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Relationship between physical activity levels and body composition of candidates for bariatric surgery: a pilot study

Relación entre los niveles de actividad física y la composición corporal en sujetos en espera de cirugía bariátrica: un estudio piloto

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Abstract. Obesity is a public health issue that is associated with the development of cardiometabolic and musculoskeletal multimorbidities, such as sarcopenia. Furthermore, the population with severe obesity confronts various barriers that hinder the practice of physical exercise, which exposes them to greater risk and fragility. In light of this, a pilot study was conducted to characterize the population eligible for bariatric surgery regarding body composition and physical activity levels and verify the relationship between the degrees of the degrees of obesity and sarcopenia. In total, a sample of 41 individuals were included in the analysis, all of whom were female, with an average age of 45 years and weighing 108 kilos, mostly with sarcopenia (28 individuals). It was possible to observe a significant difference in the fat mass of the population with Obesity in Class 2 and 3 ($p > 0.001$), Class 2 and 4 ($p > 0.001$), Class 3 and 4 ($p > 0.002$), and in the % fat of the population with Class 2 and 3 obesity ($p > 0.001$) and Class 2 and 4 (($p > 0.002$), both with strong effect sizes (0.7 and 0.5, respectively). It was possible to observe a significant difference in lean mass between the sarcopenia classification groups ($p < 0.001$) but no significant difference was observed between the physical activity levels. The candidates for bariatric surgery predominantly have Class II and III obesity, interfering with body composition (lean mass, % body fat, and BMD), and, consequently, exposing greater physical and functional fragility. Although sarcopenia and a sedentary lifestyle are presented in the literature as conditions that impact body composition, it was not possible to identify significant differences in the sample.
Keywords: Sarcopenia. Obesity. Body mass index.

Resumen. La obesidad es un problema de salud pública que se asocia con el desarrollo de multimorbilidades cardiometabólicas y musculoesqueléticas, con sarcopenia. Además, la población con obesidad severa enfrenta diversas barreras que dificultan la práctica de ejercicio físico, lo que la expone a mayor riesgo y fragilidad. Ante esto, se realizó un estudio piloto para caracterizar la composición corporal y los niveles de actividad física de la población elegible para cirugía bariátrica y verificar la corroboración de los grados de obesidad y sarcopenia. En total se incluyó en el análisis una muestra de 41 individuos, todos ellos del sexo femenino, con una edad promedio de 45 años y un peso de 108 kilos, en su mayoría con sarcopenia (28 individuos). se pudo observar diferencia significativa en la masa grasa de la población con Obesidad Clase 2 y 3 ($p > 0,001$) y Clase 2 y 4 ($p > 0,001$) y Clase 3 y 4 ($p > 0,002$) y en el % grasa de la población con obesidad Clase 2 y 3 (($p > 0,001$) y Clase 2 y 4 (($p > 0,002$), ambas con tamaños de efecto fuertes (0,7 y 0,5, respectivamente). Se pudo observar una diferencia significativa en masa magra entre los grupos de clasificación de sarcopenia ($p < 0,001$) pero no se observó diferencia significativa entre los niveles de actividad física. Los candidatos a la cirugía bariátrica presentan predominantemente obesidad de Clase II y III, interfiriendo con la composición corporal (magra). masa corporal, % de grasa corporal y DMO), y, en consecuencia, exponiendo una mayor fragilidad física y funcional. Aunque la sarcopenia y el sedentarismo se presentan en la literatura como condiciones que impactan la composición corporal, no fue posible identificar diferencias significativas en la muestra.
Palabras clave: Sarcopenia. Obesidad. Índice de masa corporal.

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Introduction

Obesity is a major public health problem, with its prevalence growing exponentially in the global population. Estimates suggest that by 2025, obesity may affect up to 18% of men and 21% of women worldwide (Blüher, 2019; Di Cesare et al., 2016). This alarming increase in incidence reflects the mounting evidence that a high body mass index (BMI) is strongly associated with the development of multiple cardiometabolic and musculoskeletal conditions (Kivimäki et al., 2017).

As a particularly effective treatment method, bariatric surgery stands out among individuals with severe obesity (Grade III Obesity, BMI > 35kg/m²) (Enríquez-Schmidt et al., 2024). However, it is noted that adopting healthy habits over five years encompasses only a small proportion of the surgically treated population, approximately 10%, with frequent recurrence in weight regain, along with the harms associated with obesity (Bellicha et al., 2021). In this context, the importance of understanding lifestyle strategies and comorbidities associated with obesity is emphasized, with the proposal of establishing markers for a more accurate prognosis for individuals facing obesity and its complications.

