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Effects of Obesity on Balance And Gait in Young Adults.

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Abstract:

Background: Obesity is a major global health issue. Obesity is a medical condition in which excess body fat accumulation in adipose tissue that has adverse health effects along with many known systemic illness and disease, obesity is a risk factor for functional decline in both genders. Individual with higher body mass demonstrate difficulty in bending, lifting, carrying, kneeling etc. Problems with these basic activities lead to limitations in mobility.

Method: 30 obese and 30 non obese ages 18 to 29 years were recruited in this study. All samples were collected randomly, out of which 30 were subjects with normal weight (BMI from 18.0kg/m-24.9kg/m). Balance was measured by Berg Balance Scale (BBS) and Modified Star Excursion Balance Test (SEBT). Balance mobility was assessed by Timed up and Go (TUG). Gait was assessed by Dynamic Gait Index (DGI).

Results: It was found in our study that the balance in the obese individual of both genders were highly affected compared to the non-obese individuals of the same age group. (P < 0.0001) which was found in the graph of Berg Balance Scale. (P< 0.0003) which was found in the graph of Timedup and Go for mobility and balance, (P< 0.0001) found in the composite data Modified Star Excursion Balance Test in both limbs i.e. right and left. Also, in our study obese patients showed deviations in gait parameters. (P< 0.0001) which showed extreme significance in the graph.

Conclusion: The clinical implication of our findings is that obese young adult's exhibit poor balance control. Our findings suggested that there is effect of obesity on gait.

Keywords: Obesity, Balance, Gait, Berg Balance Scale

Introduction:

Obesity is a major global health issue. Obesity is a medical condition in which excess body fat accumulates in adipose tissue that has adverse health effects.

Obesity is a chronic disease in the same sense as hypertension and atherosclerosis. The etiology or cause of obesity is an imbalance between the energy ingested in the food and the energy expended. The excess energy is stored in fat cells that enlarge and/or increase in number. It is hyperplasia or hypertrophy of fat cells that is the pathological lesion of obesity. Enlarged fat cells produce the clinical problems associated with obesity either because of weight of extra fat or because of the increased secretion of free fatty acids and numerous peptides from enlarges fat cells.[1]

The consequence of these two mechanisms lead to many other health problems. Obesity is related to many medical complications, such as heart diseases, diabetes mellitus, breathing problems, cancers, and many disabling musculoskeletal conditions that impede quality of life.[2]

Body Mass Index (BMI) provides a source to measure the prevalence of obesity in the population and the risks associated with it. BMI is a simple index of weight for height that is commonly used to classify underweight, overweight and obesity in the population. It is defined as weight in kilograms divided by the square of height in meters (kg/m^2). Obesity is classified as body mass index ≥30.0.

Along with other systemic illness and diseases obesity is a risk factor for functional decline in both genders. Individuals with higher body mass demonstrate difficulty in bending, lifting, carrying, kneeling etc. Problems with these basic activities lead to limitations in motility.[3]

Obesity has effect on the individuals balance and gait. Studies have identified various negative consequences of obesity such as gait alterations, postural deficits, and greater risk of falling. Obesity is associated with functional decline, altered gait parameters and significantly higher metabolic cost walking compared to people with normal body weight [4]. Greve et al[5], showed that increased body weight produces antero-posterior instability in both sexes, and medio-lateral destabilization in males. Similar study suggests dynamic instability in obese prepubertal boys. They showed significantly greater sway areas and variability in medial/lateral directions and absence of significant frequency measures suggest that the instability observed in obese boys is caused by excess weight rather than underlying postural instability.[6]

Balance is a state of equilibrium. In order to maintain balance, postural control strategies must be sufficient to counteract forces that act to move the body out of equilibrium. Obesity which is a cause of low physical activity leads to muscle weakness which indirectly contributes to a factor for imbalance.

