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Original Article

NUTRITIONAL STATUS AND CARDIOMETABOLIC RISK IN WOMEN: RELATIONSHIP WITH USUAL AND NON-USUAL COMPONENTS OF BODY COMPOSITION

ESTADO NUTRICIONAL E RISCO CARDIOMETABÓLICO EM MULHERES: RELAÇÃO COM COMPONENTES USUAIS E NÃO USUAIS DA COMPOSIÇÃO CORPORAL

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ABSTRACT
The usual parameters of body composition such as lean body mass (LM) and fat mass (FM) and the non-usual fat mass-lean ratio (FLMR), lean mass index (LMI), fat mass index (FMI) can potentially identify metabolic syndrome (MS) according to nutritional status. Accordingly, the present study aims to evaluate and discriminate LM, FM, FLMR, LMI, FMI and MS variables in women according to their nutritional status. A total of 338 women aged between 25 and 74 years were included in the study. LM, relative and absolute FM, FMI, LMI and FLMR, waist circumference (WC), systolic blood pressure (SBP), diastolic blood pressure (DBP) were measured. Results have shown differences in the usual and non-usual body composition components for the WC, SBP and fasting glycemia among the different groups: eutrophic, overweight, obese I, II and III. In addition, correlations were noted between the components of body composition when compared to triglycerides and high-density lipoproteins ($p < 0.05$). The ROC curve analysis demonstrated that LMI and FMI are able to detect MS in women in a similar way that IMC does. In conclusion, non-usual components of body composition might be an alternative way to detect MS in women, suggesting that they should be included as potential risks to develop MS. Finally, it is suggested the adoption of the non-usual components in addition with the traditional parameters in oder to diagnose the risk for MS in women.
Keywords: Obesity; Metabolic Syndrome X; Body Composition; Women.

RESUMO
Os componentes da composição corporal usuais: massa magra (MM) e massa gorda (MG) e não-usuais: relação gordura-massa magra (RGM), índice de massa magra (IMM), índice de massa gorda (IMG) são preditores de alterações em parâmetros da síndrome metabólica (SM) de acordo com o estado nutricional. Nesse aspecto, o objetivo do presente estudo foi investigar e discriminar a sensibilidade dos componentes não usuais como indicadores de risco para SM em mulheres adultas de acordo com o estado nutricional. O estudo incluiu 338 mulheres de 25 a 74 anos de idade. Avaliou-se a MM, MG relativa e absoluta, IMM, o IMG e a RGM, circunferência de cintura (CC), pressão arterial sistólica (PAS), pressão arterial diastólica (PAD). Constataram-se diferenças significativas entre os componentes usuais e não usuais da composição corporal para a CC, PAD e glicemia em jejum nos diferentes grupos: eutrófico, sobrepeso, obeso I, II e III; detectaram-se correlações entre os componentes da composição corporal quando comparados aos triglicerídeos e lipoproteínas de alta densidade ($p<0,05$). Além disso, a análise de curva ROC indicou que o IMM e o IMG podem discriminar os componentes relacionados à SM de maneira semelhante ao IMC. Conclui-se, que tanto os componentes usuais e não usuais da composição corporal podem detectar riscos associados ao sobrepeso e obesidade das mulheres analisadas nessa pesquisa.
Palavras-chave: Obesidade. Síndrome metabólica. Composição corporal. Mulher.

Introduction

Obesity has grown exponentially in Brazil, the United States of America and several countries in the world, becoming a serious public health issue worldwide (pandemic)[1]. In this sense, a very widespread indicator of nutritional status is body mass index (BMI), which is used worldwide to stratify people's nutritional status, as well as to identify risks associated with obesity[1,2].

Approximately 54% of the world population has excessive body mass[3]. In addition, Ng et al[1] report that the 10 countries with the highest prevalence of obesity are: the US, China, India, Russia, Brazil, Mexico, Egypt, Germany, Pakistan and Indonesia. Thus, more than 50% of the 671 million people assessed were classified as obese, and Brazilian women over 20 years old presented a prevalence of overweight of 58%, and 21% for obesity, respectively, at different levels of classification.

Among the consequences of obesity, the following dysfunctions can be listed: changes in systolic and diastolic blood pressure (SBP and DBP), increased risk of developing type 2 diabetes, changes in serum levels of triacylglycerols (TG) and lipoproteins (biochemical markers associated with increased cardiovascular risk), which may also cause states associated with metabolic syndrome[2,4].

