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Factors associated with the high body fat percentage in physically active individuals

Fatores associados ao elevado percentual de gordura corporal em indivíduos fisicamente ativos

Abstract

Introduction: Physical exercise is practiced with several objectives, especially the promotion of changes in body composition, with fat reduction and increase in lean mass. Thus, understanding the factors that may be associated with this modification becomes relevant. *Objective*: To analyze demographic, lifestyle, biochemical, dietary, and training factors associated with the percentage of body fat in practitioners of physical exercise in gyms. *Materials and Methods*: Cross-sectional study with 143 healthy physical exercise practitioners, of both sexes. Sociodemographic characteristics and lifestyle were obtained through the application of a questionnaire. Food consumption was obtained through 24-hour food records, considering the averages of three days. Body composition was assessed using anthropometric assessment and the electrical bioimpedance test. The statistical analysis included the Shapiro Wilk test to verify normality, the chi-square and Fisher's exact test were used to assess the association between categorical variables and the response variable and the Mann-Whitney and Student *t* tests for the continuous variables. Poisson regression with robust variance was used to determine the associations between studied variables. Stata software version 14.0 was used for statistical analysis and a value of p <0.05 was adopted. *Results*: The prevalence of high body fat was 49.3% in men and 79.2% in women. The associated factors were the higher consumption of protein and fibers in women and the concentration of monocytes in men. *Conclusion*: Despite being a physically active public, a high percentage of fat was observed among the study participants and the associated factors reinforce the multi-etiological character of this indicator

Keywords: Physical exercise. Food consumption. Distribution of body fat. Body.

Resumo

Introdução: O exercício físico é praticado com diversos objetivos, destacando-se a promoção na mudança da composição corporal, com a redução de gordura e aumento de massa magra. Assim, compreender os fatores que podem estar associados nesta modificação se torna relevante. *Objetivo*: Analisar os fatores demográficos, estilo de vida, bioquímico, alimentares e de treinamento associados ao percentual de gordura corporal em praticantes de exercício físico em academias. *Materiais e Métodos*: Estudo transversal com 143 praticantes de exercícios físicos saudáveis, de ambos os sexos. Características sociodemográficas e estilo de vida foram obtidas através da aplicação de questionário. O consumo alimentar foi obtido através de registros alimentares de 24h, considerando as médias de três dias. A composição corporal foi avaliada por meio de avaliação antropométrica e pelo teste de bioimpedância elétrica. A análise estatística contemplou o teste de *Shapiro Wilk* para verificação da normalidade; o qui-quadrado e exato de Fisher foram usados para avaliar a associação entre as variáveis categóricas e a variável resposta e os testes de Mann-Whitney e *t* de Student para as contínuas. A regressão de Poisson com variância robusta foi usada para determinar as associações entre variáveis estudadas. O *software* Stata versão 14.0 foi usado para análise estatística, tendo sido adotado o valor de *p* <0,05. ***Resultados***: A prevalência de gordura corporal elevada foi de 49,3% nos homens e 79,2% nas mulheres. Os fatores associados foram o maior consumo de proteína e fibras nas mulheres e a concentração de monócitos nos homens. ***Conclusão***: Apesar de se tratar de público fisicamente ativo, observou-se elevado percentual de gordura entre os participantes do estudo e os fatores associados reforçam o caráter multietiológico deste indicador.

Palavras-chave: Exercício físico. Consumo alimentar. Distribuição de gordura corporal. Composição corporal

INTRODUCTION

The improvement in body composition is among the main objectives with the practice of physical exercises.[1] Dissatisfaction with the body can even be a predictive factor for the time of practice of physical exercise, as well as for the frequency of training in the gym.[2] Several factors influence the proportion between fat mass and lean mass, and there is evidence that continually overweight or obesity in childhood and adolescence is associated with increased fat mass and lower fat-free mass in adulthood.[3] The level of activity influences the body composition profile,[4] and it is common with aging to observe a reduction in strength and muscle mass.[5] Thus, understanding these factors is the first step in designing effective interventions.

