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To find out the relationship between postural stability and body mass index using clinical tests like single leg stance and star excursion balance test in young healthy females

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Abstract

Background: Balance is a constraint that emerges from interaction of sensory, motor and central nervous system. Various factors influence postural stability, Body weight being one of them along with age, gender, foot length and height which contribute to static and dynamic balance. Obesity itself has already emerged as a worldwide co-morbidity. It is important to know if body weight has any effect on balance thereby determining the risk of falls and prevent injuries.

A correlation study was done on 44 healthy females aged 18 to 25 years who consented to participate in the study after taking permission from the institutional ethical committee. They were assessed by the single leg stance (SLS) and star excursion balance test (SEBT) along with their demographic data. The values of SEBT were normalized with the limb lengths of the participants. Body mass index (BMI) was measured by the formula of BMI= weight in kg/ height in m^2. Best of three trails were taken into consideration. The relationship between BMI and balance values obtained was analysed using Pearson's correlation coefficient.

Results: The correlation between BMI and static balance eyes open was 0.002. The correlation between BMI and static balance eyes closed was 0.189. The correlation between BMI and dynamic balance were also insignificant in all the eight directions. Therefore, non-significant correlation was obtained between all the components of balance testing and body mass index. i.e. ($r<0.1$) and ($p>0.1$) in this study population.

Conclusion: This study aimed at establishing the effect of body mass index on both static balance and dynamic balance. The correlation was insignificant in the study population taken. Thus, to conclude that BMI and postural stability is independent of each other.

Keywords: Balance, Body Weight, Young Females

1. Introduction

Balance is a crucial aspect of activities of daily living. It is a condition in which all the forces acting on the body are balanced in such a way that the centre of mass is within the base of support. Stability, postural control and function of an individual are achieved through integrated control of multiple systems in the body. Adaptive postural control allows the individual to appropriately modify sensory and motor systems in response to changing tasks and environment. Balance emerges from interaction of Sensory system including visual, auditory and proprioceptive systems, Motor system and Central nervous system [1].

Balance is of two types- static balance and dynamic balance. There are various factors that have influence on balance of an individual. They are internal forces and external forces affecting the balance [2, 3].

Obesity itself has already emerged as a worldwide co-morbidity. It is accumulation of adipose tissue via hypertrophy or hyperplasia of lipid cells in the body [3].

Increased body mass changes the body geometry, there is shifting of line of gravity, increases the mass of different segments of the body which imposes functional limitations pertaining to the biomechanics of activities of daily living that may predispose the individual to falls, disabilities and injury [4].

Postural stability is the ability to control the body's centre of mass (COM) over its base of support (BOS) to prevent the body from falling and to achieve specific functional tasks. Stability improves with a larger BOS, a lower COM, and/or a more central COM within the same BOS [5].

Posture analysis is vital for clinical assessments in physical medicine and rehabilitation. It is important to establish the relationship between postural balance and anthropometric measurements, to determine the postural deviation in developing treatment programs in clinic and evaluating and treating the different deformities that may have occurred.[6]

According to Hue O, when an obese person is submitted to a small and normal forward oscillation, an abnormal distribution of body fat yields to an increased restabilizing ankle torque needed to regain balance. This suggests that, when experiencing daily postural stresses and perturbations, obese people, particularly with abnormal abdominal fat distribution, may be at a higher risk of falling than lightweight individuals because they have to generate ankle torque more rapidly and with a much higher rate to recover balance [4].

According to Himes CL, individuals with obesity grades I and II face higher risk of fall while people with obesity grade III and underweight face lesser risk of falls [7].

A force platform is a highly sensitive measuring instrument that measures the ground reaction forces generated by a body standing on or moving across them, to quantify balance, gait and other parameters of biomechanics. Most common areas of application are medicine and sports. But it is unaffordable, inaccessible and cumbersome.

Therefore, the researchers thought of using clinical measures like single leg stance (SLS) and star excursion balance test (SEBT) which have high validity and reliability and are easier to perform in order to assess postural stability in young healthy females with varying body mass index.

1.1 Aim

To find out the relationship between postural stability and body mass index using clinical tests like single leg stance and star excursion balance test in young healthy females.

1.2 Objective

To assess single leg stance with eyes open and eyes closed.

To assess the star excursion balance test.

To assess the body mass index of each subject.

