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ASSOCIATION BETWEEN FOOD INTAKE, BOTH BODY COMPOSITION AND LIFESTYLE IN PATIENTS UNDERGOING BARIATRIC SURGERY

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ABSTRACT

The number of bariatric surgeries performed in Brazil increased with 85% between 2011 and 2018. ***Aim:*** The aim of the present study was to evaluate associations between food intake and both body composition and lifestyle in the preoperative period of bariatric surgery. ***Methods:*** A cross-sectional study was conducted with adults scheduled for bariatric surgery at a university hospital in the city of Recife, Brazil. Data were collected on anthropometric characteristics, body composition determined using dual emission x-ray absorptiometry (DXA), lifestyle and food intake. ***Results:*** Sixty patients participated in this study (78.3% women; mean age: 38.8 ± 9.6 years). Regarding lifestyle, 31.7% sedentary lifestyle, 33.3% consumed alcoholic beverages and 83.3% never smoked. Absolute values of trunk fat, lean mass and bone mineral density were 26.84 ± 5.34 kg, 55.85 ± 10.19 kg and 11.1 ± 0.08 g/cm^2, respectively. The association tests revealed that a lower amount of trunk fat was associated with a greater intake of carbohydrates, sedentary individuals consumed more carbohydrates and non-smokers consumed more fruits, vegetables and olive oil. ***Conclusions:*** A greater sedentary lifestyle was associated with consumption of carbohydrates. Moreover, not smoking in the preoperative period of bariatric surgery was associated with greater consumption of healthy eating markers.

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INTRODUCTION

Bariatric surgery is considered the most effective method for treating complications caused by severe obesity when other treatment options are insufficient. The effects of bariatric surgery include an accentuated reduction in fat mass, leading to a better metabolic status that results in a reduction in cardiovascular risk, insulin resistance, DM2, etc (Maïmoun *et al*., 2019). However, this procedure is also associated with an unfavorable clinical and nutritional evolution due the accentuated loss of muscle mass, a reduction in bone mineral content and nutritional deficiencies (Lalmohamed *et al*., 2012). Nutritional deficiencies may be related to the reduced food intake, low adherence to supplements and/or the malabsorption of nutrients in the postoperative period as well as deficiencies prior to surgery (Lupoli *et al*., 2017).

Indeed, studies have demonstrated that individuals with morbid obesity may have presurgical nutritional deficiencies, especially with regards to iron, calcium, vitamin B12, and vitamin D (Alexandrou *et al*., 2014). Moreover, there is a reduction in the consumption of fruits, vegetables and proteins. Inadequate protein intake is associated with the aggravation of postoperative muscle loss, as the positive nitrogen balance serves as a protective factor for the maintenance of muscle mass in the control of weight. In contrast, an increase in calorie intake from carbohydrates, trans fats and saturated fats is reported, which results in gains in body weight associated with fat mass (Hall *et al*., 2019). An adequate eating pattern combined with a healthy lifestyle, including physical activity, the non-consumption of alcohol and the cessation of smoking, is important not only to one's general health status, but also to minimize undesirable repercussions in the postoperative period of obesity surgery.

Therefore, the aim of the present study was to evaluate associations between food intake, body composition and lifestyle in the preoperative period of bariatric surgery.