Among the comorbidities, those affecting morphofunctional conditions stand out, as is the case with sarcopenia, which is a common condition among the obese population due to metabolic changes, body composition (Batsis & Villareal, 2018; Donini et al., 2022), and physical inactivity (Mijnarends et al., 2016), leading to loss of muscle mass, impacting strength and functionality, thus defined as sarcopenic obesity (Batsis & Villareal, 2018; Donini et al., 2022). Sarcopenia is a risk factor for worse surgical prognosis, increasing the chances of postoperative complications (Lou et al., 2017), and it also poses a barrier to adopting a healthy lifestyle post-surgery (Barrón-Cabrera et al., 2020;

Mijnarends et al., 2016).

In this context, seeking pre-surgical strategies that directly impact morphofunctional repercussions related to obesity appears to be a promising approach to enhance post-surgical treatment, enabling more effective weight loss and reducing barriers that may interfere with a healthier life. Evidence indicates that physical exercise has positive effects on the obese, influencing body composition, metabolic variables, and morphofunctional improvement. However, adherence to this intervention varies considerably among obese individuals (between 52% and 60%), due to ergonomic barriers to exercise, low motivation, and lack of engagement in physical activity (Barrón-Cabrera et al., 2020), in addition to sarcopenia itself (Mijnarends et al., 2016).

In this regard, with the aim of establishing a framework to understand the interaction between the level of physical activity and body composition in the clinical context of people with obesity, this pilot study investigated morphological body patterns according to obesity classification, presence of sarcopenia, and level of physical activity, with the aim of characterizing the obese population and its relationships with morphological conditions. Therefore, the goal is to direct practices that provide a more assertive intervention in the pre-surgical period, contributing not only to better surgical conditions but also to post-surgical success.

Methods

A pilot study was conducted to characterize the population eligible for bariatric surgery of body composition and physical activity levels. The analysis is part of a larger project, approved by the Ethics and Deontology Committee of the University of Pernambuco (Nº 6.092.006).

Recruitment was carried out at the Oswaldo Cruz University Hospital among patients in the bariatric surgery outpatient clinic. The recruited population was assessed for eligibility, consisting of individuals with obesity, aged between 18 years and 59 years, and eligible for bariatric surgery. Patients who did not participate in all assessments were excluded. At the beginning of the study, all individuals received detailed explanations about the experiments and, upon consenting, signed the Free and Informed Consent Form.

Study design

This is a cross-sectional, pilot study, with the recruitment of candidates for bariatric surgery in treatment units (hospitals) and dissemination on social networks. With consent to participate in the research, participants were referred to the Higher School of Physical Education (ESEF) at the University of Pernambuco (UPE), where researchers conducted a structured interview to collect sociodemographic data, followed by the International Physical Activity Questionnaire (IPAQ - short version) to characterize physical activity levels.

Anthropometric measurements and weighing of participants were carried out, following the protocol established by the International Society for the Advancement of Kinanthropometry (ISAK). Subsequently, participants performed Dual-Energy X-ray Absorptiometry (DXA), following Kim et al (2022) protocol.

Collection instrument

To identify and characterize the sample, a sociodemographic questionnaire was conducted, in addition to measuring body weight and height, with BMI calculated as body weight (kg) divided by height squared (m^2), to classify obesity levels (WHO, 2000).

To determine the level of physical activity, the International Physical Activity Questionnaire (IPAQ - short version) was applied. This questionnaire consists of six questions related to the time spent performing physical activities in the last week. Based on the provided responses, participants were classified as sedentary, insufficiently active, active, or very active (Matsudo et al., 2001). For the purposes of this study, participants were grouped into three categories: sedentary, insufficiently active, and active (active and very active).

Body composition was assessed using Dual-Energy X-ray Absorptiometry (DXA - Hologic® brand and Discovery CI/WI model, QDR4500W software, version QDR 11.2), with total body scan (TBS) to quantify muscle, adipose, and bone tissue, as well as total bone mineral density (BMD) and its classification considering the T-score. For the procedure, participants wore a gown and were positioned centrally on the DXA scanner table, with their hands extended in a supine position, taking six minutes to complete the procedure (Kim et al., 2022).