Physical exercise, in general, may change body composition, regardless of diet. The practice of aerobic exercises is more strongly related to the improvement of cardiometabolic risk factors, including resistance to insulin, triglycerides, and visceral fat.[6] However, resistance training shows a greater potential for modifying body composition even in a group of overweight and obese elderly people, as demonstrated in a randomized controlled study by Nicklas et al.,[7] in which the isolated effect of exercise on fat mass was perceived, regardless of caloric restriction. In addition to the type of exercise, the duration of training is a factor that influences body composition.[8]

Studies suggest that excess body fat leads to changes in the lipogram and increases the risks for cardiovascular diseases. A cross-sectional study with elderly women observed that the sample with global and central overweight conditions showed changes in the lipid profile, with emphasis on the reduction of HDL-c level.[9]

Thus, based on the various influences that the fat mass suffers from intrinsic and extrinsic factors, the present study sought to analyze the demographic, behavioral and dietary factors associated with the percentage of body fat in practitioners of physical exercise.

METHODS

Study design and sample

Cross-sectional study developed with practitioners of physical exercises in six gyms in São Luís, Maranhão state. The gyms were defined by convenience, considering the number of gyms operating in São Luís according to the Regional Council of Physical Education (CREF) of Maranhão. The inclusion criteria for academies were: they have varied physical areas and offer different modalities; resistance training was mandatory, and they should have more than 300 students with active enrollments.

The study sample consisted of 143 physical exercise practitioners, of both sexes, aged between 18-70 years, enrolled in gyms located in São Luís, with a weekly frequency above three and who agreed to participate in the study through signing of the Free and Informed Consent Form (ICF).

Data collection

Data was collected from May 2016 to July 2017. A validated, adapted, and pre-coded form was used with the following information: sex, age, marital status, skin color, alcohol consumption, smoking, exercise time in months and weekly frequency of physical exercise.

The dietary intake of bodybuilding practitioners was measured in three 24-hour food records, one performed at the time of the interview and the other two delivered to the participant, to be performed on a day of the week and another at the weekend. Each participant was instructed on how to fill in the time, place, preparations, and portion of the recorded meals. After filling in the food records, these were delivered to the researchers on a previously scheduled date.

The food consumption variables were: total calories, percentage of carbohydrates, proteins and lipids in relation to the total caloric heat value of the diet and daily consumption in grams per kilogram of weight per day (g/kg/day) for carbohydrates, proteins, and lipids.

For the evaluation of biochemical tests, the blood obtained by venipuncture was centrifuged and the serum from it was used to determine the fasting blood glucose and insulinemia of at least eight hours. Glucose was dosed by the endpoint method (Labtest, Brazil) in Bioplus® 2000 equipment. Glucose oxidase catalyzes the oxidation of glucose and the hydrogen peroxide formed reacts with 4-aminoantipyrine and phenol, under the catalytic action of peroxidase, through an oxidative coupling reaction forming a red antipyrilquinonimine whose color intensity is proportional to the concentration of glucose in the sample. Insulin was measured by the chemiluminescence method in automated Immulite® 2000 xpi equipment, according to the manufacturer's specifications (Siemens Healthcare Diagnósticos S.A, Germany).

Insulin resistance was measured by Homeostasis model assessment-insulin resistance (HOMA-IR), using the formula: HOMA-IR = Insulin (μU/mL) x (blood glucose mg/dL ÷ 18) ÷ 22.5.[10,11]

The body composition assessment included the electrical bioimpedance test, using a tetrapolar device (Biodynamics 450®, USA), with the individual lying on a non-conductive surface, with legs apart and arms in parallel away from the trunk. Participants received instructions for the exam in advance. Four electrodes were placed, two in the hand, with the distal electrode at the base of the middle finger and the proximal one just above the wrist joint, coinciding with the styloid process; two on the foot, with the distal electrode at the base of the middle finger and the proximal one above the ankle joint line, between the medial and lateral malleoli, both on the dominant side.[12]

After typing the data into the tetrapolar device, the test was performed, and the body composition values were immediately printed. The percentage of body fat (%BF) obtained was categorized as normal and above adequate, according to the adapted Lohman[13] criteria: normal (<15% for men and <23% for women) and above adequate (≥15% for men and ≥23% for women).

Statistical Analysis

For the analysis of food consumption data analysis, the average consumption of carbohydrates, proteins, and lipids from the three days of records was considered, through national calculations in the NutriPlan® software version 2.7. All consumption variables were continuous in the analyzes performed.

