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The association between cardiovascular risk factors and anthropometric obesity indicators in university students in São Luís in the State of Maranhão, Brazil

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Abstract *The article aims to evaluate the relation between cardiovascular risk factors (CVRF) and anthropometric indicators in a sample of university students from São Luís-MA, Brazil. It is a cross-sectional study conducted with 968 university students, with median age of 22. Glycemia, triglycerides, HDL-c, smoking, alcohol consumption, physical inactivity, metabolic syndrome (Joint Interim Statement criteria) and insulin resistance (IR), were associated and correlated with anthropometric indicators such as BMI, WC, WHR and WHtR. Associations were found between TGL, SH, SM and higher values of all anthropometric variables. The RI was associated with higher BMI values and WHtR in men and women. The low HDL-c was associated with higher values of all anthropometric variables in women. Consumption of alcohol was associated with higher values of BMI and WC in women and WHR in men and WHtR. Smoking was associated with higher values of WHtR in both sexes. Physical inactivity was associated with higher values of WHR in men only. The highest correlations were established for women between TGL and BMI CC, WHR and WHtR. The indicators most associated with CVRF were BMI, WC and WHtR in females and WHR and WHtR in men.*

Key words *Cardiovascular risk factors, Obesity, Abdominal obesity*

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Introduction

Cardiovascular diseases are the leading cause of morbidity and mortality in Brazil and in the world[1,2]. This epidemiological trend is of concern because it implies reduced quality of life for populations, in addition to high and increasing costs for the government, society, families and individuals[3].

The relationships between the development of cardiovascular diseases and risk factors such as dyslipidemia, smoking, physical inactivity and obesity, particularly central fat distribution are well established[1,4]. For a long time these cardiovascular risk factors were considered important only in advanced age groups within populations. However, recent studies have shown that risk factors exist among young adults, and even among children and adolescent[5-7].

The use of anthropometric indicators has grown as a simple and effective way of evaluating cardiovascular risk. The main indicator used for the detection of general obesity is the body mass index (BMI) and for abdominal obesity, waist circumference (WC), the waist-hip ratio (WHR) and waist-to-height ratio (WHtR)[8,9].

Although not the most accurate methods for assessing body composition, anthropometric indicators show good reliability and are the most cost effective as well as being enforceable on a large scale[9,10]. Studies have demonstrated the capacity of some anthropometric indicators in the prediction of cardiovascular risk. According to the study by Haun et al.[8], anthropometric indicators BMI, WC, WHR, WHtR and the conicity index show good predictive ability of high coronary risk. A study by Oliveira et al.[4] with adults from Florianópolis, Santa Catarina State, found a high correlation between BMI, WHR and cardiovascular risk factors, particularly dyslipidemia.

Insulin resistance is one of the leading cardiovascular risk factors and is associated with visceral fat, hypertension, diabetes, dyslipidemia, and other metabolic disorders[11]. Nevertheless, the diagnosis of insulin resistance is not yet part of routine medical examinations in Brazil, because diagnostic methods have high costs. Insulin resistance appears to be associated with anthropometric indicators of obesity, especially of central distribution[11,12].

College students represent a section of the public whose lifestyle within an academic environment can result in missed meals and high consumption of fast foods that are nutritionally inadequate[13]. Other cardiovascular risk factors are high in this group, including high rates of physical inactivity and being overweight. In Brazil there are reports of a high prevalence of these risk factors in the university population. Moreira et al.[7] observed a prevalence of 38.1% of overweight, 34.8% of sedentary lifestyles, 27.5% of hypercholesterolemia, 14.6% of cigarette smoking and 8.4% of hypertension in the college population.

Identifying cardiovascular risk factors allows the development of preventative planning against cardiovascular disease, in addition to supporting public health programs against these diseases. Considering that the onset of cardiovascular disease has manifested itself increasingly early, it has become important to study how the correlation happens between these diseases and anthropometric indicators in young individuals. Therefore, this article looked to evaluate the association between cardiovascular risk factors and anthropometric indicators in a number of university students in the city of São Luís, in Maranhão State, Brazil.

Methods

This is a transversal study conducted in São Luís, with students from public and private universities. Data collection was performed between August 2011 and October 2012 by a group of students who were selected and introduced to protocols.