Another effect of excessive body mass is the accumulation of body fat. Studies in general have used absolute values of fat body mass (FBM), body fat percentage (F%), and lean body mass (LBM) to verify the distribution of such components[5,6]. In this sense, Vanitallie et al.[7] proposed a potentially useful indicator to complement the assessment of nutritional status, which consists of adjusting LBM and FBM for height, since people with similar body mass and height values may have different body compositions. Additionally, the aforementioned research verified that fat mass index (FMI), calculated from FBM adjusted by height, is inversely related to resting metabolic rate (RMR), and the higher the FMI the lower the RMR.

On the other hand, Schutz et al.[8] used the indicators proposed by Vanitallie[7] and elaborated percentage cutoff points for men and women between 18 and 98 years of age, apparently healthy. In this aspect, it was verified that the aging process influences the increment of FMI. On the other hand, Prado et al.[9] point out the importance of maintaining body homeostasis between LBM, understood as a capacity indicator, and FBM, a load indicator. In addition, the same authors suggest that the ratio between load and capacity (FBM/LBM) can provide values indicative of the magnitude of cardiometabolic risks.

In this way, considering the aspects listed, it was observed that studies involving women over 25 years of age are still scarce in the national and international scientific literature regarding the "new parameters for measuring body composition", as well as for possible correlations with cardiometabolic risk. Therefore, the objective of the present article was to investigate and discriminate the sensitivity of lean-to-fat ratio (LFR), LMI and FMI as indicators of cardiometabolic risk for MS in adult women, according to nutritional status.

Methods

This study is characterized as a descriptive research with *ex post facto* design and quantitative approach. The descriptive research was conducted based on a past event, using descriptive methods in which variables were explored[10].

All participants signed a free and informed consent form that was approved by the local ethics committee of the State University of Maringá (UEM) under legal opinion 412/2008, in accordance with the Helsinki declaration.

Participants

A total of 338 women participated in the study, recruited as of the publishing of the study in electronic and printed media, at the State University of Maringá/PR and at basic health units (BHUs) in the metropolitan area of Maringá/PR. The assessments were conducted by a multidisciplinary team (physical education, nutrition and psychology professionals). As

inclusion criteria, women aged ≥ 18 years old were accepted. To standardize measurements, the participants were instructed not to perform moderate or intense physical activity in the 24 hours preceding the assessments, neither ingest alcohol or caffeine-containing substances during this period. As for the exclusion criteria, no pregnant women and patients with pacemakers or prostheses were included.

Collection Procedures

The below figure displays the study's methodological design.

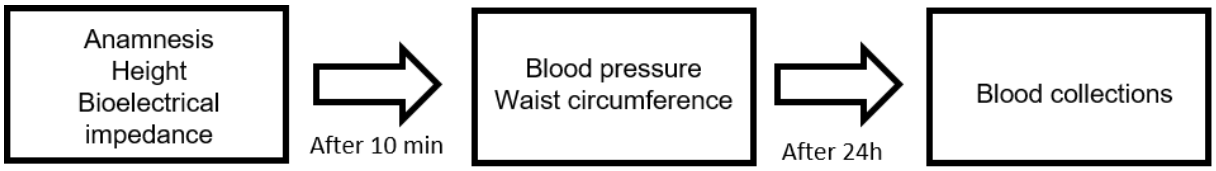

Figure 1. Study design
Source: The authors

Anthropometric and Clinical Assessment

The tests were conducted from 7:00 a.m. to 10:00 a.m. Body mass, height, waist circumference (WC) and blood pressure (BP) were measured. Height was measured by means of a stadiometer (Sanny®, São Paulo, Brazil), with a precision of 0.1 cm, attached to a wall. BMI was calculated dividing body mass in kilograms by height squared in meters. WC was measured using a measuring tape (WISO®, Santa Catarina, Brazil), with a measuring capacity of 2 meters and precision of 0.1 cm. BP was verified by means of a manual sphygmomanometer (Sanny®, São Paulo, Brazil), after 10 minutes of total rest, using the assessed participant's right arm, as per the V Brazilian Guideline on Hypertension[11]. All measurements were performed in controlled environment with temperature between 22º and 24ºC.