Balance is commonly described as the ability to maintain the center of mass (COM) with respect to the base of support (BOS). Several systems, such as the brain, vision, vestibular, proprioceptive sense, and musculoskeletal systems, contribute to the control of postural stability while standing.[7]Any deficits in these systems result in imbalance. Previous studies have suggested that obese individuals are at risk of falling[2]. Vincent et al[8] reported that obese individuals have reduced functional ability as compared with individuals with normal weight.

In obese individuals, body geometry is modified by the increased mass of body segments[9, 10]; for example, previous studies have reported that obese individuals have significantly greater trunk mass and that increased abdominal fatness is correlated with a higher BMI[9,10]. Increased abdominal fatness contributes to increased lumbar lordosis and anterior shift of the COG[2]. Another hypothesis concerns changes of sensory functions of lower limbs[11,12]. Hue et al[11] suggested that obese individuals have reduced sensory functions of lower limb due to the pressure generated by large mass. These altered body geometry and impaired senses impose functional limitations and postural imbalance that impact the activities of daily life[2]. Studies have shown improvement in stability and balance in individuals after a body weight reduction program entailing specific balance training[13]

Berg Balance Scale (BBS) is designed to help determine changes in functional standing balance over time. It is used as an outcome measure in order to measure the ability or the capability of the individual to maintain his balance. It is a 14 item scale that should be completed within 15-20 minutes. It’s scoring has a five point scale, ranging from 0-4. “0” indicates the lowest of function and “4” indicates the highest of function. The total score is of 56. It is interpreted by scoring ranging from 0-20 as high risk of fall, 21-40 as moderate risk of fall, and 41-56 as low risk of fall.

Modified Star Excursion Balance Test (SEBT) which is also known as “Y” Balance Test is used as an outcome measure to test balance in adults. Individual has to perform this test in three directions i.e. Anterior, Postero-medial, and Postero-lateral. Ability to perform n reach to a distance on single limb is checked.

Gait is locomotion pattern of an individual. Gait cycle has two main phases: Stance phase in which the foot is on ground, and the swing phase in which that same foot is no longer in contact with the ground and the leg is swinging through in preparation for the next foot strike.

Obesity is strongly related to gait abnormalities. Previous studies have suggested that with the increasing incidence of obesity, the musculoskeletal condition becomes a factor that interferes with the quality of life, functional capacity, and increased healthcare costs. Several studies have described the changes that affect obese individuals, from demonstrations to systemic complications suffered by the locomotor system, or musculoskeletal complaints, including changes in weight-bearing and postural balance.[5]

Obesity causes alterations in gait that are associated with an increased risk of falls. Several studies have found that walking speed, step length, and step frequency to be significantly lower in obese compared to the non-obese.[14]

Obese have a longer stance phase and greater period of double support.[15] De vita et al[15] have found that obese adults tend to have more erect posture while walking compared to non-obese adults. This is a result of reduced hip flexion and knee flexion. This posture provides some stability in the obese adults by counteracting an anterior displacement of COG, reducing the amount of corrective torque needed to maintain balance.[15]Since there is shifting of COM, in order to maintain it within the BOS the body uses strategies which leads to various gait deviations.

Spyropoulos et al[16] have suggested that obese individual require time to walk, obesity makes them walk slowly, take small strides, and remain in double support longer in order to maintain balance. Deviations from the obese gait pattern would result in instability and imbalance.[14] Authors also have found that the obese adults have a larger step width during walking which provides a wider BOS for balance.[16] The dynamic aspects of gait in the obese individual showed lower cadence, stride, speed, and foot angle, except for BOS which was greater.[14] These were consistent with poor skeletal muscle performance, high metabolic expenditure and constant physical exhaustion.[17]

Previous studies gave significant differences in temporal-spatial, joint motion and joint moment data between the obese and the non-obese participants. The obese individuals might adjust their gait characteristics in response to their heavy bodies to reduce the moment about the knee and the energy expenditure per unit time.[18] They showed that obese adults spend more time on stance phase and double support in walking.

Obesity is the leading cause many systemic illness which reduces mobility and may affect balance and gait. Hence there is a need to assess affection of balance and gait in obesity.