METHODS

A cross-sectional study was conducted with a convenience sample of patients at the Oswaldo Cruz University Hospital in the city of Recife, Brazil, admitted to hospital for submission to bariatric surgery in the period from 2018 to 2019. Male and female patients between 20 and 59 years of age hospitalized to undergo the surgical procedures were included in the study. All volunteers who agreed to participate signed as statement of informed consent. This study received approval from the Human Research Ethics Committee of Oswaldo Cruz University Hospital (HUOC/PROCAPE) in accordance with Resolution 466/12 of the Brazilian National Board of Health (certificate number: 67051817.9.0000.5192). The exclusion criteria were a history of psychiatric disease, liver disease, kidney disease, the use of illicit drugs, physical disability that impeded the determination of anthropometric characteristics and body composition, previous surgical intervention of the digestive tract, history of plastic surgery or major surgery, patients scheduled for reoperation due to weight regain and edema (due to the influence on the evaluation of body composition). Data were collected on age, sex, weight (kg), height (m) and preoperative waist circumference (WC in cm) (Jellife, 1968). The body mass index (BMI) was then calculated (AACE/TOS/ASMBS, 2008). Body composition (fat mass, trunk fat, lean mass and bone mineral content) was determined using dual emission x-ray absorptiometry (DXA) (Lunar Prodigy DF+ 14.319 *Radiation*-Madison, WI, USA). For such, whole body scans were performed (Lohman, 1988).

Lifestyle was evaluated based on physical activity level, alcohol intake and smoking habits (current smoker, ex-smoker or non-smoker). The short version of the International Physical Activity Questionnaire (IPAQ) was used (physically active $\geq$ 150 min/week) (Craig *et al*., 2003). Among those who reported consuming alcohol, the Alcohol Use Disorders Identification Test (AUDIT) (Lima *et al*., 2005) was administered to classify intake as low risk/abstinence, risk or hazardous use and possible alcohol dependence. The quantity of standard drinks (40 mL sugarcane alcohol, whisky or vodka; 85 mL of port wine or liquor; 140 mL of wine; 340 mL of beer) and frequency of consumption were also evaluated. Food intake was evaluated using a specific food frequency questionnaire (FFQ) adapted (Soares, 2013) based on the dietary pyramid for patients submitted to bariatric surgery proposed by Moizé *et al*. The FFQ lists foods distributed into four groups (1-proteins; 2-vegetables, fruits and olive oil; 3- grains, roots and tubers; 4- highly processed foods, alcoholic beverages and foods rich in sugar, saturated fat, *trans* fat and cholesterol). The frequencies were recorded using the previous month as reference in order to avoid overreporting and to assist in the recording of intake: never or rarely, one to three times per month, once per week, two to four times per week, five to six times were per week, once per day and two or more times per day. Consumption frequency was converted into scores (Fornés *et al*., 2002). To transform the frequencies reported into daily frequency, a report of "once per day" (scored 1) was used as the reference. Thus, a frequency of "never or rarely" corresponded to a daily intake of 0; “one to three times per month” was scored as 0.067 (2x/30 days); “once per week” was scored as 0.143 (1/7 days); “two to four times per week” was scored as 0.429 (3/7 days); “five to six times per week” was scored as 0.786 (5.5/7 days) and “two or more times per day” was scored as 2. The statistical analyses were performed with the aid of SPSS version 25.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov was used to determine the normality of the continuous variables. Variables with parametric distribution were expressed as mean and standard deviation values, whereas those with nonparametric distribution were expressed as median and interquartile range (IQR: 25^{th} and 75^{th} percentiles). The comparison of means was performed using the Student's t-test and the Mann-Whitney U test (variables with nonparametric distribution).

The food frequency scores (variables on an ordinal scale) were expressed as median and IQR. Associations between food intake and the explanatory variables were evaluated using the Mann-Whitney U test (two medians) and Kruskal-Wallis test (more than two medians) with the *a posteriori* Mann-Whitney U test. The level of significance for the rejection of the null hypothesis was 5%.

RESULTS

Sixty patients were analyzed, 78.3% (n=47) of whom were women. Mean age was 38.88 ± 9.67 years. The lifestyle characteristics are displayed in Table 1. It was observed that 33.3% (n = 20) ingested alcoholic beverages, most of which ingested more than 3 doses per occasion. No participants were smokers at the time of the survey.