Overall samples consisted of students taken from nine universities in São Luís which together accounted for 95% of university students in the city. Sampling was carried out in clusters in two stages. In the first stage subjects were selected and in the second stage students were selected. The sample was divided into public and private universities. Each university provided a list of all subjects offered and based on the lists provided by all universities, a simple random sampling of the subjects was carried out. This sampling considered the proportional probability to the number of students in each university, in relation to the total number of students from all the universities. 12 students were randomly selected in each subject drawn. We calculated the correction by multiplicity, considering the number of subjects studied by each student because each student generally attends more than one subject and this alters the probabilities of selection.

The sample was estimated at 1,276 students. This sample size allowed estimating a prevalence

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of approximately 50% with a margin of error of 3% and a confidence interval of 95%. It was still possible to detect an 8% difference in the prevalence of metabolic syndrome (estimated at 10%) between the exposed and unexposed groups, assuming a probability of type I error of 5% and settling at 80% the power of the study and with a design effect of 2. The final sample was of 968 students, with 25.3% of losses occurring due to refusal or absence of the student in the classroom on the day of the interview. The attendance rate of students for performing laboratory tests was 45.5%.

Each participant underwent an interview, answering a questionnaire and having his/her anthropometric measurements and blood pressure measured. On this occasion, the participant was instructed to perform a free blood test in registered laboratories in order to obtain their metabolic variables. The questionnaire consisted of questions regarding socioeconomic data, alcohol consumption, smoking, food consumption and physical activity levels.

Anthropometric variables used in this study were: BMI, WC, WHR, and WHtR. The BMI was calculated by the formula BMI = weight (kg) / height^2 (m), and classified according to the values established for adults by the World Health Organization (WHO)[14]. Weight was measured using the Tanita portable scale BC533® (Brazil), with the individual standing and barefoot. Height was measured using the Alturaexata® stadiometer (Brazil), with the individual standing barefoot, with heels together, back straight and arms outstretched beside the body[15].

The WC was obtained using non-elastic tape, positioned immediately above the umbilicus, and the reading made immediately after expiration[15]. For classification cut off points were used as proposed by the National Cholesterol Education Program (NCEP), pointing to cardiovascular risk values ≥ 102 cm for men and for women ≥ 88 cm[16].

Hip circumference (HC) was measured in the region of largest circumference between the waist and the thigh[15]. The WHR was calculated by the ratio between WC and the hip circumference (HC) and classified according to the cut off points as proposed by the WHO [14].

WHtR was found by the ratio between WC and height, both in centimetres, and values of ≥ 0.52 for men and ≥ 0.53 for women were considered of risk[17].

As cardiovascular risk factors the following variables were considered: glycemia, elevated triglycerides, reduced HDL-C, smoking, excessive alcohol consumption, physical inactivity, metabolic syndrome and insulin resistance.

Laboratory tests of fasting glycemia, insulinemia and lipid profile (Triglycerides, HDL-C) were carried out using the ADVIA 1650 equipment (Bayer Co, USA). Glycemia was considered high when ≥ 100mg/dl[18]. Lipid profile changes were considered for the following values: triglycerides ≥ 150mg/dl; HDL-C < 50mg/dl in women and < 40mg/dl in men[16].

Insulin resistance was measured by the Homeostasis Model Assessment-Insulin Resistance (HOMA-IR) using the formula: HOMA-IR = Insulin (μU/mL) x (glycemia mg/dL ≤ 18) ≤ 22.5[19]. Insulin resistance diagnosis was made when HOMA-IR > 2.7[20].

Blood pressure was measured twice within an interval of five minutes; the measurement with the lowest value was used, using digital automatic devices Omron® (Japan) with different cuff sizes. Hypertension was considered for blood pressure values of ≥ 130x85mmHg[16].

Smoking was considered when there was the consumption of at least one cigarette in the last month. The excessive consumption of alcohol was considered when there was a consumption of more than five doses in a single occasion.