AIM:

- To assess effects of obesity on balance and gait in young adults.

OBJECTIVES:

- To assess the effect of obesity on balance by using Berg Balance Scale (BBS)
- To assess the effect of obesity on balance by using Modified Star Excursion Balance Test (SEBT)
- To assess the effect of obesity on balance by using Timed Up And Go (TUG)
- To assess the effect of obesity on gait by using Dynamic Gait Index (DGI)

MATERIALS AND METHODOLOGY

Study design: Comparative study

Study setting: Pune

Target population: Obese and Non Obese Young Adults

Sample size: 60

Inclusion criteria: Obese people between 18-29 years of age, Non obese people between 18-29 years of age, Both males and females, People whose consent have been obtained

Exclusion criteria: People who are below 18 years of age and above 29 years of age, People not willing to participate in the study, Subjects who have juvenile diabetics, Subjects who have any neurological conditions

Outcome measure: Berg Balance Scale. (BBS),Modified Star Excursion Balance Test. (SEBT) Timed Up And Go. (TUG), Dynamic Gait Index. (DGI)

PROCEDURE

Samples were selected according to the inclusion and exclusion criteria.They were explained about the aim and objectives of the study.Written consent forms were signed by the patients before starting the tests.

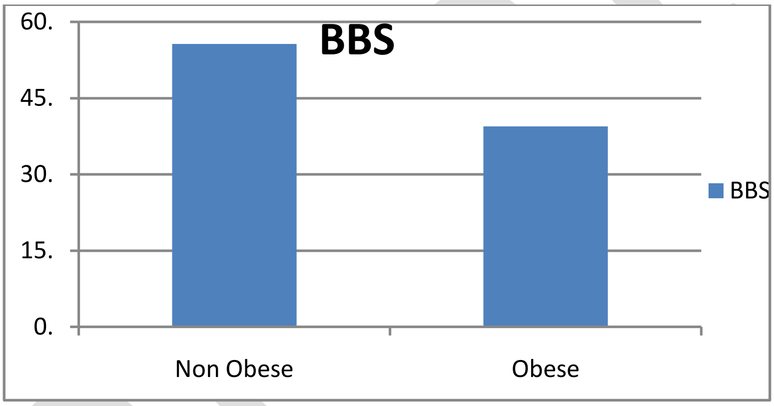
Balance was checked by Berg Balance Scale (BBS). A 15ft walkway was measured, subject was told to perform all the 14 items on the scale within a time of 15-20min. Score was calculated and interpreted.Balance was also measured by Modified Star Excursion Balance Test (SEBT). Subject was asked to perform reach outs while maintaining single leg stance. Subject is asked to reach with their free limb in the anterior, postero-medial and postero-lateral directions. In each test direction, 3 trails were taken. Leg length was measured of each subject and then average of all three readings was the divided with the leg length in order to get a composite score.

Balance and mobility was assessed by Timed up and Go (TUG). The test began in seated position. The subject was asked to stand up on therapist's command and walk 3 meters, turn around, walk back to the chair and sit down. Time was sopped and recorded as soon as subject sat down.
Gait was assessed by Dynamic Gait Index (DGI). 8 functional components were performed by the subjects and was marked out of three according to lowest category which applies.

RESULTS

TABLE 1: Comparison of mean of berg balance score of non-obese subjects with obese subjects.