Table 1. Lifestyle characteristics of patients in preoperative period of bariatric surgery. Oswaldo Cruz University Hospital, Recife, Brazil, 2018-2019

Characteristics	n	%
Physical activity		
Sedentary	19	31.7
Insufficiently active	17	28.3
Active	24	40.0
Alcohol consumption		
Yes	20	33.3
No	40	66.7
AUDIT*		
Low risk/abstinence	15	75.0
Risk	5	25.0
Drinks*		
< 3	7	35.0
$\geq$ 3	13	65.0
Frequency of alcohol intake *		
$\leq$ once/month	8	40.0
2-4 times/month	10	50.0
2-3 times/week	2	10.0
Smoking		
Non-smoker	50	83.3
Ex-smoker	10	16.7

AUDIT: Alcohol Use Disorders Identification Test; *n = 20

In table 2, displays the anthropometric measurements and body composition by sex. Weight, height, WC, lean mass and total bone mineral content was higher in men. The mean percentage of total body fat was 48.2 ± 5.11%. In addition, the mean trunk fat mass, lean mass and bone mineral density was 26.84 ± 5.34Kg, 55.85 ± 10.19Kg, 1.11 ± 0.08g/cm^2, respectively. In the association tests for lifestyle and food intake, sedentary individuals consumed more foods in the carbohydrate group (p=0.041) and non-smokers consumed more fruits, vegetables and olive oil (p = 0.031) (Table 3). In the association tests for body composition and food intake, individuals who consumed more carbohydrates had less truncal fat (p = 0.044) (Table 4). No significant associations were found between food intake and anthropometric measurements. As by adopting the above practices all major constructs of a research paper can be written and together compiled to form a completeresearch ready for Peer review.

DISCUSSION

To evaluate body composition, segmental evaluation methods are interesting to understand changes in body fat, muscle mass and bone mineral content that occur after bariatric surgery, with DXA being considered the gold standard (Maïmoun *et al*., 2019). Furthermore, the body fat percentage is able to predict weight loss after gastric bypass, regardless of BMI and age, and consequently metabolic improvement (Hogling *et al*., 2018). The average body fat percentage of patients of both sexes in this study was lower than in the Zhang *et al*.(54.6%) e Hogling *et al*. (51.4 + 3.8%). Although the literature states that WC is a predictor of central fat (170 and the data in this study show a higher measure of WC in men, there was no significant difference in truncal fat between the sexes (p=0.789).

Table 2. Anthropometric characteristics and body composition of patients in preoperative period of bariatric surgery. Oswaldo Cruz University Hospital, Recife, Brazil, 2018-2019

Variables	Women	Men	Total	p-value*
	Mean ± SD	Mean ± SD	Mean ± SD	
Weight (kg)	114.98 ± 15.36	148.40 ± 26.03	122.22 ± 22.69	0.001
Height (m)	1.59 ± 0.07	1.78 ± 0.04	1.62 ± 0.09	0.000
BMI (kg/m^2)	46.64 ± 6.57	49.79 ± 8.04	47.3 ± 6.96	0.150
WC (cm)	122.11 ± 12.69	135.31 ± 14.30	124.97 ± 14.04	0.002
FM (kg)	55.34 ± 9.63	54.10 ± 5.84	55.08 ± 8.90	0.767
TFM (kg)	26.70 ± 5.65	27.38 ± 4.36	26.84 ± 5.34	0.787
LM (kg)	52.83 ± 8.31	67.41 ± 8.71	55.85 ± 10.19	0.001
BMD (g/cm^2)	1.11 ± 0.09	1.11 ± 0.05	1.11 ± 0.08	0.952
TBMC (g)	2112.28 ± 401.23	2528.33 ± 260.18	2198.28 ± 409.89	0.024

SD: standard deviation; BMI: body mass index; WC: waist circumference; FM: fat mass; TFM: truncal fat mass; LM: lean mass; BMD: bone mineral density; TBMC: total bone mineral content; *Student T-test

Table 3. Food intake according to lifestyle variables of patients in preoperative period of bariatric surgery. Oswaldo Cruz University Hospital, Recife, Brazil, 2018-2019