The instrument used to assess the level of physical activity was the short version of the International Physical Activity Questionnaire (IPAQ - International Physical Activity Questionnaire - Short Form). Participants in this study were classified as sedentary, active and sufficiently active[21]. For the association analysis, active and sufficiently active participants were categorized together. Below are the criteria used for each group:

- *Active*: Individuals who underwent intense physical activity for at least three days, reaching at least 1,500 METs (Metabolic Equivalent of Task); or performed seven days or more of combined activities (walking, moderate activity or intense activity), reaching at least 3,000 METs.
- *Sufficiently active*: Individuals who underwent intense physical activity at least 20 minutes daily for three days or more; or five or more days of moderate activity and / or walking at least 30 minutes per day; or five or more days of combined activities, reaching at least 600 METs.
- *Sedentary*: Those who do not fit in any of the previous groups.

For the classification of Metabolic Syndrome (MS) criteria of the *Joint Interim Statement* (JIS) was used. Under this criterion MS is defined from the presence of three of the following criteria: 1) fasting glucose ≥ 110mg/dL; 2) systolic arterial pressure ≥ 130mmHg and/or diastolic blood pressure ≥ 85 mmHg; 3) HDL-C ≤ 40mg/dL in men and ≤ 50mg/dL in women; 4) triglycerides ≥ 150 mg/dL; 5) waist circumference > 90 cm in men and > 80 cm in women.

Data was entered into Microsoft Excel® software then processed and analyzed using Stata 10.0® statistical software. To test the normality of distribution of variables the Shapiro-Wilk test was used. Quantitative variables were expressed using medians and the 25th and 75th percentiles, and qualitative variables were presented as frequency and percentage. To investigate the association between anthropometric variables and cardiovascular risk factors the chi-square test was used. For the analysis of the correlation between anthropometric indicators, metabolic indicators and blood pressure, the Pearson correlation coefficient with inclusion of sample weights was used. Although all variables have not presented normal distribution, in Stata® it is not possible to perform an estimate of the correlation using the Spearman coefficient, correcting for the complex delineation of sampling or considering the sample weights. The calculation of the Spearman correlation without correction for the design of the study produces lower estimates of correlations and underestimates sampling errors. To obtain the p-value of the correlations, linear regression was used considering the complex delineation of sampling. In all tests the significance level was set at 0.05. To classify the correlation coefficients a correlation was considered weak when $r < 0.4$, moderate when $r \geq 0.4$ and $r < 0.5$ and strong when $r \geq 0.5$[22].

The probability of selection for each student was calculated for the two stages. In the first stage the ratio between the number of subjects drawn and the number of subjects offered in each university was used. In the second stage the number of students interviewed was divided by the number of students in each discipline. The probabilities obtained at each stage were multiplied among themselves and finally, by the number of subjects that the student was studying. For the statisticalt analysis, data was weighted by the inverse of the probability of selection, considering also the division by university (public and private) and the effect of conglomerate, through the svy command in Stata®. As the losses of performing the exams in the laboratory were high, there was no response by weighting through the inverse of the selection probability of each individual.

This study was approved by the Ethics Committee in Research of the Presidente Dutra University Hospital at the Federal University of Maranhão. All participants signed and received a copy of the Free and Clarified Consent Term.

Results

968 university students were studied, with a predominance of females (62% vs. 38%) and a median age of 22 years for men and 23 for women.

Table 1 presents the descriptive measures of the metabolic variables, blood pressure and anthropometric indicators.

Alteration in the lipid profile showed high results in both genders. Triglycerides were significantly higher in men (27.5% *vs.* 10.3%, p = 0.004) and in both genders showed significant association with higher values for all anthropometric variables. The decrease in HDL-C was significantly higher in women (63.7% *vs.* 55.7%, p = 0.001). In females decreased HDL-C was associated with higher BMI (p = 0.035), WC (p = 0.001), WHR (p = 0.021) and WHtR (p = 0.005). For men association was observed only with higher values of WC. (p = 0.035).

The prevalence of hypertension was significantly higher in men (57.0% *vs.* 13.1%, p < 0.001), however, was associated with higher values for all anthropometric variables in both genders.

Positively, the frequency of smoking was low for both sexes, but men smoked more (7.1% *vs.* 2.2, p = 0.002) than women. Smoking was associated with higher BMI (p = 0.010) and WHtR (p = 0.003) in women, and WHR (p = 0.036) and WHtR (p = 0.002) in men. Excessive alcohol consumption was higher in men (30.9% *vs.* 16.7%, p < 0.001) and was related to higher values of WHR (p = 0.018) and WHtR (p = 0.003) in this gender. Women who reported excessive alcohol consumption had higher BMI (p = 0.039) and WC (p = 0.039). Sedentary lifestyle was quite high in both genders, being higher in women (73.9%). Although showing highest prevalence in women no significant relationship with any anthropometric variable for this gender was observed. On the other hand, sedentary men had higher values of WHR (p = 0.038).