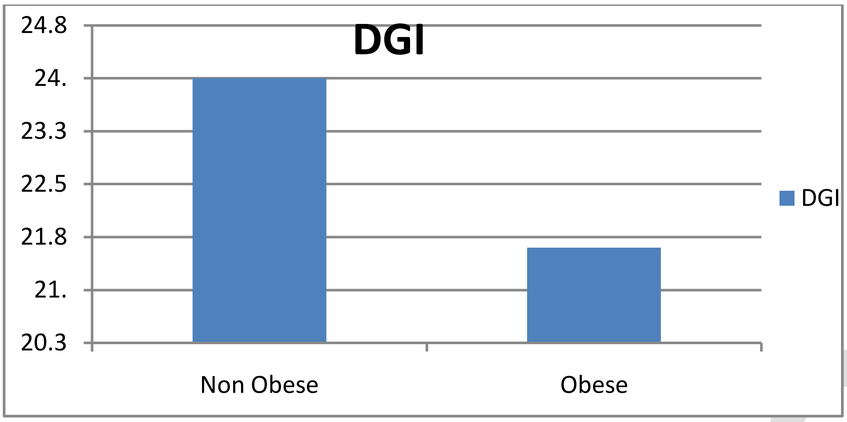
TABLE 1	BERG BALANCE SCALE (BBS)
NON-OBESE	55.63
OBESE	39.46



GRAPH 1: Comparison of mean of berg balance score of non-obese subjects with obese. P value is <0.0001 i.e. extremely significant

TABLE 2: Comparative mean value of Dynamic Gait Index in non-obese subjects and obese subjects

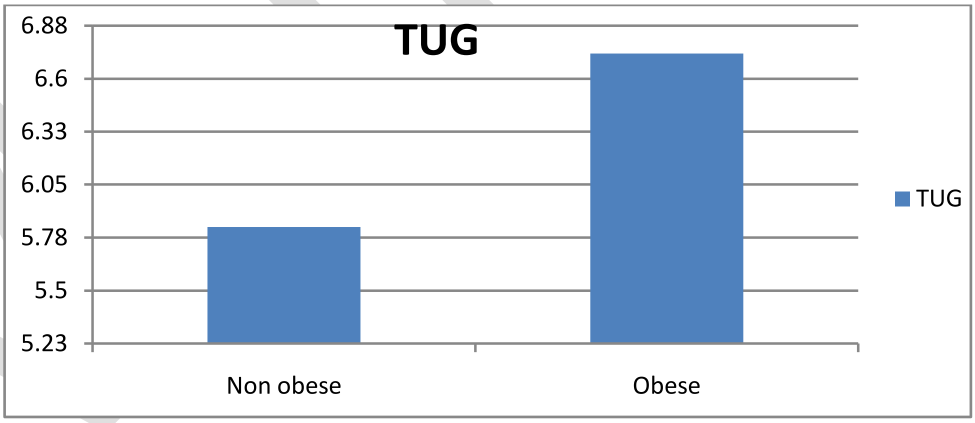
TABLE 2	DYNAMIC GAIT INDEX (DGI)
NON OBESE	24
OBESE	21.66



GRAPH 2: Comparative mean values of Dynamic Gait Index in non-obese subjects and obese subjects. P value is <0.0001 i.e. extremely significant.

TABLE 3: Comparison mean of timed up and go score of non-obese subjects with obese subjects