Body Composition

Body composition measurements were carried out using the bioimpedanciometry method, with the aid of an octapolar multi-frequency analyzer (InBody®, model 520 Body Composition Analyzers, South Korea), following recommendations proposed by Heyward[12]. The variables used were LBM and FBM. Based on these variables, the following body composition parameters were calculated: LMI, FMI and LFR. LMI [LBM (kg) / height (m)²] and FMI [FBM (kg) / height (m)²] were calculated according to recommendations proposed by Vanitallie et al[7], and LFR [FBM (kg) / LBM kg)] was calculated in accordance with Prado's study[9].

Parameters Referring to Metabolic Syndrome

NCEP-ATP III[4] classification parameters were used for central obesity (abdominal circumference > 88 cm), hypertriglyceridemia (TG ≥ 150 mg/dL), low values for HDL-c (< 50 mg/dL), high blood pressure (systolic blood pressure [SBP] ≥ 130 mmHg and/or diastolic blood pressure (DBP ≥85 mmHg and/or treatment for hypertension), hyperglycemia (fasting glycemia ≥ 110 mg/dL and/or treatment for type II diabetes).

Blood Analysis

Blood tests were performed in the morning, after overnight fasting (~ 10 hours). The following biochemical parameters were determined: fasting glycemia (venous blood was

stored in Vacutainer®-type tubes containing sodium fluoride, with analysis by means of fluorinated plasma), triglycerides (TG) and high-density lipoproteins (HDL-c)], using Vacutainer®-type tubes with stacking gel, with serum-based analyses. The samples were centrifuged at 3,600 rpm for 11 minutes at room temperature and analyzed by Siemens Advika 1800 Chemistry Analyzer®. For blood analyses, Siemens® kits (Frimley, Camberley, Great Britain) were used. All analyses were performed by biochemists from a private laboratory, with ISO 9002 (International Organization for Standardization) certification.

Statistical Analyses

Data are presented by means and (±) standard deviation. Data normality was tested using the Kolmogorov-Smirnov test, and the Levene test was used to verify data homogeneity. Subsequently, a covariance analysis (ANCOVA) was performed using age as a one-way covariate, and when there was difference between the five experimental groups (eutrophic, overweight, obese I, obese II and obese III), the Bonferroni test was used as post-hoc. Sphericity was tested by Mauchly's test, while the Greenhouse-Geisser correction was applied when necessary. In addition, to assess the magnitude of the differences observed, effect size was calculated by means of the eta squared, $\eta 2$, and interpreted according to the classification proposed by Cohen[13] < 0.2 [small], > 0.2 to < 0.8 [moderate] and > 0.8 [large]. Subsequently, Pearson's correlation was applied between usual and unusual body composition components, as well as for cardiovascular risk indicators of MS. Correlations were interpreted as per to the classification by Hopkins et al.[14]: < 0.1 [trivial], > 0.1 to < 0.3 [small], 0.3 to 0.5 [moderate], 0.5 to 0.7 [high], 0.7 to 0.9 [very high] and 0.9 to 1.0 [near-perfect]. In addition, the Receiver Operating Characteristic (ROC) curve analysis was performed to assess the diagnostic capacity of the metabolic syndrome (under different aspects), by usual and unusual body composition components. The area under the ROC curve was used to assess and compare the performance of measures to discriminate the participants in two groups, with and without MS. In this circumstance, a measure perfectly discriminates women if the area under the curve is equal to 1. On the other hand, when an area under the curve is equal to 0.5, the measure does not allow group discrimination. Statistical analyses were done using SPSS®, version 20.0, and Statistica, version 12.0®. In addition, for ROC curve analyses, the statistical program R (R Development Core Team), version 3.3.1, was employed. A significance of 5% was set for all analyses conducted in the present study.

Results

Table 1 presents components of body composition and metabolic syndrome of adult women according to nutritional status. Table 2 shows correlations between usual body composition parameters (BMI, LBM, LFR), unusual parameters (LMI, FMI and LFR) and MS components among the women participating in the study.