	Food group			
Variables	Group 1	Group 2	Group 3	Group 4
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Physical activity				
Sedentary	0.57 (0.32 - 1.10)	0.75 (0.25 - 1.00)	0.89 (0.75 - 1.25)[a]	0.54 (0.20 - 1.15)
Insufficiently active	0.54 (0.44 - 0.70)	0.69 (0.48 - 1.05)	0.71 (0.44 - 0.98)[b]	0.34 (0.10 - 0.42)
Active	0.56 (0.45 - 0.83)	0.80 (0.59 - 0.98)	0.75 (0.31- 1.00)[b]	0.45 (0.08 - 0.82)
p-value*	0.912	0.924	0.041	0.205
Alcohol intake				
Yes	0.57 (0.48 - 0.69)	0.71 (0.49 - 1.00)	0.92 (0.60 - 1.12)	0.56 (0.29 - 0.95)
No	0.55 (0.42 - 0.88)	0.75 (0.44 - 1.00)	0.75 (0.37 - 1.00)	0.38 (0.10 - 0.78)
p-value	0.808	0.900	0.081	0.106
AUDIT+				
Low risk/abstinence	0.57 (0.44 - 0.83)	0.75 (0.50 - 1.00)	0.76 (0.42 - 1.00)	0.40 (0.15 - 0.80)
Risk	0.46 (0.41 - 0.63)	0.46 (0.37 - 0.78)	0.80 (0.64 - 1.11)	0.80 (0.19 - 1.04)
p-value	0.303	0.172	0.574	0.495
Drinks+				
< 3	0.63 (0.57 - 1.10)	0.71 (0.67 - 1.00)	0.89 (0.57 - 1.05)	0.40 (0.22 - 1.15)
≥ 3	0.54 (0.45 - 0.66)	0.71 (0.46 - 1.00)	0.96 (0.64 - 1.19)	0.67 (0.30 - 0.87)
p-value	0.154	0.781	0.721	0.751
Smoking				
Non-smoker	0.59 (0.45 - 0.85)	0.75 (0.55 - 1.00)	0.75 (0.41 - 1.00)	0.40 (0.09 - 0.81)
Ex-smoker	0.49 (0.36 - 0.77)	0.51 (0.24 - 0.78)	0.84 (0.67 - 1.06)	0.69 (0.32- 0.96)
p-value	0.326	0.031	0.444	0.193

Group 1 = proteins; Group 2 = vegetables, fruits and olive oil; Group 3 = grains, roots and tubers; Group 4 = highly processed foods, alcoholic beverages, foods rich in sugar, saturated fat, *trans* fat and cholesterol IQR: interquartile range; (n=60). AUDIT: Alcohol Use Disorders Identification Test; +n=20
[a,b] Different letters denote significant differences between categories. * Kruskal-Wallis test. *A posteriori* test: Mann-Whitney U test.

Table 4. Food intake according to body composition of patients in preoperative period of bariatric surgery Oswaldo Cruz University Hospital, Recife, Brazil, 2018-2019