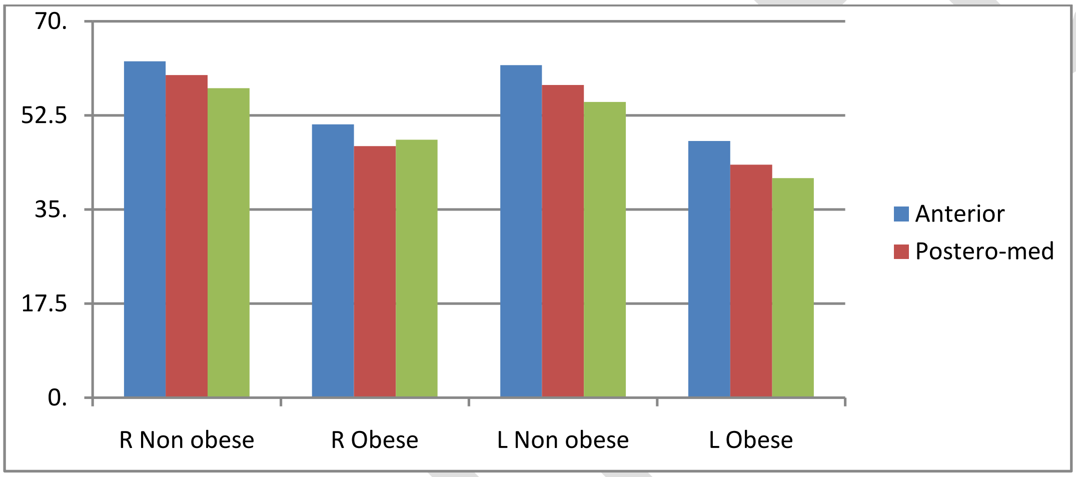
TABLE 3	TIMED UP AND GO (TUG)
NON OBESE	5.83
OBESE	6.73



GRAPH 3: Comparative mean value of timed up and go score in non-obese subjects and obese subjects. P value is <0.0003 i.e. extremely significant.

TABLE 4: Comparative mean value of reach distance for modified star excursion balance test in non-obese subjects and obese subjects.

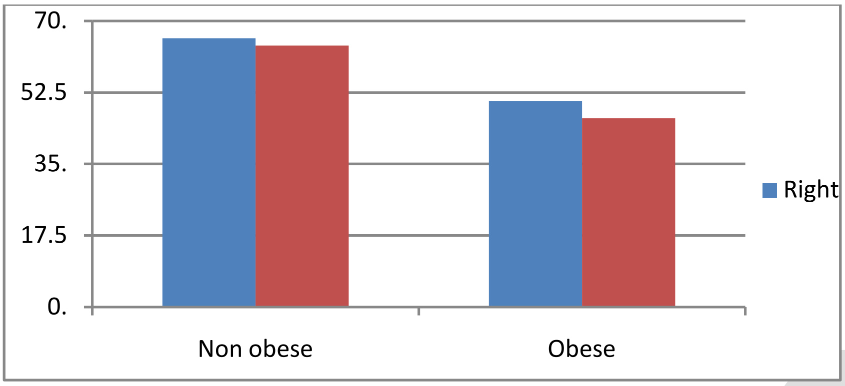
TABLE 4	NON OBESE-R	NON OBESE-L	OBESE-R	OBESE-L
ANTERIOR	62.56	61.83	50.86	47.76
POSTERO-MEDIAL	60	58.16	46.76	43.33
POTERO-LATERAL	57.53	55	48	40.86



GRAPH 4: Comparative mean between non obese and obese reach distance for SEBT

TABLE 5: Comparative mean between non obese subjects and obese subjects for the composite data of SEBT

TABLE 5	RIGHT	LEFT
NON OBESE	65.74	63.96
OBESE	50.46	46.24



GRAPH 5: Comparative mean between non obese subjects and obese subjects for the composite data of SEBT. P value for right composite data is <0.0001 i.e. extremely significant. And p value for left composite data is <0.0001 i.e. extremely significant

DISCUSSION

Obesity is a medical condition in which excess body fat has adverse health effects. To control weight and maintain general good health, attention should not only be paid to the food and drinks consumed but also to the amount of energy metabolized by physical activity. The World Health Organization recommends a minimum of 150 minutes of moderate-intensity aerobic exercises per week.

Obesity is a leading cause to many systemic illnesses which reduces mobility and thus affects balance and gait. Hence there was a need for the study of effects of obesity on balance and gait.In addition, the obese tend to have to have higher levels of functional limitations that the non-obese.[19]

In our study 60 subjects were recruited, in which both the genders were included. All the samples were collected randomly, out of which 30 were subjects with normal weight (BMI from 18.0kg/m²-24.9kg/m²) and 30 were obese subjects (BMI ≥30.0kg/m²). Written consent was taken and whole procedure was explained to them. In our study balance was assessed by three outcome measures, that are 1) Berg Balance scale, 2) Modified Star Excursion Balance Test, 3) Timedup and Go. Gait in our study was assessed by Dynamic Gait Index.