To establish a correlation between single leg stance test (static balance) and body mass index.

To establish a correlation between star excursion balance test (dynamic balance) and body mass index.

2. Methodology

2.1 Material

Star excursion balance test chart

Weighing machine and measuring tape for body mass index

Sample Size: 44

Study Design: Correlation study

Study Setting: Community dwelling young healthy females aged 18 to 25 from Pune city.

Sampling Design: Convenient sampling

Inclusion Criteria: All young healthy females in the age group of 18 to 25 years

2.2 Exclusion Criteria

- Any recent fracture or dislocation involving lower extremity
- Any neurological disorders
- Limb length discrepancy
- Foot deformities
- Cognitive impairments

2.3 Technique

Informed consent was taken by the participants approved by the ethical committee. All participants were explained the procedure, the tests, and were made sure about confidentiality.

Forty-four healthy females were included in this study aged 18 to 25 years. Demographic data was taken of the subjects showing a wide range of anthropometric characteristics like height, weight, age, dominance and body mass index. Subjects with known exclusion criteria given above were not included in this study.

The data collected from the subjects was analysed. The static balance i.e., the Single leg stance test both eyes open and eyes closed and the dynamic balance i.e., Star excursion balance test were correlated individually with Body mass index of the subjects by using the Pearson's correlation coefficient in SPSS software version 22.

Body mass index was measured by the formula: BMI= weight in kg/ height in m^2 [3].

All the participants were assessed for their demographic data. Height, weight age and dominance were taken. Body mass index was evaluated using the above formula. The participants' BMI was correlated with the static balance and dynamic balance.

Balance stability was evaluated with single leg stance and star excursion balance test.

The subjects stood barefoot on their dominant leg were asked to stand straight with hands across their chest, other leg bent at 90-90. The subject is asked to concentrate on one point so that the head is vertical. Three trials were taken with both eyes open and eyes closed and timings were noted with the help of a stopwatch. Best of three was taken and documented [9].

For star excursion balance test, the participants were made to stand in the middle of a grid formed by eight lines extending out at 45° from each other. The participant was asked to reach as far as possible along each of the eight lines, make a light touch on the line and returning leg back to the centre of the grid.

Participants were instructed to make a light touch on the ground with the most distal part of the reaching leg and return to a double leg stance without allowing the contact to affect the overall balance. Following a 2 min rest period, participants performed three trails in each of the eight directions. They began with the anterior direction and progressed clockwise around the grid. All participants performed with the dominant leg because according to Phillip A. Gribble, the dependent t tests revealed no significant differences between right and left limb excursion distances; therefore, data for both limbs were combined for subsequent analyses. A significant correlation was found between height, weight and excursion distances in six out of eight directions i.e. ($p<.05$) for anterior, anetromedial, posterior, posteromedial, medial and anetrolateral. While non-significant correlation was found for lateral and posterolateral directions [8].

An assistant helped throughout the session to ensure that all the procedures were adequately followed and that the foot position was constant across all trails.

3. Result

Table 1 (Result)

The subjects participated in this study went through all the procedures of single leg stance test and star excursion balance test along with their demographic data.

The mean values of all the components of the tests are as given above.

The mean age of the subject population is 22$\pm$ 0.9068153 years of age.

The mean value of body mass index of the subject population is 22.58$\pm$ 4.1022260 kg/m^2 (normal grade of obesity)

The mean value of single leg stance eyes open best of three trials was 70.80 $\pm$ 43.778 seconds.

The mean value of single leg stance eyes closed best of three trials was 8.64 $\pm$ 6.232 seconds.

The mean values of all the eight directions in star excursion balance test were ranging from 63.57 cm to 73.95 cm.

Anterior Direction 73.95 + 16.301 cm
Anteromedial Direction 73.34 + 16.811 cm
Medial Direction 71.68 + 16.719 cm
Posteromedial Direction 68.57 + 14.987 cm
Posterior Direction 70.02 + 12.941 cm
Posterolateral Direction 64.73 + 13.515 cm
Lateral Direction 63.57 + 16.033 cm
Antero lateral Direction 71.41 + 16.865 cm

The directions which showed difference individually with body mass index were as follows:

Anteromedial direction with r 0.097
Anterolateral direction with r 0.093
Medial direction with r 0.082
Posteromedial direction with r -0.036 and p 0.815
Posterolateral direction with r -0.037 and p 0.810
Lateral direction with r -0.033 and p 0.831

Since all the values are ($r<0.1$) and ($p<0.1$), non-significant relationship was gained.