Based on DXA results, sarcopenia was defined as appendicular lean mass (sum of lean mass from both arms and legs) divided by height squared (Studenski et al., 2014).

Data analysis

A double-entry typing was conducted, with a third researcher responsible for analyzing the database. To describe the sample, an exploratory analysis was conducted to verify the normality of the data (Shapiro-Wilk test). The data were described according to the normality assumptions, with mean and standard deviation or median and interquartile range. A correlation analysis with the Pearson and Spearman tests was conducted (respecting the principles of data normality) for the outcomes of body composition and sarcopenia classification. The mean difference between body composition and sarcopenia classification was analyzed using the Student's T and Mann-Whitney U test, additionally, the *ANOVA* and Kruskal-Wallis test was conducted to analyze differences in body composition and physical activity levels and Obesity Class. Data were analyzed using the computerized statistical package Jamovi Software (version 2.3).

Results

In total, a sample of 41 individuals was included in the analysis, all female, the majority with Class III Obesity (48.8%) and Class II Obesity (24.4%), presenting high and low levels of active physical activity. , 48.8% were sedentary and 31.7% physically active. Sarcopenia was present in 68.3% of the sample (Table 1). Those evaluated had an average age of 45 years, with an average fat mass (g) of 64379.227 (SD 75477.5118), lean mass (g) of 47905.841 (SD 4917.7496), and BMD of 1.061 (SD 0.0902) (Table 2).

Table 1.
Sample description

		N	% Total
Sex	Woman	41	100%
BDI	Obesity Class I	2	4.9%
	Obesity Class II	10	24.4%
	Obesity Class III	20	48.8%
	Obesity Class IV	9	22.0%
IPAQ	Sedentary	20	48.8%
	Irregularly active	8	19.5%
	Active	13	31.7%
Sarcopenia	Yes	28	68.3%
	No	13	31.7%

IPAQ: International Physical Activity Questionnaire

Table 2.
Characterization of the population

	Mean (Median)	Minimum	Maximum	SD
Age(years)	45.5 (46)	28	62	9.8
Weight (Kg)	108.47 (108.00)	84.70	131.00	12.48
Sarcopenia index	5.29 (5.21)	3.95	7.04	0.62
Bone mass (g)	1641.543 (1663.960)	1058.450	2163.090	205.5406
Fat mass(g)	64379.227 (50860.500)	36001.200	528138.200	75477.5118
Lean mass (g)	47905.841 (47271.300)	37478.200	58990.300	4917.7496
Total Mass (g)	100264.224 (100457.400)	61388.800	123529.400	13375.9931
% body fat	49.602 (49.600)	41.800	60.000	4.3682
BMD	1.061 (1.079)	0.827	1.185	0.0902
BMD t-score total body	-0.112 (0.00)	-3.400	2.100	1.0196

BMD: bone mineral density

Relationship between class obesity and body composition

In the analysis of body composition between obesity classes, it was possible to observe a significant difference in the fat mass of the population with Obesity Class 2 and 3 (p> 0.001) and Class 2 and 4 (p> 0.001) and Class 3 and 4 (p > 0.002) and in the % fat of the population with Class 2 and 3 obesity (p> 0.001) and Class 2 and 4 ((p> 0.002), both with strong effect sizes (0.7 and 0.5, respectively).

Table 3.
Body composition profile between different class of obesity

	BMI	Mean	Median	SD	p	ES
Fat body mass	Obesity Class I	38546.450	38546.450	3068.6313	< .001	0.707
	Obesity class II	42222.970	42151.250	4296.9143		
	Obesity class III	52624.855	51467.250	6246.9503		
	Obesity class IV	120858.733	63737.000	153802.1299		
Lean body mass	Obesity Class I	44253.650	44253.650	1893.8441	0.243	0.105
	Obesity class II	47442.530	46100.250	6674.9358		
	Obesity class III	47451.915	46799.300	4331.3684		
	Obesity class IV	50240.956	49501.400	3942.0362		
% body fat	Obesity Class I	44.400	44.400	1.1314	< .001	0.568
	Obesity class II	45.350	45.600	2.1366		
	Obesity class III	50.430	49.700	3.6488		
	Obesity class IV	53.641	53.100	3.0100		
BDM	Obesity Class I	1.167	1.167	0.0106	0.210	0.113
	Obesity class II	1.097	1.102	0.1254		
	Obesity class III	1.116	1.119	0.0467		
	Obesity class IV	1.077	1.102	0.0755		
BMD t-score total	Obesity Class I	0.800	0.800	0.1414	0.036	0.214
	Obesity class II	-0.330	-0.500	1.5195		
	Obesity class III	0.170	0.300	0.6001		
	Obesity class IV	-0.700	-0.800	0.9421		

