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The influence of overweight on postural balance and mobility of candidates for bariatric surgery

Influência do excesso de peso sobre o equilíbrio postural e a mobilidade de candidatos à cirurgia bariátrica

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Abstract — Obesity is considered a risk factor to health and besides generating metabolic and cardiovascular alterations, it is related to mechanical complications. Since stability may be altered due to anthropometric and biomechanical factors, studies investigating the relationship of excess weight on the mobility and balance of obese adults are still scarce. The research aimed to evaluate the postural balance and mobility of obese individuals who are waiting for bariatric surgery. This is a cross-sectional and descriptive study, conducted at the Hospital das Clínicas of the Universidade Federal de Pernambuco. The sample consisted of 97 individuals, 81 women, 16 men, age 38.39 ± 10.60 years and body mass index 47.5 ± 6.9 kg/m2. The Timed Up and Go test, which evaluates the mobility, resulted in 7.6 ± 1.7 seconds as the average of the longest times spent to perform the test. Regarding the evaluation of dynamic balance and mobility, it was found that the domains of anticipatory postural adjustments, necessary to prevent postural disturbances (median 5, 95%CI 5-6) and the domain of dynamic movement, which corresponds to the balance necessary to walk (median 8, 95%CI 7-9) are the most impaired in the subjects with obesity. Positive correlations were found between weight and dynamic balance. The findings indicate that excess body fat interferes with dynamic balance.

Key words: Bariatric surgery; Mobility limitation; Obesity; Postural balance.

Resumo — *A obesidade é considerada fator de risco à saúde e além de gerar alterações metabólicas e cardiovasculares, está relacionada a complicações mecânicas. Uma vez que a estabilidade pode estar alterada em função de fatores antropométricos e biomecânicos, ainda são escassos os estudos que investigam a relação do excesso de peso sobre a modilidade e equilíbrio dos adultos obesos. A pesquisa teve como objetivo avaliar o equilíbrio postural e a mobilidade dos indivíduos com obesidade que estão aguardando a realização da Cirurgia Bariátrica. Trata-se de um estudo transversal e descritivo, realizado no Hospital das Clínicas da Universidade Federal de Pernambuco. A amostra foi composta por 97 indivíduos, sendo 81 mulheres, 16 homens, idade 38,39 ± 10,60 anos e índice de massa corporal 47,5 ± 6,9 kg/m².* *O teste Timed Up and Go, que avalia a mobilidade, teve como resultado 7,6 ± 1,7 segundos como a média dos maiores tempos gastos para a execução do teste. A respeito da avaliação do equilíbrio dinâmico e da mobilidade, verificou-se que os domínios de ajustes posturais antecipatórios, necessários para prevenir perturbações posturais (mediana 5, IC95% 5-6) e o domínio de movimentação dinâmica, que corresponde ao equilíbrio necessário para a realização da marcha (mediana 8; IC95% 7-9) são os mais prejudicados nos sujeitos com obesidade avaliados. Foram constatadas correlações positiva entre peso e equilíbrio dinâmico. Os achados indicam que o excesso de gordura corporal interfere no equilíbrio dinâmico.*

Palavras-chave: *Cirurgia bariátrica; Limitação de mobilidade; Obesidade; Equilíbrio postural.*

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INTRODUCTION

The excessive increase in body weight with fat accumulation is associated with metabolic and cardiovascular impairments in addition to changes in body geometry and posture. Obesity modifies the body's size and shape, influencing postural stability and changing the location of the center of pressure, in addition to interfering with motor performance[1,2].

Furthermore, the excess of weight in combination with poor body alignment leads to changes in the distribution of load and pressure on joint surfaces, causing muscle overload. Higher pressure values and greater contact areas in the feet's plantar region can impair the sensory capacity of plantar mechanoreceptors, which are essential for postural control and balance[3,4].

Associated with that sensory dysfunction, there is the mechanical stress caused by the high weight on the joints that affects the lower limbs and alters the gait pattern. More time is spent on double support and less time on single support, in addition to decreasing stride length and walking speed. Intense overload on the main area of absorption and dissipation of force in the foot (the medial longitudinal arch) is usually accompanied by mobility loss, low cadence and imbalance[3,5,6].