Variables	Group 1	Group 2	Group 3	Group 4
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Bone mineral density (g/cm^2)				
< 1.05	0.80 (0.61 - 1.08)	1.12 (0.77 - 1.43)	0.87 (0.75 - 1.18)	0.34 (0.33 - 0.68)
1.05 - 1.14	0.91 (0.57 - 1.12)	0.87 (0.58 - 1.50)	0.98 (0.61 - 1.08)	0.80 (0.12 - 1.33)
≥ 1.14	0.49 (0.44 - 0.80)	0.58 (0.32 - 0.89)	0.80 (0.53 - 1.00)	0.52 (0.30 - 0.83)
p-value*	0.093	0.104	0.485	0.471
Lean mass (kg)				
< 49	0.62 (0.58 - 0.85)	0.94 (0.73 - 1.37)	1.00 (0.75 - 1.00)	0.33 (0.11 - 0.50)
49 - 58.5	0.90 (0.46 - 1.12)	0.82 (0.42 - 1.31)	0.91 (0.50 - 1.25)	0.68 (0.33 - 1.06)
≥ 58.5	0.66 (0.42 - 0.96)	0.65 (0.49 - 1.31)	0.74 (0.46 - 0.98)	0.65 (0.34 - 0.88)
p-value*	0.506	0.771	0.308	0.136
Fat mass (kg)				
< 48	0.52 (0.38 - 0.63)	0.69 (0.33 - 1.00)	0.71 (0.37 - 1.00)	0.20 (0.10 - 0.66)
48 - 58	0.74 (0.45 - 1.10)	0.82 (0.41 - 1.31)	0.98 (0.70 - 1.25)	0.75 (0.47 - 1.08)
≥ 58	0.60 (0.46 - 0.94)	0.75 (0.55 - 1.14)	0.74 (0.47 - 0.87)	0.47 (0.32 - 0.70)
p-value*	0.275	0.069	0.160	0.694
Truncal fat (kg)				
< 23.5	0.70 (0.46 - 1.10)	1.25 (0.46 - 1.50)	1.00 (0.80 - 1.03)[a]	0.67 (0.16 - 0.84)
23.5 - 28.3	0.85 (0.52- 1.10)	0.94 (0.62 - 1.43)	0.98 (0.75 - 1.25)[a]	0.59 (0.33 - 0.99)
≥ 28.3	0.58 (0.37 - 0.83)	0.65 (0.45 - 0.98)	0.72 (0.29 - 0.86)[b]	0.41 (0.24 - 0.70)
p-value*	0.142	0.239	0.044	0.550

Group 1 = proteins; Group 2 = vegetables, fruits and olive oil; Group 3 = grains, roots and tubers; Group 4 = highly processed foods, alcoholic beverages, foods rich in sugar, saturated fat, *trans* fat and cholesterol IQR: interquartile range [a,b] Different letters denote significant differences between categories. * Kruskal-Wallis test. *A posteriori* test: Mann-Whitney U test.

This may have occurred because of the difficulty in obtaining the mid-point between the last rib and the iliac crest in patients with morbid obesity, therefore, such measurements may be overestimated, unlike DXA, which provides accurate volumetric evaluations of the region. The truncal fat found in the study (26.84 + 5.34 kg)was higher than that observed by Zhang *et al*. (25.24 + 6.56 kg) in the preoperative period of Gastric Bypass. When analyzed lean body mass and total bone mineral content, men showed significantly higher values than women. These results reaffirm the existence of sexual differences in body composition, in which men have more lean mass than women (Kelly, 2009). Lean mass is an important determinant of bone metabolism and the tension force exerted by the muscle system is a stimulus to bone tissue remodeling in patients with obesity (Lalmohamed *et al*., 2012). In this study, this relationship is perceived in men, since they presented higher body weight, leaner mass and consequently higher bone mineral content. individuals who consumed more carbohydrates had less truncal fat. In the present study, the individuals with higher truncal fat had lower carbohydrate consumption (p=0.044). Unlike in the literature, the high consumption of carbohydrates, associated with low intake of fruits, vegetables, milk and derivatives has a direct relationship with the total fat mass and the location of this fat, and can be stored in greater proportion in the trunk area (Jastrzębska-Mierzyńska *et al*., 2014; Parri *et al*., 2019). It is plausible to assume that these results configure a situation of reverse causality, likely to occur by the cross-sectional design of the study, probably due to the preoperative multiprofessional care that addressed quality of diet and basic notions of feeding, since the evaluation of food consumption was only 30 days prior to hospitalization. The sample consisting mostly of young adult women, is suggestive that the female population is more concerned with seeking health care. Therefore, the female gender may be associated with a greater understanding of the health condition, related to certain healthy life habits (Lim *et al*., 2019). This fact was observed in the population studied, since the majority never smoked (83.3%), did not drink alcohol (66.7%) and was classified as active (40%). No patient reported being a smoker in the preoperative period of bariatric surgery, unlike the work of Wolvers *et al*. (25.6% were smokers) (Wolvers *et al*., 2020). Evidence points to an association between smoking and food choices (Palaniappan *et al*., 2001; Raatz *et al*., 2017). In a study that evaluated adults with obesity, smokers and non-smokers, a higher intake of unsaturated fatty acids and micronutrients, such as iron and vitamin C, was observed among non-smokers, being fruits and vegetables the source of these micronutrients (Raatz *et al*., 2017). In the present study, it was found that individuals who never smoked had a higher consumption of fruits, vegetables and olive oil (p=0.031) when compared to former smokers. Positive fact, since regular ingestion of these foods improves metabolic health, helps in reducing fat mass and may reduce the risk of weight gain in the postoperative period (Sharma *et al*., 2016).