Relationship between sarcopenia and body composition

The population with sarcopenia had lower average bone mass, fat, and lean mass, on the other hand, it had a higher average % body fat (table 2). It was possible to observe a significant difference in lean mass between the sarcopenia classification groups ($p<0.001$) (table 3), with a significant association between the sarcopenia index and the lean mass of the lower limbs ($p<0.01$, R 0.80) (figure 1).

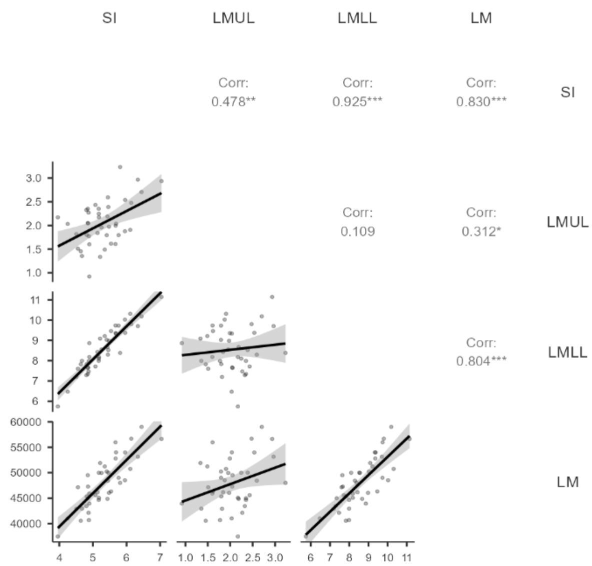

Figure 1. Correlation matrix between lean mass and limbs. LMUL: Lean mass upper limber; LMLL: Lean mass of lower limbs; LM: Lean mass

Table 4.
Body composition profile among participants with and without sarcopenia

				Paired differences			
	Sarcopenia	Mean	SD	Mean(%)	SD error	p	ES
Fat body mass*	Yes	48157.20	13011.2500	7381.1500	25633.1689	0.80	0.08468
	No	56999.70	9201.4000				
Lean body mass**	Yes	45691.69	3608.7181	-6983.10659	1242.3951	< .001	-1.88638
	No	52674.79	3903.2720				
% body fat**	Yes	68.24	91.8003	-0.02015	1.4847	0.989	-0.00455
	No	50.70	4.3556				
BMD**	Yes	1.05	0.1017	-0.03586	0.0360	0.328	-0.39746
	No	1.08	0.0650				
BMD t-score**	Yes	0.671	0.737	0.00467	0.3466	0.989	0.00452
	No	1.080	0.6125				

*Mann-Whitney, **T Student

Relationship between levels od physical and body composition

In the analysis of the mean difference between levels of physical activity, the physically active population presented lower means of fat mass, lean mass, and total BMD t-score, however, no significant difference was observed between the groups (table 5).

Table 5.
Body composition profile between different levels of physical activity

	IPAQ	Mean	SD	Erro-padrão	f	p
Fat body mass	Sedentary	79652.49000	106819.8626	23885.6474	-	0.328*
	Irregularly active	51193.43750	8959.2827	3167.5848		
	Active	48996.23077	10725.6902	2974.7712		
Lean body mass	Sedentary	49115.90000	3624.2490	810.4067	3.0890	0.075
	Irregularly active	49096.10000	6887.8591	2435.2260		
	Active	45311.74615	4633.2487	1285.0320		
% body fat	Sedentary	49.93833	4.1579	0.9297	0.1291	0.880
	Irregularly active	49.08750	4.2455	1.5010		
	Active	49.40000	5.0306	1.3952		
BMD	Sedentary	1.10235	0.0656	0.0147	-	0.796*
	Irregularly active	1.10038	0.1103	0.0390		
	Active	1.11300	0.0808	0.0224		
BMD t-score total	Sedentary	-0.10000	0.8398	0.1878	0.1306	0.879
	Irregularly active	-0.31250	1.4476	0.5118		
	Active	-0.00769	1.0428	0.2892		

*Kruskal-Wallis

Discussion

The results of this study show that more severe levels of obesity have influenced body fat mass and % body fat, although it is not possible to associate this with different levels of physical activity or the presence of comorbidities, such as sarcopenia. The results corroborate and challenge previous findings on obesity, highlighting the need to expand the understanding of outcomes in populations severely ill due to obesity.