The variables were described using means, standard deviation, median, interquartile ranges, absolute and relative frequencies. Normality was assessed using the Shapiro-Wilk test. In the bivariate analysis, chi-square or Fisher's exact tests were used for associations of categorical variables and Student's *t*-test or Mann-Whitney for associations of numerical variables with the percentage variable of body fat. The variables with $p < 0.20$ were for multivariate analysis, in which Poisson regression with robust variance was used, considering as statistically significant difference $p < 0.05$. The analyzes were performed using the software Stata® version 14.0.

Ethical criteria

Ethical approval for the study was obtained from the Research Ethics Committee of the Federal University of Maranhão (CEP-UFMA) under Opinion number 1.378.129. The research fulfilled the requirements demanded by Resolution 466/2012 of the National Health Council and its complementary acts for research involving human beings.

RESULTS

Data from %BF were collected from 143 individuals who practiced physical exercise almost homogeneously distributed between men and women (49.6% vs 50.4% respectively). They had an average age of 30.9 years (SD: 12.0) and most were married couples (74.1%). The description of the sociodemographic characteristics of the individuals stratified by sex and adequacy of %BF is shown in table 1.

Table 1. Association between demographic characteristics, lifestyle, and training with the percentage of body fat (%BF) of physical exercise practitioners by sex. São Luís-MA, 2017.

Variables	Normal %BF		Above adequate %BF		*p*
	n	%	n	%	
Men					
Age[1]					**0.033**
<30 years	29	80.6	20	57.1	
≥ 30 years	7	19.4	15	42.9	
Consumption of alcoholic beverages [1]					0.363
Yes	20	55.6	17	48.6	
Did not stop	16	44.4	18	51.4	
Smoking[2]					0.239
Yes	36	100.0	33	94.3	
Did not stop	0	0.0	two	5.7	
Weekly training frequency[1]					0.614
≤ 4 times	27	75.0	28	80.0	
> 4 times	9	25.0	7	20.0	
Practice practice time[1]					0.834
≤ 6 months	17	47.2	19	54.3	
> 6 months	19	52.8	16	45.7	
Women					
Age[1]					**0.038**
<30 years	10	66.7	21	36.8	
≥ 30 years	5	33.3	36	63.2	
Consumption of alcoholic beverages[1]					0.629
Yes	9	60.0	38	66.7	
Did not stop	6	40.0	19	33.3	
Smoking[1]					0.479
Yes	12	80.0	48	84.2	
Did not stop	3	20.0	9	15.8	
Weekly training frequency[1]					0.352
≤ 4 times	13	86.7	43	75.4	
> 4 times	two	13.3	14	24.6	
Practice time[1]					0.481
≤ 6 months	8	53.3	26	45.6	
> 6 months	7	46.7	31	54.4	

[1]Pearson's chi- square; [2]Fisher's exact. Values in bold: statistically significant (*p* <0.200).

The global average body fat percentage was 21.6% (SD: 8.1). By gender, women (27.7%; SD: 6.0) had a higher average than men (15.4%; SD: 4.6). The general prevalence of %BF above the adequate was 64.3% (95% CI: 56.4 – 72.3). In the distribution by sex, women had a higher prevalence of this condition (79.2%; 95% CI: 69.6 – 88.8) when compared to men (49.3%; 95% CI: 37.4 – 61.2) (data not shown in table).

To more accurately determine the factors associated with %BF, the sample was divided according to sex, given the physiological differences between the two groups.[14] In the bivariate stage of the analysis, the age variable was associated with both sexes. No variable in the lifestyle and training blocks was significant (table 1).

Among men, the biochemical variables erythrocyte, monocyte, eosinophil concentrations, HDL-c, AST and ALT were associated with the high percentage of fat (table 2), while in women, the concentrations of erythrocytes, leukocytes, basophils, total cholesterol, serum creatinine, fasting blood glucose, HOMA-IR index and urea (table 3).

Table 2. Difference between biochemical and food consumption variables with the percentage of body fat (% BF) of male physical exercise practitioners. São Luís - MA, 2017.