It was found in our study that the balance in the obese individuals of both genders were highly affected compared to the non-obese individual of same age group. (P<0.0001) which was found in Graph 1 of Berg Balance Scale, (P<0.0003) which was found in Graph 3 of Timed Up And Go for mobility and balance, (P<0.0001) which was found in Graph 5 of Composite Data Of Modified Star Excursion Balance Test in both limbs i.e. right and left. Goulding et al. found that the balance of obese individuals was poorer and the score of test was lesser in obese individuals than in non-obese individuals.

In our study obese subjects showed deviations in gait parameters. ($P<0.0001$) which showed extreme significance in Graph 2. Previous studies showed increase in the step width of obese individuals that in non-obese individuals ($P<0.01$) which was also evidenced by the studies of Spyropoulous et al[16] and Hills and Parker[20] who also found that obese had larger step width during walking, which provides a wider base of support (BOS) for maintaining balance while walking. They also found that obese subjects displayed a consistently higher double stance period at normal, fast and slow walking speeds.[20] Obesity modifies the body geometry by adding mass to different regions and influences the biomechanics of activities of daily living.[21]The increased body mass seems to produce postural instability in both genders as evidenced from our study. Similar postural instability was evidenced in previous study by Aparna Sarkar etal[14] but it has more impact on females of same age group. Cynthia Norkins,[22]observed that the walking speed of obese individuals was found to be decreased than that of non-obese individuals. Postural balance was improved in fee individuals following a weight reduction program combined with balance training[13].

Zoltan Pataky et al,[4] suggested that obese women have slower gait speed and accompanying shorter stride lengths, relatively less powerful lower limbs which supports our studies as per shown in Graph 3, of Timed Up And Go (TUG) ($P<0.0003$) which gave an extremely significant interpretation. Authors also found a poorer endurance than in normal weighted people[4] Most other studies concerning obese people investigated the influence of weight loss programs and/or physical activity programs on individual’s body composition, physical performance, and cardiovascular risk factors. For example, the study of Maffiuletti et al. reported a clinical success (higher percent of fat-free mass, muscle strength, HDL-cholesterol, increased self-reported physical activity level, and lower total cholesterol and glucose levels) after a hospital-based, body weight reduction program lasting 3 weeks for severely obese individuals, in particular females.[13]

Few studies[23,24,25] evaluated the effect of weight loss programs on functional capacities and movement characteristics, and few demonstrated that weight loss increased gait speed, stride length, swing time, hip range of motion, maximal knee flexion, ankle plantar flexion, 1-leg limb stance time, and self-reported physical function, whilst also reducing frailty. This indirectly supports our study suggesting that increase in weight causes impaired balance and gait.

One study, by Hergenroederetal.[26] recently evaluated the influence of body mass index (BMI) on functional capacities. The authors assessed self-reported, and performance-based physical function in which obese adult women were most impaired in physical functions. In comparison to this study, our study also included balance and gait outcome measures.

Walking involves repeated loss and recovery of balance.[4]Perhaps low gait speed helps obese people to keep their dynamic balance through a more controlled gait pattern. It helps them to keep the center of mass (COM) within their base of support (BOS). Another explanation for slow gait could be shorter stride length or lower cadence.[3] A study done by Corbeil et al.[27] suggested that obese people with abnormal distribution of body fat, particularly in the abdominal area, might be an increased risk of falling compared to individuals who are not obese. This study supports the graph of Modified Star Excursion Balance Test (SEBT) which showed significant decrease in reach distance in all the three directions in obese subjects compared to the non-obese subjects. Along with decreased reach distance, loss of balance was also observed while performing this test in the obese individuals.

Another study by MaximeDutil et al.[28] was done to assess the impact of obesity on balance control in community-dwelling older women which suggested that obese individual swayed at a faster speed in the same boundary compared to the normal weight group, this supports the outcome measure for balance in our study, i.e. Berg Balance Scale (BBS) which showed a lower score in tandem standing with eyes closed and open both.

Thus the study was successfully completed and has proved that obesity does have effect on balance and gait in young adults.

CONCLUSION

The clinical implication of our findings is that obese young adults exhibit poor balance control. Our findings suggested that there is effect of obesity on gait.

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