It was not possible to observe differences in body composition between different levels of physical activity, this finding converges with the systematic presentation, that exercise in protocols lasting 8 to 16 weeks was not able to modify fat mass, fat-free mass, and % fat in candidates for bariatric surgery, on the other hand, exercise significantly affected the functional capacity of the population in the 6-minute walk test (95% CI: 1.89–3.30; $I^2 = 0\%$; $p < 0.0001$) (Herrera-Santelices et al., 2022).

On the other hand, bariatric surgery promotes significant effects on body composition (lower waist-hip ratio (WHR), lower percentage of body fat (PBF), lower appendicular lean mass, lower trunk fat mass, greater lean mass, fat-free mass, greater skeletal muscle, greater trunk lean mass and fat-free mass index) over 12 months; significantly higher response when compared to a population of similar weight that does not undergo bariatric surgery and is exposed to similar levels of physical activity (Tangjittrong et al., 2023).

It is important to consider that the obese population faces additional challenges when performing the exercise, as they present greater musculoskeletal impairment (knee osteoarthritis, low back pain, among other conditions) and structural and functional changes in the airways due to excess weight, resulting in physical deconditioning and less motivation to perform exercises (Bianchettin et al., 2023). The context of obesity has possibly affected the physical activity and exercise routine of the study population and consequently limited the effects that the intervention may have on body composition.

Clinical studies indicate that physical exercise programs for 24 weeks, when compared to traditional health education programs to change lifestyle for bariatric surgery candidates, have a superior and significant effect on reducing body composition measurements such as weight, BMI, fat mass, and % body fat, waist/hip ratio, in addition to promoting better conditioning through increased VO^2max. Signaling the importance of exercise as part of preparation interventions for bariatric surgery (Durey et al., 2022; Hsu et al., 2019; Marc-Hernández et al., 2019; Picó-Sirvent et al., 2022).

In addition to aspects of body composition, the obese population is exposed to risks and problems related to sarcopenia, as it is already known that in patients undergoing bariatric surgery, the presence of sarcopenic obesity in the preoperative period was associated with severe complications after surgery (Voican et al., 2018). Furthermore, it is observed that bariatric surgery itself can develop sarcopenia in the first ten years after surgery, associated with the progressive loss of BMI, muscle, and bone composition (Vieira et al., 2022; Voican et al., 2018).

A higher percentage of the population in our study presented sarcopenia when compared to other studies; however, we converge with previous findings and proposals that physiologically explain sarcopenia, since our sample had a higher %fat mass and lower lean mass (González Arnáiz et al., 2024). Therefore, it is essential to evaluate body composition preoperatively and to adopt a more active lifestyle before surgery, to increase muscle mass and muscle strength during this phase. Furthermore, studies indicate that exercise practice is inversely proportional to weight regain up to 10 years after surgery, reinforcing the need for early implementation of exercise in the lifestyle of candidates for bariatric surgery (Santos, 2022).

Our results pointed to a relationship between sarcopenia and lean mass, corroborating the literature description that sarcopenic obesity presents a decrease in lean mass and a higher % body fat, influencing muscle weakness and inability to function (Kato et al., 2022; Prado et al., 2024). Considering the clinical picture, different studies have investigated the effects of exercise in reducing the frailty of the population with sarcopenia obesity, and it was observed that physical exercise for 12 weeks was able to reduce the frailty of the population with low muscle mass and mobility difficulties (Liao et al., 2017).

Given the above, it should be noted that the present study has limitations, such as the unequal distribution of participants between different degrees of obesity and the absence of quantitative measures of the population's physical activity.

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Conclusion

Candidates for bariatric surgery are seriously ill due to obesity (predominance of Obesity Class II AND III), interfering with body composition (lean mass, % body fat, and BMD) and, consequently, exposing greater physical and functional fragility. Although sarcopenia and a sedentary lifestyle are presented in the literature as conditions that impact body composition, it was not possible to identify significant differences in the sample.

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