Since stability can be altered due to overweight and biomechanical factors, studies investigating the relationship of excess weight on mobility and balance in obese adults are still scarce. Thus, the objective of this study was to evaluate postural balance and mobility in individuals with obesity who are awaiting bariatric surgery.

METHODS

Study design and participants

Cross-sectional study, with a descriptive approach, approved by the local ethics committee (approval protocol nº 4.958.338/2021). The research was conducted in a referral university hospital of bariatric surgery, in a capital city of northeastern Brazil.

The sample size was calculated in an online sample calculator provided by USP-Bauru (http://calculoamostral.bauru.usp.br/calculoamostral/calculos.php). The following parameters were used: alpha error (α) = 5%, beta error (β) = 20% and power = 80%. From the total calculated, a percentage of 5% was added for the sampling error and a confidence interval of 95% of the individuals included in the research, resulting in a total sample of 97 individuals.

The sample was selected from volunteers referred to the Health Promotion and Quality of Life Service after screening at the general surgery outpatient clinic. Before starting data collection, all participants were instructed about the study procedures and signed the informed consent form.

It was included in the study Individuals aged 18 years or older, of both sexes, with BMI ≥ 35 kg/m^2, who had not been practicing systematic physical exercises for at least 6 months and who were candidates for bariatric surgery at the hospital. The exclusion criteria were: (a) having vestibulocerebellar disorders; (b) presence of musculoskeletal disorders that interfere with balance; (c) neurological dysfunctions or sequelae, rheumatologic diseases, severe heart disease, cognitive deficit, lower limb dysmetria of 2 centimeters or more; and (d) use of orthoses for ambulation.

Anthropometric measures

Values of body weight and height were obtained with a Filizola scale (SP, Brazil). The body mass index (BMI) was calculated using the formula BMI=body weight (kg)/height^2 (m^2).

Postural dynamic balance

Postural dynamic balance was assessed using the Y-Balance Test (YBT), which verifies reaching distance and dynamic balance capacity, both are indicators of sensorimotor function and represent risk of falling[7]. The volunteers were instructed to wear light clothing on the scheduled day of the evaluation, which allowed mobility of the lower limbs, and at the time of the test, they should be barefoot. The YBT allows the execution of movements in 3 directions (anterior, posteromedial and posterolateral). The patients stood in the middle of a crossing of three lines on the floor at an angle of 135º forming a Y. They were asked to reach with one foot as far as possible along each line, without touching it, and then return to the starting position. Before beginning the test, the length of each limb (iliac crest to the lateral malleolus) was measured, the result was in centimeters, and a familiarization was performed, in which the volunteers performed six tests on each limb, two for each direction. It was considered an error when the volunteer performed the movement incorrectly, was unable to return to the starting position or touched the floor. Then, three measurements were performed in each direction, for each lower limb, the greatest distance reached was used to calculate the composite score. This score was calculated by dividing the sum of the maximum reach distance in the anterior (A), posteromedial (PM) and posterolateral (PL) directions by 3 times the individual's limb length (CM), multiplied by 100. $\{[(A + PM + PL) / (CM \times 3)] \times 100\}$[8].

The MiniBESTest was also used, which is a reduced version of the BESTest, and it was developed with the aim of facilitating the use of the instrument in clinical practice for the assessment of dynamic balance. It is a test translated and cross-culturally adapted to Portuguese - Brazil and its application requires a short time[9]. The test consists of 14 items scored on a scale from 0 (important balance deficit) to 2 (no balance impairment) and assesses biomechanical restrictions, stability limits, anticipatory postural adjustments, sensory orientation and dynamic balance during gait.

Mobility

Patients underwent the Timed Up and Go (TUG) to access the functional mobility. Its implementation is simple and can be applied in all environments. The TUG is a reliable, economical, and safe test for functional mobility assessment[10]. The volunteer starts sitting on the chair, rises from the chair, walks a set distance of 3 m, turns around a fixed point marked on the floor, returns to the chair, and finally sits down. A familiarization test and two trials were performed. The score provided was the average time taken in the two trials, in seconds to complete the test. No special bariatric chair was needed. The subjects who completed the test in more than 13.5 seconds were considered to have an increased risk of falling[11].