The prevalence of MS was high, especially in men (31.9% *vs.* 11.5%, p = 0.002). There was an association between this variable and higher values of all anthropometric indicators in both men and women. The prevalence of insulin resistance did not differ between genders. However, a sig-

Table 1. Descriptive characteristics of students according to gender, São Luís, Maranhão State, Brazil, 2011-12.

Variables	Women Median (P25-P75)	Men Median (P25-P75)	P-value
Age	23 (21,0-28,0)	22 (21,0-27,0)	0,657
Weight	58,3 (51,9-64,9)	74,9 (65,8-84,2)	< 0,001
Height	160 (155,5-163,6)	172,4 (168,0-176,5)	< 0,001
Body mass index	22,7 (20,4-25,5)	25,2 (22,6-27,9)	< 0,001
Waist circumference	75 (68,5-83,0)	87 (78,3-95,0)	< 0,001
Hip circumference	97 (92,0-102,0)	100 (94,7-105,0)	0,001
Waist-hip ratio	0,78 (0,7-0,8)	0,86 (0,8-0,9)	< 0,001
Waist-to-height	0,47 (0,4-0,5)	0,50 (0,5-0,6)	< 0,001
Systolic blood pressure	111,5 (104,5-119,0)	127 (120,5-134,5)	< 0,001
Diastolic blood pressure	73 (67,5-80,5)	78 (72,0-86,5)	< 0,001
Glycemia	82 (77,0-87,0)	86 (81,0-93,0)	0,009
Insulinemia	3,41 (2,0-7,1)	2,21 (2,0-5,7)	0,010
Triglycerides	71 (55,0-97,0)	98 (68,0-158,0)	< 0,001
HDL-cholesterol	45 (39,3-53,6)	38,9 (32,4-43,7)	< 0,001
HOMA-IR	0,68 (0,4-1,5)	0,50 (0,4-1,3)	0,224

HOMA-IR = Homeostasis Model Assessment - Insulin Resistance; BMI = Body mass index; WC = Waist circumference; WHR = Waist-hip ratio; WHtR = Waist-to-height; HDL-C = High density lipoprotein cholesterol; SBP Systolic blood pressure; DBP = Diastolic blood pressure.

nificant association was observed between this variable and higher values of WC (p = 0.001) in women, and WHR (p = 0.001) in men. Insulin resistance was related to higher BMI and WHtR in both genders (Table 2 and 3).

The results obtained in the analysis of correlation between metabolic parameters and blood pressure and anthropometric indicators showed a weak correlation between them, although it was significant in many cases. The highest correlations were established for females between triglycerides and BMI (r = 0.31), WC (r = 0.39), WHR (r = 0.38) and WHtR (r = 0.39); and between DBP and BMI (r = 0.43), WC (r = 0.41) and WHtR (r = 0.38), Insulin and WHR (r = 0.31), HOMA-IR and WHR (r = 0.35), for men (Table 4).

Discussion

The prevalence of cardiovascular risk factors found in this population of students was high, especially for being a young audience, with a median age of 22 years. Anthropometric indicators of obesity used in this study were, in general, associated with cardiovascular risk factors, indicating its potential performance in tracking this risk, even in younger individuals.

The medians of all anthropometric indicators of obesity, triglycerides, HDL-C, SBP, DBP and glycemia were higher in men. Insulin and HOMA-IR were higher in women. Other studies have also found similar results with higher serum lipids, blood pressure and anthropometric measurements in males, and are higher in adults than for younger people[23-25].

An altered lipid profile is an important cardiovascular risk factor, which has been increasingly observed in young individuals[9]. The main dyslipidemia associated with cardiovascular risk are increased serum triglycerides and decreased HDL-C. We found a high rate of low HDL-C in both genders, which is probably due to high frequency of overweight, physical inactivity and alcohol consumption.