Variables	Normal %BF						Above adequate %BF						*p*
	n	Average	SD	Median	P25	P75	n	Average	SD	Median	P25	P75	
Hemoglobin [1]	29	14.9	0.9	15	14.1	15.7	28	14.6	0.7	14.7	14.3	15.2	0.354
Erythrocytes [1]	29	5.0	0.4	4.9	4.7	5.2	28	4.8	0.3	4.8	4.6	5.0	**0.188**
Hematocrit [1]	29	44.1	3.0	44.4	41.7	46.2	28	43.5	2.1	44.0	41.8	45.1	0.393
Leukocytes [1]	29	5435.5	1988.9	5070.0	4470.0	5790.0	28	5448.9	1372.1	5270.0	4380.0	6260.0	0.696
Neutrophils [1]	29	52.7	10.5	54.4	46.9	58.5	28	54.6	7.8	54.5	50.3	58.8	0.434
Lymphocytes [1]	29	36.2	9.2	36.7	29.8	41.8	28	35.1	6.9	36.1	30.6	39.4	0.774
Monocytes [1]	29	5.8	1.4	5.5	4.9	6.4	28	6.3	1.0	6.3	5.7	7.0	**0.030**
Eosinophils [1]	29	4.2	3.4	3.0	2.1	5.5	28	2.9	2.2	2.3	1.8	3.1	**0.049**
Basophils [1]	29	1.1	0.5	1.1	0.7	1.3	28	1.2	0.7	1.2	0.6	1.6	0.637
Total cholesterol [1]	18	164.9	30.6	168.5	151.0	188.0	20	180.5	42.6	178.5	138.0	201.5	0.279
HDL-c [2]	18	63.2	6.9	63.0	60.0	65.0	20	59.8	6.2	59.0	56.0	63.0	**0.116**
Serum creatinine [2]	18	1.1	0.2	1.1	1.0	1.2	21	1.1	0.2	1	0.9	1.2	0.687
Urinary creatinine [1]	29	165.6	74.8	158.1	97.4	208.8	28	171.4	83.0	171.0	126.9	233.0	0.587
Uric acid [2]	18	8.4	1.9	8.2	6.7	9.5	21	8.1	1.6	7.5	7.2	8.9	0.693
Albumin [1]	18	3.8	0.7	3.6	3.3	4.2	21	3.6	0.5	3.6	3.3	3.7	0.660
Fasting glucose [1]	18	77.4	8.5	77.0	72.0	87.0	20	83.2	23.9	77.0	69.5	80.5	0.838
Insulin [1]	32	7.6	5.3	6.1	4.1	9.5	33	9.6	10.3	6.3	4.9	10.9	0.684
HOMA-go [1]	16	1.1	0.6	0.9	0.7	1.4	19	2.8	5.2	1.0	0.6	1.4	0.753
Total proteins [1]	18	5.4	0.9	5.6	4.8	5.7	21	5.5	1.1	5.5	5.0	5.8	0.955
Urea [1]	18	34.0	11.2	33.0	24.0	40.0	21	32.0	6.4	32.0	28.0	37.0	0.866
AST [1]	18	22.2	15.1	15.0	15.0	26.0	21	31.9	23.3	26.0	20.0	41.0	**0.058**
ALT [1]	18	32.8	33.6	26.0	16.0	31.0	21	31.2	15.8	29.0	24.0	31.0	**0.172**
Total calories [1]	36	2367.6	925.2	2048.4	1760.8	2596.9	35	1965.8	622.1	1993.0	1498.0	2228.0	**0.099**
Carbohydrate (%) [1]	36	45.5	9.7	46.4	39.5	53.4	35	46.9	7.8	48.2	42.2	53.3	0.646
Carbohydrate (g/kg/day) [1]	36	3.6	2.0	3.0	2.2	4.4	35	3.2	1.4	2.9	2.3	3.9	0.604
Proteins (%) [1]	36	16.1	9.8	13.6	7.4	21.7	35	15.3	8.1	12.7	8.2	19.9	0.995
Proteins (g/kg/day) [1]	36	1.9	0.8	1.8	1.2	2.4	35	1.6	0.6	1.5	1.1	2.1	**0.113**
Lipids (%) [1]	36	29.6	8.7	27.8	23.6	33.2	35	29.0	6.6	27.2	24.7	34.0	0.849
Lipids (g/kg/day) [1]	36	1.1	0.6	0.9	0.6	1.4	35	0.9	0.4	0.8	0.6	1.2	**0.172**
Total fibers [1]	36	20.3	11.4	16.8	13.1	23.4	35	20.7	12.2	19.8	12.7	28.7	0.553

[1] Mann-Whitney U test. [2] Student's *t* test. Values in bold: statistically significant ($p < 0.200$). SD: standard deviation; P25: 25th percentile; P75: 75th percentile; Abbreviations: HDL-c, High density lipoprotein cholesterol; AST, Aspartate aminotransferase; ALT, Alanine aminotransferase.