Posterolateral and lateral direction being the less distance covered than the other directions thereby supporting the article quoted by Phillip A. Gribble in considerations for normalizing measures of the star excursion balance test in the journal of measurement in physical education and exercise science [8].

Pearson's correlation test was used as both the components were parametric in nature. i.e., body mass index in kg/m^2, single leg stance in seconds, and star excursion balance test in cm.

SLS eyes open and eyes closed and SEBT eight directions (A, AM, M, PM, P, PL, L, AL) of both static balance and dynamic balance were correlated with body mass index of the subjects.

Non-significant correlation was obtained between all the components of balance testing and body mass index. I.e. ($r<0.1$) and ($p<0.1$).

4. Discussion

Balance is an important factor in every day chores. It is a condition where the individual remains erect without any falls, injuries and disabilities. It is possible when the forces act on the body in such a way that centre of mass and line of gravity are within the individual's base of support. To maintain balance there has to be combined effect of many external and internal factors. Body weight is one of the main factors which can predict a person's postural stability. Thus, obesity can impair an individual's balance. Therefore, the researchers thought of finding out the relationship between body mass index and balance.

The relationship between body mass index and static balance of the study population with vision and without vision was insignificant (0.002 and 0.189 respectively)

The relationship between body mass index and dynamic balance of the study population was also insignificant in all the eight directions although individually they did show changes.

In a study performed in children aged 8 to 12, 26 participants were studied to measure centre of pressure under one normal condition (eyes open and hard surface) and two challenging sensory condition (eyes closed and head back and eyes open and compliant surface). Smith A also showed that girls had significantly lower centre of pressure path velocity, smaller radial displacement and lower area velocity as compared to boys when the three conditions were pooled. Postural stability of girls had higher correlations with age, body mass, foot length and physical activity, but were more affected by altered sensory input information. Therefore, exercises like standing on unstable surface with eyes open instead of eyes closed and head back are more beneficial to children's postural stability control system.

It also stated that lower the centre of mass or a more central centre of mass / a centre of mass within the base of support or a wider base of support all results in a better postural stability of an individual.

Since women have a wider pelvis anatomically, and their most common site of excess fat accumulation is at the abdomen, hips, thighs, etc. this gives them a lower centre of mass thereby showing better postural stability than men.

Poor correlation between Balance and BMI was found due to less variability amongst the samples although 30% error was taken into consideration with context to the reference where Hue O stated that body weight is a strong predictor of an individual's postural stability. In this study 59 males were recruited with body mass index ranging from 17.4 to 63.8 kg/m2. Their postural stability was assessed using a force platform with and without vision. A stepwise multiple regression analysis was done. With vision, body weight accounted for 52% variance of balance. While age contributed to only about 3 %. Without vision, body weight accounted for 54%variance while age and height added a further 8% and 1% respectively. A decrease in postural stability is strongly correlated to an increase in body weight. Thus, suggesting that body weight is an important risk factor for impaired balance and activities of daily living.

With the help of this we would like to suggest that probably considering that a higher BMI would improve balance which was present in our subjects, the BMI did not affect the balance of our subject population due to insignificant correlation obtained between varying body mass index and postural stability.

The limitation of this study was that only females were taken as the participants. 50% of the study population were falling into normal grade of body mass index giving less variability of it on postural stability. While the future recommendations regarding this study would be taking a larger sample size which may help us establish the knowledge whether the body mass index does or does not influence the balance of young healthy adults. Each obesity grade can be correlated with body mass index to know the effect on balance by each grade of obese subjects. And many other variables like age can be taken into consideration with changes in postural stability of an individual.

5. Conclusion

This study aimed at establishing the effect of body mass index on both static balance and dynamic balance. The correlation was insignificant in the study population taken. Thus, to conclude that BMI and postural stability is independent of each other.

6. Acknowledgement

I am thankful to all my subjects who participated and gave their valuable time to my study.

I am grateful of all our colleagues to help us with their guidance and knowledge throughout the study.

7. Clinical Application

The clinical implication of this study includes increased need of public education and awareness about the effects of body weight on daily living. And to prevent obesity, its consequences like falls, injuries and balance impairments.

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