For triglycerides, significant associations with higher values of all anthropometric variables for both genders were observed. On the other hand, more associations between HDL-C and anthropometric variables in females were found. In women in Curitiba, Paraná State, Krause et al.[26] found a direct relationship between changes in triglyceride and HDL-C and anthropometric

Table 2. Association between anthropometric indicators of obesity and cardiovascular risk factors in college women of São Luís. São Luís, Maranhão State, Brazil, 2011-12.

	BMI ≥ 25 Kg/m² % weighted (n)	WC High % weighted (n)	WHR High % weighted (n)	WHtR High % weighted (n)	Total % weighted (n)
Glycemia					
Normal	8.0 (23)	18.4 (53)	19.7 (55)	19.9 (66)	98.1 (371)
≥ 100 mg/dl	0.2 (1)	0.9 (4)	0.5 (3)	1.3 (6)	1.9 (11)
p value	0.697	0.043	0.257	0.002	
Triglycerides					
Normal	4.9 (17)	12.8 (40)	13.5 (40)	14.1 (51)	89.7 (349)
≥ 150 mg/dl	3.4 (7)	6.6 (17)	6.7 (18)	7.1 (21)	10.3 (32)
p value	< 0.001	< 0.001	< 0.001	< 0.001	
HDL-C					
Normal	2.7 (3)	1.9 (7)	2.7 (11)	3.1 (13)	36.3 (122)
Diminished	9.8 (21)	17.4 (50)	17.5 (47)	18.1 (59)	63.7 (260)
p value	0.035	0.001	0.021	0.005	
Hypertension					
Yes	1.5 (11)	4.8 (23)	5.2 (22)	5.8 (27)	15.3 (77)
No	5.1 (30)	10.0 (65)	11.4 (69)	15.2 (93)	84.9 (536)
p value	0.004	< 0.001	< 0.001	< 0.001	
Smoking					
Yes	0.0 (0)	0.3 (3)	0.1 (1)	0.3 (3)	2.2 (16)
No	6.1 (37)	13.9 (80)	15.8 (84)	19.4 (107)	95.6 (572)
Ex-smoker	0.6 (5)	0.7 (6)	0.7 (6)	1.4 (11)	2.2 (23)
p value	0.010	0.243	0.198	0.003	
Alcohol excess					
Yes	1.24 (10)	3.0 (18)	2.9 (15)	3.8 (20)	16.7 (82)
No	5.5 (32)	11.9 (71)	13.7 (76)	17.2 (101)	83.3 (532)
p value	0.039	0.039	0.342	0.252	
Sedentarism					
Yes	5.3 (30)	11.5 (63)	13.2 (69)	16.6 (89)	72.6 (454)
No	1.4 (12)	3.4 (26)	3.4 (22)	4.4 (32)	27.4 (160)
p value	0.701	0.463	0.658	0.914	
Metabolic Syndrome					
Yes	3.8 (10)	9.2 (26)	9.1 (25)	10.9 (30)	11.5 (41)
No	4.2 (13)	9.9 (30)	11.1 (33)	10.0 (41)	88.5 (339)
p value	< 0.001	< 0.001	< 0.001	< 0.001	
Insulin resistance					
Yes	2.0 (6)	2.8 (10)	2.0 (7)	3.1 (12)	6.5 (27)
No	6.3 (18)	16.8 (47)	18.2 (51)	18.1 (60)	93.5 (355)
p value	< 0.001	0.001	0.107	< 0.001	

BMI = Body mass index; WC = Waist circumference; WHR = Waist-hip ratio; HtR = Waist-to-height; HDL-C = High density lipoprotein cholesterol.

variables BMI, WC and WHR, with higher levels of significance being observed for WC and WHR. These results suggest that the increase in body fat, particularly in the abdominal level tends to cause changes in serum lipid parameters.

Prevalence of SAH was found to be significantly higher in men. It is known that excessive weight is related to other cardiovascular risk factors such as decreased HDL-C and hypertriglyceridemia, which have a great impact on high blood pressure[23]. Therefore, the high prevalence of hypertension in this study may be explained by the high frequency of overweight and altered lipid profile as well as a sedentary lifestyle. SAH can be considered a predictor of risk for other cardiovascular diseases and is directly related

Table 3. Association between anthropometric indicators of obesity and cardiovascular risk factors in college men of São Luís. São Luís, Maranhão State, Brazil, 2011-12.