Statistical analysis

The data were processed with the computerized Statistical Package for the Social Sciences (SPSS®, version 25) and the graphs were constructed using the Prism 8.0 software (Graphpad Software). Continuous variables were expressed as mean and standard deviation or median and 95% confidence interval, when they did not obey the normal distribution. To verify the normality of the data, the Shapiro-Wilk test was used. Due to the absence of normal distribution in most of the continuous variables investigated, the Spearman's rho (r) test was used to investigate the presence of correlations between the variables and to interpret the results, r - 0 to 0.19 (very weak correlation); 0.2 to 0.39 (weak correlation); 0.4 to 0.69 (moderate correlation); 0.7 to 0.89 (strong correlation) and 0.9 to 1 (very strong correlation). For all statistical tests performed, a significance level of 5% was adopted.

RESULTS

Ninety-seven individuals participated of the research, 81 women and 16 men. The distribution of the profile of the volunteers shows that 83.5% were women and the age ranged from 19 to 57 years (mean 39.88 ± 10.59) (Table 1). It was found that of the total sample, 11.3% had a BMI between 35 and 39.9 kg/m2 (grade II obesity) and the other 88.7% had a BMI above 40 kg/m2 (grade III obesity).

The prevalence of falls self-reported by the patients corresponded to 19.6% (n=19) of women and 3.1% (n=3) of men. Of the 22 individuals who reported fall, 40.91% (n=9) had impaired walking, 13.64% (n=3) had a fracture associated with the fall and 63.64% (n=14) indicated being afraid of falling again.

Regarding the performance of the TUG test, used in the mobility assessment, the duration of the two attempts and the average time of performing the test were collected, with the longest time in the execution of the test being 12.15 seconds (median 7.30; 95%CI 7.27-7.95).

The results of the YBT varied according to the direction and the free lower limb. For the right side, in the anterior direction, the maximum reach was 73.57 centimeters (median 24.04; 95%CI 22.62 – 25.78). On the left side, the anterior direction had a maximum reach of 75.71 centimeters (median 27.08; 95%CI 25.12 – 31.23) (Table 1).

The results of MiniBEST indicated that the domains of anticipatory postural adjustments (median 5.0; 95%CI 5.0 - 6.0) and dynamic movement, which corresponds to the balance necessary to perform the gait (median 8.0; 95%CI 7.0 – 9.0) are the most impaired in the evaluated people with obesity (Table 1).

A positive correlation was found between body weight and dynamic balance (Figure 1).

Table 1. Median and 95% confidence interval (95%CI) of the mobility and postural dynamic balance tests performed (n=97).

Test	Median	95%CI
TUG	7.30	7.27-7.95
YBT total (right)	24.04	22.62-25.78
YBT total (left)	27.08	25.12-31.23
MiniBEST anticipatory	5.0	5.0-6.0
MiniBEST postural	4.0	3.0-6.0
MiniBEST sensory orientation	6.0	6.0-6.0
MiniBEST dynamic balance gait	8.0	7.0-9.0
MiniBEST total	23.0	22.51-23.80

Note. TUG: timed up and go; YBT: Y-balance test.

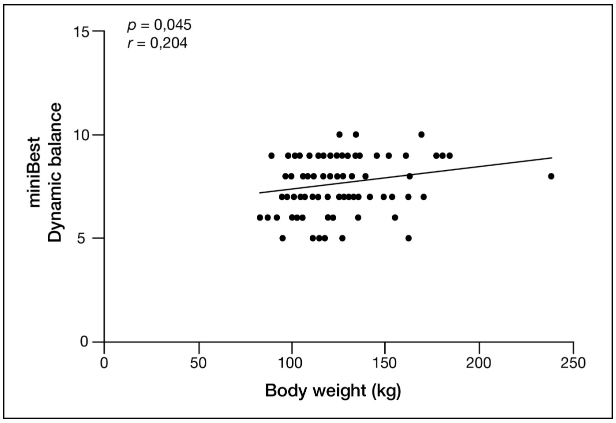

Figure 1. Correlation between body weight and dynamic balance.

DISCUSSION

There are epidemiological investigations suggesting that obesity is a risk factor for the fall's occurrence, however, there is little experimental evidence proving a relationship between obesity, postural disorders, and the occurrence of falls. In contrast, studies have found that increased body mass, in the absence of other obesity-related comorbidities, may have minimal impact on gait stability and, in turn, on the risk of falling[12].