Regarding alcohol intake, although it was observed that the majority did not drink, 33.3% of patients used alcohol in the preoperative, a frequency higher than that demonstrated by Amorim *et al*. (26.6%) and Burgos *et al*. (24.2%). As well as the number of doses was also higher than the studies mentioned (greater than 3 doses per occasion). It is fundamental to evaluate the candidates to bariatric surgery regarding the use of alcoholic beverages, as well as abuse and dependence in any phase of life, and not only in the preoperative period, because many individuals stop drinking at that moment to avoid the contraindication of surgery (Ivezaj *et al*., 2019). Factors such as young age, smoking, regular intake and harmful use of alcohol in the preoperative period are predictors for a high risk of developing alcohol problems after surgery (Burgos *et al*., 2015; Ivezaj *et al*., 2019). Lower level of physical activity (found in 60% of volunteers) is considered an independent risk factor for obesity and weight recovery, due to a state of metabolic inflexibility (Rynders *et al*., 2018), aggravated when associated with high consumption of fatty foods and high glycemic carbohydrates, a practice commonly observed in candidates for bariatric surgery (Siervo *et al*., 2013). The present study corroborates this fact already consolidated in the literature (Esmaillzadeh *et al*., 2008; Skop-Lewandowska *et al*., 2017), because sedentary individuals presented higher carbohydrate consumption (p=0.041). However, the percentage of patients classified as active in the practice of physical activity (40%) is highlighted. This condition may have occurred due to the obligation of the candidate for surgical treatment to attend the meetings of the multidisciplinary group of the hospital's surgery service, held monthly, and the practice of physical activity being one of the subjects addressed during the meetings. Physically active individuals, before and after surgery, experience greater weight loss and effective increase in quality of life (Tabesh *et al*., 2019). Some limitations of the study should be recognized, such as the small number of the sample, the methodological character and the memory of the interviewee. In addition, information on the consumption of some foods is lost because in the QFA it is not possible to include all the food items consumed by a population. Another limitation of this study would be the method of evaluation of body composition in morbidly obese patients, because the width of the trunk of these individuals was many times greater than the width of the surface of the examination table, however, because it is a gold standard evaluation justifies its use. Thus, this study reinforces the importance of early identification of patients prone to adopt unhealthy eating and lifestyle patterns, as it can help multidisciplinary team members to intervene to improve metabolic and body composition surgical (Kanerva *et al*., 2017) outcomes with proper management before and after bariatric surgery (Tabesh *et al*., 2019), since surgery does not eliminate unhealthy habits.

CONCLUSION

Sedentarism was associated to a higher consumption of carbohydrates, while the habit of not smoking was associated to better nutritional quality and healthier foods in the preoperative period of bariatric surgery. Thus, identifying the lifestyle and food pattern before surgery to prevent major changes in body composition and ensure satisfactory postoperative results is important. More studies, especially longitudinal follow-up studies, are necessary to better understand the relationship of body composition, lifestyle and food consumption in the preoperative period of bariatric surgery and its impacts in the postoperative period.

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