	BMI ≥ 25 Kg/m² % weighted (n)	**WC High** % weighted (n)	**WHR High** % weighted (n)	**WHtR High** % weighted (n)	**Total** % weighted (n)
Glycemia					
Normal	11.4 (19)	11.2 (16)	22.2 (48)	29.5 (67)	90.9 (201)
≥ 100 mg/dl	1.0 (3)	0.7 (2)	6.9 (5)	7.2 (6)	9.1 (12)
p value	0.086	0.292	0.166	0.237	
Triglycerides					
Normal	5.5 (12)	6.1 (12)	17.0 (36)	19.9 (48)	72.5 (177)
≥ 150 mg/dl	6.6 (9)	5.9 (6)	12.0 (16)	16.5 (23)	27.5 (34)
p value	< 0.001	0.038	0.001	< 0.001	
HDL-C					
Normal	2.7 (6)	2.2 (4)	12.0 (22)	13.6 (28)	44.3 (97)
Diminished	9.8 (16)	9.8 (14)	16.6 (30)	23.3 (44)	55.7 (114)
p value	0.063	0.035	0.541	0.137	
Hypertension					
Yes	10.2 (23)	10.2 (21)	16.5 (48)	23.2 (67)	46.3 (149)
No	1.9 (11)	1.5 (8)	12.0 (37)	16.0 (55)	53.7 (205)
p value	0.001	0.001	0.002	< 0.001	
Smoking					
Yes	0.7 (3)	0.7 (3)	2.9 (10)	4.8 (16)	7.1 (25)
No	10.8 (28)	10.2 (22)	24.5 (66)	32.0 (94)	88.9 (305)
Ex-smoker	0.3 (1)	0.7 (2)	1.5 (7)	1.7 (8)	4.0 (18)
p value	0.771	0.595	0.036	0.002	
Alcohol excess					
Yes	3.0 (14)	2.8 (12)	9.1 (37)	13.8 (53)	30.9 (117)
No	9.0 (20)	9.0 (17)	19.4 (48)	25.3 (69)	69.2 (237)
p value	0.289	0.320	0.018	0.003	
Sedentarism					
Yes	6.1 (20)	5.3 (15)	18.9 (60)	23.7 (82)	61.2 (216)
No	5.9 (14)	6.5 (14)	9.6 (25)	15.4 (40)	38.8 (138)
p value	0.783	0.284	0.038	0.083	
Metabolic Syndrome					
Yes	8.8 (14)	8.9 (12)	17.4 (25)	22.8 (33)	31.9 (42)
No	3.4 (7)	3.1 (6)	11.0 (26)	13.8 (38)	68.2 (168)
p value	< 0.001	< 0.001	< 0.001	< 0.001	
Insulin resistance					
Yes	2.9 (4)	2.3 (2)	3.9 (8)	3.9 (8)	5.7 (13)
No	9.9 (18)	10.0 (16)	22.3 (44)	30.3 (64)	94.3 (199)
p value	0.013	0.357	0.001	0.030	

BMI = Body mass index; WC = Waist circumference; WHR = Waist-hip ratio; HtR = Waist-to-height; HDL-C = High density lipoprotein cholesterol.

to anthropometric measures of obesity[5]. SAH was significantly associated with higher values for all anthropometric variables in both men and women. Mascena et al.[27], found an association (p<0.001) between SAH and obesity (measured by BMI and the WC) in college students in Campina Grande, Paraíba State. Nascente et al.[24], in a study of adults in Goiás, found a higher prevalence of SAH in men, while the obese had a 2.3 times higher risk of SAH and those with high WC, a 3.2 times greater risk. Anthropometric indicators of abdominal obesity, especially WC and WHtR, appear to have better performance in predicting high blood pressure[9].

A low frequency of smoking in the sample (4.3%) was a positive finding. This practice was

Table 4. Correlation between metabolic indicators and blood pressure and anthropometric indicators of obesity in college students of São Luís. São Luís, Maranhão State, Brazil, 2011-12.

