female) on static balance measures for surface types (hard and soft) and visual conditions (eyes opened and eyes closed).

Table 5: Two factor ANOVA for participants balance measures on surface types and visual conditions

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	23871.12	1	23871.12	2.533629	0.116082	3.981896
Columns	281875.3	1	281875.3	29.91764	6.99E-07	3.981896
Interaction	1974.014	1	1974.014	0.209518	0.648605	3.981896
Within	640676.4	68	9421.712			
Total	948396.9	71				

Result on table 5 shows that there was no statistical significant difference between static balance on hard and soft surfaces (F (1, 68) = 3.98, $p > 0.05$). There was however a significant difference between the EO and EC conditions (F (1, 68) = 3.98, $p< 0.05$). This is an indication that there was a difference in the static balance measures of the participants when balance measures were taken with EC and with EO. The participants had a better balance measures with EO than with EC. There was however no significant interaction effect between surface type (hard and soft) and visual condition (EO an EC) (F (1, 68) = 3.98, $p > 0.05$).

Discussion

This study found out that both male and female participants had higher balance test measures in conditions with eyes open than with eyes closed on both hard and soft surfaces. This has established a typical performance of balance test in young adults. Potvin and Tourtellotte (1975) made a claim that young healthy adults should be able to balance on 1 limb with eyes closed for 30 seconds. Okawara & Usuda (2014) only 22 out of 66 patients were able to stand for more than 30 second on all surfaces. This study has showed that young adults can balance on 1 limb with eyes closed for more than 30 seconds on both hard and soft surfaces. This study however used young and healthy adults who have good postural control ability. Most other studies make use of aged population and recovery patients whom may not have good postural control abilities. In another study conducted by Bohannon, Larkin, Cook, Gear, and Singer (1984), it was found that there was a decreased in balance measure when the eyes were closed than when the eyes were open. Bohannon et al. also added that this decrease will continue with age. Bendo, Skënderi, and Veveçka (2014), found out that the effect of visual information on balancing the body movements is essential. Bendo et al studied the effect of vision and orientation in human balance and the results show that biomechanical parameters can be used in measuring body movements in postural stability.

Body characteristics had slight but considerable effects on the variations of body balance in balance tests. Okawara & Usuda (2014) investigated the influence of visual and supporting surface conditions on standing postural control in patients with post-stroke hemiplegia by measuring postural sway the further examined the associations of postural sway under these conditions with somatosensory impairments, clinical standing balance measures, and walking ability. Postural sway was significantly greater in the eyes-closed and foam rubber conditions than the eyes open and firm floor condition. In almost all conditions, sway length was significantly correlated with standing balance score, walking ability, and superficial sensory disturbance of the paretic side. Therefore, Okawara & Usuda (2014), concluded that patients with hemiplegia have a reduced ability to select or compensate for appropriate sensory information when there are changes in various conditions and that they require environmental exercises.

Conclusion

It was concluded that participants had better static balance measures when eyes were open than when eyes were closed on both hard and soft surfaces. Also, male participants had better static balance measures than the female participants on both hard and soft surfaces.

Limitations

The limitations of this study are that the balance test used measures only static standing balance and is therefore insufficient to inform clinical decision-making. A computerized force platform is commonly used to measure standing balance, however, this equipment is expensive and not readily. However, the static standing balance test used in the present study involves standing with eyes closed or open on a firm surface or foam rubber, is easy and safe to use and does not require any special or expensive equipment. Though results from this study showed a greater instability when eyes were closed than when eyes were open, an intervention should be done to show if there will be any effect on balance with both visual condition and on different surfaces.

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