Table 1. Body composition, anthropometry, biochemical and hemodynamic measures according to nutritional status in women

Body Composition (n=338)	Eutrophic (n=73)	Overweight (n=113)	Obese I (n=86)	Obese II (n=46)	Obese III (n=20)
Age (years)	43.52±11.62	46.12±11.51	47.72±11.03	50.87±9.74	48.20±8.04
Height (m)	1.6 ± 0.07	1.6 ± 0.06	1.6 ± 0.05	1.6 ± 0.05	1.6 ± 0.06
Body Mass (kg)*	58.4 ± 6.7	69.4 ± 6.1	82.1 ± 6.3	93.8 ± 6.5	108.3 ± 10.3
Body Mass Index (kg/m²)*	22.6 ± 1.6	27.4 ± 1.40	32.4 ± 1.5	37.3 ± 1.4	42.5 ± 2.0
Lean Body Mass (kg)@	39.0 ± 4.6	41.3 ± 5.4	44.0 ± 4.3	45.5 ± 4.4	50.0 ± 4.7
Fat Body Mass (kg) *	17.3 ± 4.2	25.2 ± 4.3	35.5 ± 4.2	44.9 ± 5.5	55.3 ± 6.8
Body Fat Percentage (%)#	29.3 ± 5.0	36.1 ± 5.0	43.2 ± 3.8	48.1 ± 3.4	51.0 ± 2.8
Lean Mass Index (kg/m²)*	15.1 ± 1.2	16.3 ± 1.6	17.3 ± 1.0	18.1 ± 1.0	19.6 ± 1.1
Fat Mass Index (kg/m²)*	6.7 ± 1.5	9.9 ± 1.7	14.0 ± 1.6	17.9 ± 20.0	21.7 ± 1.9
Lean-to-Fat Ratio (kg/kg)*	0.4 ± 0.1	0.6 ± 0.1	0.8 ± 0.1	1.0 ± 0.1	1.1 ± 0.1
Metabolic Syndrome Components (n=197)	Eutrophic (n=35)	Overweight (n=67)	Obese I (n=46)	Obese II (n=31)	Obese III (n=18)
Age (years)	49.51±11.04	47.37±11.36	49.85±11.82	53.6±8.07	49.67±8.18
Waist Circumference (cm)*	75.6 ± 7.5	82.2 ± 6.1	91.3 ± 6.1	102.6 ± 8.0	109.3 ± 12.9
Systolic Blood Pressure (mmHg)	121.4 ± 21.2	124.5 ± 17.0	130.3 ± 22.8	128.1 ± 15.7	135.9±16.0
Diastolic Blood Pressure (mmHg)**	74.2 ± 11.07	76.9 ± 11.6	80.3 ± 11.7	77.0 ± 22.2	85.4 ± 11.3
Fasting Glycemia (mm/dL)°	89.0 ± 7.2	93.6 ± 16.0	98.8 ± 23.9	104.9 ± 36.0	117.2 ± 46.8
HDL-c (mm/dL)‡	69.2 ± 12.1	65.6 ± 15.5	58.9 ± 14.9	62.0 ± 12.1	61.3 ± 15.3
Triglycerides (mm/dL) †	79.9 ± 28.0	85.3 ± 31.1	104.9 ± 60.2	117.0 ± 83.6	114.5 ± 39.6
MS Prevalence (%)	-	3.0	6.5	22.6	33.3

Note: data presented by means and standard deviation. P<0.05. * = difference between all groups; # = difference between all groups, except for obese II and obese III groups; @ = difference between groups, except for obese I and obese II; º = difference between obese III and eutrophic and overweight groups; ‡ = difference between eutrophic group and obese group I; † = difference between obese II group and eutrophic and overweight groups.
Source: The authors

Table 2. Correlation between usual components (BMI, LBM, FBM – absolute and relative), unusual components (LFR, LMI and FMI) and MS components in adult women