Table 3. Difference between biochemical and food consumption variables with the percentage of body fat (% BF) of female exercise practitioners. São Luís-MA, 2017.

Variables	Normal %BF						Above adequate %BF						p
	n	Average	SD	Median	P25	P75	n	Average	SD	Median	P25	P75	
Hemoglobin [1]	10	13.1	1.6	13.2	12.9	13.5	40	12.9	1.1	12.9	12.4	13.4	0.239
Erythrocytes [1]	12	3.6	1.7	4.2	3.9	4.3	41	4.5	1.7	4.3	4.1	4.5	**0.089**
Hematocrit [1]	11	35.7	12.6	39.0	38.0	40.4	41	37.6	6.7	38.2	36.9	39.6	0.439
Leukocytes [1]	11	4523.6	1940.4	4860.0	3610.0	6470.0	41	5855.4	1533.2	5780.0	5260.0	7170.0	**0.012**
Neutrophils [1]	11	48.9	19.3	50.2	44.3	66.4	41	53.0	11.3	54.2	49.7	58.0	0.460
Lymphocytes [1]	11	33.3	14.2	37.8	24.7	43.7	41	35.3	9.2	35.4	31.9	39.9	0.946
Monocytes [1]	11	4.8	1.7	5.2	4.6	5.6	41	5.3	1.4	5.4	4.7	6.0	0.297
Eosinophils [1]	11	3.3	2.2	2.8	1.7	6.2	41	3.0	2.1	2.3	1.7	3.4	0.545
Basophils [1]	11	0.7	0.5	0.7	0.3	1.0	41	1.0	0.7	0.9	0.5	1.3	**0.148**
Total cholesterol [1]	8	141.5	33.9	141.5	127.0	162.0	38	176.2	39.7	169.0	147.0	202.0	**0.054**
HDL-c [2]	8	64.0	7.5	61.5	59.0	68.0	38	61.2	7.6	61.0	56.0	68.0	0.352
Serum creatinine [2]	8	1.0	0.1	1.0	0.9	1.1	38	0.9	0.1	0.9	0.8	1.1	**0.039**
Urinary creatinine [1]	11	123.9	71.2	111.2	90.3	154.9	41	112.2	57.9	92.6	69.8	136.5	0.288
Uric acid [2]	8	7.1	1.3	7.0	6.4	7.8	38	6.4	1.8	6.2	5.3	7.3	0.228
Albumin [1]	8	3.2	0.8	3.8	3.2	4.0	38	3.3	0.6	3.3	3.0	3.7	0.991
Fasting glucose [1]	8	69.9	4.1	70.0	67.5	73.0	38	78.0	15.1	72.5	70.0	81.0	**0.126**
Insulin [1]	14	7.1	4.3	6.4	3.7	9.3	56	9.5	6.8	8.0	4.7	13.0	0.351
HOMA-go [1]	8	1.0	0.5	0.9	0.6	1.1	37	1.6	1.2	1.3	0.8	2.1	**0.163**
Total proteins [1]	8	5.1	1.0	5.4	4.2	6.0	38	5.1	0.8	5.3	4.5	5.7	0.850
Urea [1]	8	31.5	8.3	33	24	39.5	38	27.1	7.1	26.5	22.0	32.0	**0.150**
AST [1]	8	17.0	4.8	15.0	15.0	20.0	38	15.3	6.8	15.0	10.0	20.0	0.268
ALT [1]	8	25.9	13.0	23.0	16.5	35.5	38	21.7	6.8	20.0	17.0	26.0	0.475
Total calories [1]	15	2187.1	567.4	2255.3	1826.0	2684.7	57	1802.5	574.6	1750.3	1385.0	2109.0	**0.019**
Carbohydrate (%) [1]	15	41.9	8.1	44.7	33.9	49.0	57	46.9	9.1	47.9	40.2	53.9	**0.046**
Carbohydrate (g/kg/day) [1]	15	3.2	1.0	3.0	2.7	3.7	57	3.0	1.2	2.9	2.2	3.5	0.393
Proteins (%) [1]	15	15.6	8.3	12.0	8.3	22.2	57	16.3	9.2	15.5	8.4	22.8	0.978
Proteins (g/kg/day) [1]	15	2.1	0.9	1.8	1.3	2.4	57	1.4	0.6	1.2	1.0	1.8	**0.005**
Lipids (%) [1]	15	35.4	17.4	34.0	24.7	38.8	57	29.4	6.7	30.2	24.7	34.1	0.225
Lipids (g/kg/day) [1]	15	1.0	0.4	1.0	0.6	1.4	57	1.0	0.8	0.8	0.6	1.2	0.275
Total fibers [1]	15	16.6	8.7	15.2	12.1	22.8	57	12.4	7.9	11.8	6.8	17.4	**0.095**