Variables	Sexo	BMI	WC	WHR	WHtR
Glycemia	Female	r = 0.03 (p = 0.674)	r = 0.11 (p = 0.170)	r = 0.03 (p = 0.625)	r = 0.16 (p = 0.056)
	Male	r = -0.02 (p = 0.848)	r = -0.04 (p = 0.614)	r = 0.33 (p = 0.109)	r = 0.28 (p = 0.079)
Triglycerides	Female	r = 0.31 (p = 0.009*)	r = 0.39 (p = 0.001*)	r = 0.38 (p = 0.001*)	r = 0.39 (p < 0.001*)
	Male	r = 0.23 (p = 0.061)	r = 0.18 (p = 0.134)	r = 0.20 (p = 0.099)	r = 0.30 (p = 0.052)
HDL-C	Female	r = 0.19 (p < 0.001*)	r = 0.27 (p < 0.001*)	r = 0.24 (p = 0.001*)	r = 0.24 (p = 0.002*)
	Male	r = 0.17 (p = 0.019)	r = 0.19 (p = 0.013*)	r = 0.03 (p = 0.781)	r = 0.11 (p = 0.372)
SBP	Female	r = 0.12 (p = 0.032*)	r = 0.24 (p < 0.001*)	r = 0.25 (p < 0.001*)	r = 0.26 (p < 0.001*)
	Male	r = 0.31 (p < 0.001*)	r = 0.32 (p < 0.001*)	r = 0.12 (p = 0.116)	r = 0.19 (p < 0.001*)
DBP	Female	r = 0.14 (p = 0.007*)	r = 0.23 (p < 0.001*)	r = 0.22 (p < 0.001*)	r = 0.31 (p < 0.001*)
	Male	r = 0.43 (p < 0.001*)	r = 0.41 (p < 0.001*)	r = 0.28 (p = 0.006*)	r = 0.38 (p < 0.001*)
Insulin	Female	r = 0.29 (p < 0.001*)	r = 0.26 (p = 0.001*)	r = 0.20 (p = 0.021*)	r = 0.26 (p < 0.001*)
	Male	r = 0.22 (p = 0.156*)	r = 0.18 (p = 0.210)	r = 0.31 (p = 0.014*)	r = 0.19 (p = 0.101)
Homa-IR	Female	r = 0.28 (p < 0.001*)	r = 0.25 (p = 0.001*)	r = 0.19 (p = 0.020*)	r = 0.26 (p < 0.001*)
	Male	r = 0.21 (p = 0.155)	r = 0.17 (p = 0.218)	r = 0.35 (p = 0.002*)	r = 0.22 (p = 0.046*)

HOMA-IR = Homeostasis Model Assessment - Insulin Resistance; BMI = Body mass index; WC = Waist circumference; WHR = Waist-hip ratio; WHtR = Waist-to-height; HDL-C = High density lipoprotein cholesterol; SBP Systolic blood pressure; DBP = Diastolic blood pressure. r = correlation coefficient, * p < 0.05.

more common in men and those who mentioned smoking had higher WHR and WHtR. Smoking seems to be a predictor of abdominal obesity in men, which is consistent with the relationship found in our study[28].

Excessive alcohol consumption was high, especially in men. There are not many studies about the association between alcohol consumption and anthropometric variables, making it difficult to compare the results of this study. Consumption of alcohol whether excessive or not, seems to be associated with adiposity and abdominal obesity in young adults[29]. In our study, this finding was also confirmed, since women drinkers had higher BMI and WC, while men had higher values of WHR and WHtR.

Alcohol consumption favours the development of obesity because generally the energy that alcohol provides is added to the daily energy value of individuals. Furthermore, alcohol consumption increases the appetite and is associated with consumption of other foods simultaneously, which also contributes to the weight gain[30]. By being prioritized in metabolism, alcohol can alter lipid oxidation, contributing to fat accumulation, especially in the abdominal region[30]. This may explain the fact that we found significant association of excessive alcohol consumption with the variables of abdominal obesity.

The increased use of computers and the greater occupation of time by students in activities related to the university interferes negatively in the practice of physical activities[27,31]. The rate of sedentary lifestyle in this sample was high, being higher in women. Nevertheless, this variable was significantly higher only for the anthropometric indicator WHR in males. The higher prevalence of abdominal obesity in sedentary men was also found by Pinho et al.[29]. This result is exected, since there seems to be an inverse relationship between body fat and energy expenditure, and a better distribution of fat in active individuals[32].