In the present research, the prevalence of self-reported falls corresponded to 22.7% of the individuals, which is in line with the findings of Rossi-Izquierdo et al.[13] which demonstrated a significantly higher predisposition and probability of recurrence of falls in people with obesity than individuals with healthy BMI.

Campos et al.[14] reported that, to date, there are no TUG reference values for adults with obesity, so the survey results were compared with the expected reference values for healthy individuals - 7.1-9.0 seconds[13].

The investigation conducted by Rodrigues et al.[15] confirmed the interference of obesity on dynamic balance, as it was found that obese elderly women spent more time to perform the TUG test compared to normal weight women, 7.8 and 7.1 seconds, respectively. The present study found similar results to those spent by obese elderly women in performing the test, with the average time for performing the TUG test being 7.6 ± 1.7 (seconds).

Regarding the use of the YBT to assess dynamic balance, a cross-sectional study with 145 individuals between 18 and 50 years of age with non-specific chronic low back pain associated the results of test to BMI, between another variables. The analysis showed that excessive fear of performing certain movements, known as kinesiophobia, was associated with decreased reach on the YBT (worse performance) and individuals with obesity had a decreased kinesiophobia score compared to eutrophic individuals[16].

Another study with a cross-sectional design investigated the effects of increasing body mass on dynamic balance in schoolchildren and the findings indicated that increasing BMI reduces balance ability in the YBT forward reaching direction and has no interference in the other directions[17]. Corroborating with the previous information, in the present research, alterations were found in the ranges in the previous direction of the YBT test.

Bueno et al.[18] suggested that there is an association between body weight and balance, and it can be considered critical in cases of morbid obesity, when the BMI is equal to or greater than 40 kg/m^2. However, the present study did not find a correlation between BMI and postural dynamic balance, even though 88.7% of the sample were morbidly obese. It can be inferred that these findings are related to those found by Cieślińska-Świder et al.[19] who suggested that people with obesity increases balance using a compensatory mechanism of widening the base of support.

The results of Simoneau and Teasdale[20] indicate that body weight is responsible for more than 50% of the variation in balance stability, which proves the significance of the current research findings, relating weight and balance. Danis et al.[21] also suggested that excess body fat alters the position of the center of mass and consequently influences the balance of individuals with obesity.

Although there is a positive correlation between the body weight and dynamic balance, there was no correlation between the dynamic balance tests results and BMI in the current study. This may be related to the findings of Sun et al.[22] who found that the association of postural instability with obesity can result in altered biomechanical strategies aimed at improving a person's sense of balance during locomotion. Therefore, individuals with excessive body fat can make postural adaptations that will influence their postural stability.

A study to assess gait in people with obesity pointed out that adaptive changes occur in the gait pattern of these individuals[23], reaching the conclusion that people with obesity develop stability control mechanisms during locomotion. Postural changes trigger changes throughout the body and this happens as the sensorimotor system adapts to this acquired posture for better control of movements during displacements[24]. This would explain the findings of the current study, in which no correlation was found between the BMI variable and the mobility variable.

The present study had limitations regarding the sample, which was composed majority by women, which does not allow generalizations. The study was conducted in a group, which does not allow comparisons with healthy individuals, for example. It is also necessary to evaluate other variables that contribute to the improvement of balance and mobility, including strength and muscle mass. Therefore, experimental studies should be conducted using training programs aimed at improving balance and mobility in adults with obesity awaiting bariatric surgery.

CONCLUSION

The findings demonstrate that excess of body fat is related to dynamic balance and functional mobility of the adults with obesity. Once these attributes are fundamental to perform daily living activities, there is a certain commitment in their execution. Considering that excessive body weight is a public health problem and in association with it there are several chronic non-communicable diseases growing in the country, it is important that further research be encouraged. It is suggested the development of studies that verify whether there are differences between the genders regarding the damages in the dynamic balance, or if there is an exercise program that is more effective in improving the functional mobility of people with obesity.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the Human Research Ethics Committee of the Federal University of Pernambuco – and the protocol (no. 4.958.338) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: BABS, ASC and PRCC; Performed the experiments: BABS; Analyzed the data: BABS, JCFS and TVOC; Contributed reagents/materials/analysis tools: BABS, JCFS and TVOC; Wrote the paper: BABS, JCFS and TVOC.

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