[1]Mann-Whitney U test. [2]Student's *t* test. Values in bold: statistically significant (p <0.200). SD: standard deviation; P25: 25th percentile; P75: 75th percentile; Abbreviations: HDL-c, High density lipoprotein cholesterol; AST, Aspartate aminotransferase; ALT, Alanine aminotransferase.

Table 4. Multivariate analysis of factors associated with the percentage of body fat in male physical exercise practitioners. São Luís - MA, 2017.

Variables	1st model		2nd model		3rd model		Final model	
	PR (95% CI)	*p*	PR (95% CI)	*p*	PR (95% CI)	*p*	PR (95% CI)	*p*
Age ≥ 30 years	1.67 (1.07 - 2.60)	**0.024**	1.67 (1.06 - 2.64)	**0.027**	1.31 (0.61 - 2.80)	0.491	-	-
Energy consumed	-	-	1.00 (1.00 - 1.00)	0.205	-	-	-	-
Proteins (g/kg/day)	-	-	0.87 (0.52 - 1.44)	0.585	-	-	-	-
Lipids (g/kg/day)	-	-	0.95 (0.50 - 1.80)	0.855	-	-	-	-
Erythrocytes	-	-	-	-	0.50 (0.10 - 2.50)	0.391	-	-
Eosinophils	-	-	-	-	1.07 (0.96 - 1.20)	0.235	-	-
Monocytes	-	-	-	-	2.00 (1.52 - 2.63)	**0.000**	1.94 (1.44 - 2.62)	**0.000**
HDL-c	-	-	-	-	0.96 (0.87 - 1.06)	0.422	-	-
AST	-	-	-	-	1.05 (0.99 - 1.11)	**0.124**	1.06 (0.98 - 1.11)	0.081
ALT	-	-	-	-	0.93 (0.86 - 1.01)	**0.075**	0.92 (0.87 - 1.01)	0.066

Poisson regression with robust hierarchical variance. Values in bold: statistically significant (p <0.200 up to the 3rd block; p <0.05 in the final model). Acronym: HDL-c, High density lipoprotein cholesterol; AST, Aspartate aminotransferase; ALT, Alanine aminotransferase.

Table 5. Multivariate analysis of the factors associated with the percentage of body fat in female exercise practitioners. São Luís - MA, 2017.

Variables	1st model		2nd model		3rd model		Final model	
	PR (95% CI)	*P*	PR (95% CI)	*P*	PR (95% CI)	*P*	PR (95% CI)	*P*
Age ≥ 30 years	1.30 (0.99 - 1.70)	**0.060**	1.30 (1.00 - 1.68)	**0.047**	1.15 (0.82 - 1.61)	0.549	-	-
Total energy	-	-	1.00 (1.00 - 1.00)	0.640	-	-	-	-
Carbohydrates (%)	-	-	1.01 (0.99 - 1.02)	0.360	-	-	-	-
Proteins (g/kg/day)	-	-	0.79 (0.62 - 1.01)	**0.057**	0.71 (0.54 - 0.94)	**0.017**	0.74 (0.59 - 0.94)	**0.012**
Total fibers	-	-	0.99 (0.97 - 1.00)	**0.081**	0.97 (0.95 - 0.99)	**0.009**	0.98 (0.96 - 0.99)	**0.024**
Erythrocytes	-	-	-	-	1.20 (0.89 - 1.61)	0.229	-	-
Leukocytes	-	-	-	-	1.00 (1.00 - 1.00)	0.604	-	-
Basophils	-	-	-	-	1.04 (0.66 - 1.63)	0.860	-	-
Total cholesterol	-	-	-	-	1.00 (1.00 - 1.01)	0.332	-	-
Serum creatinine	-	-	-	-	0.24 (0.03 - 1.65)	**0.147**	0.83 (0.38 - 1.82)	0.642
Fasting blood glucose	-	-	-	-	1.01 (0.99 - 1.02)	0.433	-	-
HOMA-Ir	-	-	-	-	0.99 (0.90 - 1.08)	0.773	-	-
Urea	-	-	-	-	0.84 (0.17 - 4.06)	**0.190**	1.00 (0.98 - 1.02)	0.809