MS was higher in men, which may be linked to the fact that most of the variables that make the diagnosis of the syndrome were more prevalent in males. Additionally, the high consumption of alcohol and smoking more observed among men may also be related to the development of MS. Similarly to this study, other studies have shown a significant association of anthropometric indicators with MS[33,34]. Rocha et al.[33], by studying the relationship between MS and the variables BMI, WC, HC, WHR, WHtR and lean mass, concluded that they are all able to identify carriers of MS.

Insulin resistance was present in 6.2% of college students and there was no difference in prevalence between genders. Significant association of insulin resistance with WHtR and BMI for both sexes was observed. Higher values of WC were associated only in females, while higher values of WHR in men only. In a São Paulo study, Matos et al.[12] observed that BMI, WC and WHtR were the anthropometric indicators most associated with insulin resistance. Increased body adiposity contributes to decreased insulin sensitivity, so individuals with obesity, especially central, tend to have a higher prevalence of insulin resistance[11,33]. In our study, this finding was confirmed.

Among the lipid profile variables, the highest correlations were observed between triglycerides and anthropometric indicators of abdominal obesity. In the study by Gharakhanlou et al.[25], with the urban population of Iran, the variables of abdominal obesity were best correlated with hypertriglyceridemia and low HDL-C, but the opposite was observed in our study, these correlations were more pronounced in men.

The components of blood pressure (SBP and DBP) also showed significant correlations with anthropometric indicators of obesity. In the study by Rezende et al.[23] mild to moderate correlations between BMI and SBP were observed. ($r = 0.36$), DBP ($r = 0.41$); and WC and SBP ($r = 0.46$), DBP ($r = 0.50$).

In general, the correlation between fasting insulin and HOMA-IR were slight but significant. The highest correlations for these measures were established with WHR in men. Rocha et al.[33], found mild to moderate correlations between HOMA-IR and BMI ($r = 0.50$), WC ($r = 0.49$), WHR ($r = 0.26$) e WHtR ($r = 0.51$).

Abdominal obesity is directly linked to visceral fat which is indicative of a series of metabolic changes observed in this study such as decreased HDL-C, hypertension and insulin resistance[26]. In general the variables of abdominal obesity had a higher correlation with the factors of cardiovascular risk than BMI, indicating that this type of obesity may be more related to cardiovascular risk than general obesity as measured by BMI[25].

One of the strengths of this study is the fact of working with a population-based sample, made up of young adults, a population in which there are few studies in Brazil. Furthermore, this study presents the association, as yet little studied, between anthropometric indicators and insulin resistance. The Joint Interim Statement (JIS) was used, which is the most current criteria for the diagnosis of MS and considers lower values for WC. The percentage of losses was satisfactory considering the proportions of the study (25.3%). In contrast, the rate of attendance at performing laboratory tests was low at 45.5%. As a result, it is possible that some estimates are overestimated if individuals who have attended the examinations are those who reported a higher number of changes.

One limitation of the study was to have made the calculation of correlations using the Pearson coefficient, which assumes normal distribution. This was done to avoid underestimation of sampling errors. A comparison of the estimates obtained with the weighted Pearson correlation and the un-weighted Spearman and the values obtained with the Pearson correlation was performed in the same direction but were slightly higher. The p-values of the Spearman coefficient were also compared with the p-values obtained by linear regression with correction for the sampling delineation. Both provided similar and consistent estimates.

Conclusion

In conclusion, this study found a high frequency of major cardiovascular risk factors such as changes in lipid profile, SAH, alcohol consumption, physical inactivity, MS and insulin resistance. These risk factors showed a significant association with major anthropometric indicators of obesity. These results point to the usefulness of these indicators for identifying individuals at risk.

The indicators that were most associated with cardiovascular risk factors were BMI, WC and WHR in females and WHR and WHtR in men. Anthropometric indicators of obesity correlated more with the metabolic variables and blood pressure in females than in males.

All cardiovascular risk factors analyzed in this study are modifiable, so it reinforces the importance of encouraging the adoption of a healthier life style in the public studied.

Collaborations

CA Carvalho and PCA Fonseca participated in the analysis and interpretation of data, drafting of the article and critical revision. JB Barbosa participated in the conception and delineation and analysis and interpretation of data. SP Machado participated in the critical revision and approval of the version to be published. AM Santos participated in the analysis and interpretation of data. AAM Silva participated in the conception and delineation, analysis and interpretation of data, critical revision and approval of the version to be published.

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