Poisson regression with robust hierarchical variance. Values in bold: statistically significant (p <0.200 up to the 3rd block; p <0.05 in the final model). Acronym: HDL-c, High density lipoprotein cholesterol; HOMA, Homeostatic Model Assessment - Insulin resistance.

Finally, the consumption variables associated with body fat in the bivariate analysis were total calories and consumption in g/kg/day of proteins and lipids in men (table 2). In women, total calories, total carbohydrate consumption, protein in g/kg/day and fiber were the associated variables (table 3).

In the multiple analysis model, factors associated with %BF in men (table 4) were monocyte concentration, while in women (table 5) they were protein consumption in g/kg/day and total fiber consumption ($p < 0.05$).

DISCUSSION

The prevalence of high %BF in both sexes was higher than expected since they are physically active individuals. When stratifying by sex, the magnitude of gravity on women is recognized, since three fourths of them had increases in their BF deposits. Despite the lower prevalence, just under half of men were also at risk for their %BF. The associated factors found reflect the multiple etiology of this anthropometric indicator and how it behaves differently between the sexes.

Also, we included as limitations of this study the absence of variables classically associated with %BF such as the intensity and duration of the training as well as the physical capacity of the interviewees.

Monocyte concentration was the only variable with a statistically significant association with %BF in men. It is probably possible to explain the increase in these cells based on the proinflammatory factor that fat cells have.[15-17] Obesity causes, through adipocytes, the secretion of a variety of adipokines and acute phase proteins, which can increase the production and circulation of factors related to inflammation. Since it is a process of constant inflammation, white cells are usually enlarged.[15]

In a study with obese children,[17] the monocyte concentration was higher in individuals with body fat above the adequate level, which corroborates the results of this study. It is known that this mechanism is not yet fully understood, however obesity is related to the increase in circulating cytokines that can contribute to the increase in circulating white cells.[16]

In women, protein consumption in g/kg/day was less associated with the percentage of body fat, in accordance with the position of the International Society of Sports Nutrition (ISSN) for diets and body composition, by Aragon et al.[18] However, previous studies found different repercussions, as proposed by Correa-Rodríguez et al.,[19] in which a positive association between protein consumption and body mass index (BMI) and lean mass was found; however when assessing the association with fat mass, there was no statistically significant differences were observed.

Another result that did not cooperate with our findings was the study by Drenowatz et al.,[20] as they found a high consumption of proteins and increased the risk of being overweight, questioning current recommendations for increasing the supply of proteins for weight loss. Complementing these findings, Arciero et al.,[21] in a randomized, placebo-controlled study, stated that moderate protein intake in overweight individuals provides the same benefits for body composition and insulin sensitivity as a high protein diet.

However, the broader scope of evidence consistently advocates increasing protein intake to improve body composition. Antonio et al.[22] in a follow-up study for eight weeks, found that, even comparing two already high-protein diets (2.3g/kg/day and 3.4g/kg/day), there was a greater reduction in fat mass and percentage body fat in the group with the highest intake. The authors also estimate that the minimum daily protein requirement for trained individuals should be 2g/kg/day, dissociating from the idea advocated by the positioning of the American College of Sports Medicine,[23] which includes the consumption range of 1.2 to 2g/kg/day, with suggestion of increased consumption in situations of intensified training or reduced energy intake.

The protein requirement in active individuals can be 50-175% higher compared to sedentary individuals, normally related to values 2-3 times higher than the RDA, of 0.8 g/kg/day, although this recommendation is dependent on the volume of physical exercise practiced, body composition, training status and the total energy offered in the diet, especially in those who are in caloric restriction.[24] The fact that protein is related to the improvement of body composition is justified mainly by its retaining and promoting effect on lean mass, in addition to allowing greater energy expenditure for inducing greater postprandial thermogenesis, as demonstrated by Arciero et al.,[25] who found greater reduction in abdominal fat and greater energy expenditure in the group with higher protein consumption (35% vs 15%) and more frequent (6 vs. 3 meals). This is in agreement with the findings of Areta et al.,[26] in which better fractionation of the protein supply allowed greater efficiency in the stimulus of protein synthesis and, therefore, this repercussion can culminate in better maintenance or gain of lean mass.

Likewise, women who had high fiber consumption had a lower prevalence of high %BF. The intake of dietary fiber has a positive impact on health, given its role in glycemic control, improving glucose sensitivity and, in the long run, helping to reduce total body weight.[27-32] This is probably due to the strong feeling of satiety caused by a diet rich in dietary fiber,[28] which prevents hunger in the appetite of individuals, with consequent reduction in the intake of highly energetic foods and low in micronutrients.

As for physical activity, the literature brings numerous benefits of the practice for general health and weight reduction. It was observed by Woolf et al.[33] that higher levels of physical activity are associated with a lower percentage of fat and a reduction in risk factors for cardiovascular diseases. Regarding the adaptations that occurred with exercise, resistance training produces an increase in lean body mass and bone mass, contributing to the increase in fat-free mass, increasing energy expenditure at rest, which may be associated with a reduction in the stocks of body fat.[34] Aerobic training contributes to the increase in oxygen consumption of muscles, mitochondrial activity and oxidative enzymes, favoring the use of adipose tissue.[35]

When evaluated by Cavalcante et al.,[36] resistance training for 12 weeks of 2-3 sessions per week with eight exercises, resulted in a decrease in total body fat.[36] Intermittent aerobic exercise programs with moderate intensity totaling 150 minutes per week seemed to be more efficient than continuous exercise for weight loss in obese and overweight women.[37] However, a high intensity circuit training program in healthy individuals, performed three times a week for eight weeks with sessions totaling between 55 to 78 minutes, also showed favorable results for fat loss, as shown by Alcaraz et al.[38] This is an important finding, as many people attribute the lack of time to perform physical exercise to physical inactivity. Thus, it appears that the intensity of the exercise is related to the loss of fat, in which more intense exercises promote greater caloric burning.[39]

Other studies[40,41] found in the combination of resistance and aerobic exercises, greater reductions in the percentage of fat, than when performed alone, which can be attributed to the different adaptations generated by the types of training, which may have even greater weight reductions when combined with food.[38] However, unlike another study,[42] combined training did not significantly reduce the percentage of body fat, but improved the health and quality of life of the participants, and when applied only for four weeks it did not seem to be sufficient for significant reductions in body fat.[43]

The fact that we did not find an association between the categories of carbohydrate consumption both with insulin levels and with the percentage of fat may, in part, be justified by the low average consumption of carbohydrates among the interviewees, with levels close to the lower threshold among recommended by The American College of Sports Medicine (ACSM).[23]

We consider as a strong point of this study the fact that it was carried out with a physically active population, with analysis of biochemical and nutritional variables involved with the pathogenesis of obesity and excess body fat in people with normal BMI.

CONCLUSION

Physical exercise can improve body composition regardless of diet, although when combined, they will have a synergistic response. The prevalence of high %BF was quite high and even higher when stratified by sex. Our findings suggest that there is a strong association between the biochemical concentration of monocytes in men and between the higher categories of protein consumption and dietary fiber with a lower percentage of fat in individuals who exercise.

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Contributors

All authors made substantial contributions to the conception and design of the work; Silva SC, Castro AS and Veloso HJF actively participated in data collection; Silveira VNC, Padilha LL, Santos AF, Castro AS and Veloso HJF participated in the analysis and interpretation of the data; Silveira VNC, Moreira JSB, Martins ICVS, Reis AD, Veloso HJF actively participated in the writing and critical review of the manuscript; all authors approved the final version to be published.

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