	BMI (kg/m²)	**LBM** (kg)	**FBM** (kg)	**FBM** (%)	**LFR** (kg/kg)	**LMI** (kg/m²)	**FMI** (kg/m²)	**WC** (cm)	**GLY** (mg/dL)	**HDL-c** (mg/dL)	**TG** (mg/dL)	**SBP** (mmHg)	**DBP** (mmHg)
BMI (kg/m²)	1	0.48** *moderate*	0.95** *near-perfect*	0.87** *very high*	0.89** *very high*	0.72** *very high*	0.97** *near-perfect*	0.84** *very high*	0.33** *moderate*	-0.20** *small*	0.26** *small*	0.20* *small*	0.17* *small*
LBM (kg)	0.48** *moderate*	1	0.50** *high*	0.21** *small*	0.17* *small*	0.78** *very high*	0.37** *moderate*	0.43** *moderate*	0.19** *small*	-0.12 *small*	0.15* *small*	0.00 *trivial*	0.01 *trivial*
FBM (kg)	0.95** *near-perfect*	0.50** *high*	1	0.92** *near-perfect*	0.93** *near-perfect*	0.59** *high*	0.98** *near-perfect*	0.82** *very high*	0.30** *moderate*	-0.23** *small*	0.25** *small*	0.14 *small*	0.14* *small*
FBM (%)	0.87** *very high*	0.21** *small*	0.92** *near-perfect*	1	0.98** *near-perfect*	0.38** *moderate*	0.95** *near-perfect*	0.75** *very high*	0.26** *small*	-0.23* *small*	0.22** *small*	0.12 *small*	0.13 *small*
LFR (kg/kg)	0.89** *very high*	0.17* *small*	0.93** *near-perfect*	0.98** *near-perfect*	1	0.35** *moderate*	0.96** *near-perfect*	0.77** *very high*	0.26** *small*	-0.22** *small*	0.22** *small*	0.15* *small*	0.16* *small*
LMI (kg/m²)	0.72** *very high*	0.78** *very high*	0.59** *high*	0.38** *moderate*	0.35** *moderate*	1	0.58** *high*	0.59** *high*	0.28** *small*	-0.11 *small*	0.22** *small*	0.16* *small*	0.09 *trivial*
FMI (kg/m²)	0.97** *near-perfect*	0.37** *moderate*	0.98** *near-perfect*	0.95** *near-perfect*	0.96** *near-perfect*	0.58** *high*	1	0.83** *very high*	0.31** *moderate*	-0.22** *small*	0.25** *small*	0.18* *small*	0.16* *small*
GLY (mg/dL)	0.33** *moderate*	0.19** *small*	0.30** *moderate*	0.26** *small*	0.26** *small*	0.28** *small*	0.31** *moderate*	0.38** *moderate*	1	-0.29** *small*	0.51** *high*	0.13 *small*	-0.23** *small*
HDL-c (mg/dL)	-0.20 *small*	-0.12 *small*	-0.23** *small*	0.23** *small*	-0.22 *small*	-0.11 *small*	-0.26 *small*	-0.29** *small*	-0.29** *small*	1	-0.33** *moderate*	0.03 *trivial*	0.03 *trivial*
TG (mg/dL)	0.26** *small*	0.15* *small*	0.25** *small*	0.22** *small*	0.22** *small*	0.22** *small*	0.25** *small*	0.35** *moderate*	0.51** *high*	-0.33** *moderate*	1	0.12 *small*	-0.04 *trivial*
WC (cm)	0.84** *very high*	0.43** *moderate*	0.89** *very high*	0.75** *very high*	0.77** *very high*	0.59** *high*	0.83** *very high*	1	0.38** *moderate*	-0.29** *small*	0.35** *moderate*	0.19** *small*	0.15* *small*
SBP (mmHg)	0.20** *small*	0.00 *trivial*	0.14 *small*	0.12 *small*	0.15* *small*	0.16* *small*	0.18* *small*	0.19** *small*	0.13 *small*	0.02 *trivial*	0.12 *small*	1	0.58** *high*
DBP (mmHg)	0.17* *small*	0.01 *trivial*	0.14* *small*	0.13 *small*	0.16* *small*	0.09 *trivial*	0.16* *small*	0.16* *small*	-0.23** *small*	0.03 *trivial*	-0.04 *trivial*	0.58** *high*	1

Note: BMI = body mass index; LBM = lean body mass; FBM = fat body mass; LFR = lean-to-fat ratio; LMI = lean mass index; FMI = fat mass index; GLY = fasting glycemia; HDL-c = high-density lipoproteins; TG = triglycerides; WC = Waist Circumference = SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; ** = P < 0.01.
Source: The authors

Figure 2 shows the relationship between sensitivity and specificity for different cutoff points of body composition measures for diagnosis of different metabolic syndrome components, presented in the ROC curves. It is noted that, for systolic and diastolic blood pressure, and HDL-c, regardless of the composition measure assessed, the ROC curves are close to the bisector, indicating that such measures have a low discrimination capacity for these components. Also, it is verified that, in general, lean body mass shows a lower capacity of discrimination, presenting low values of sensitivity and specificity.

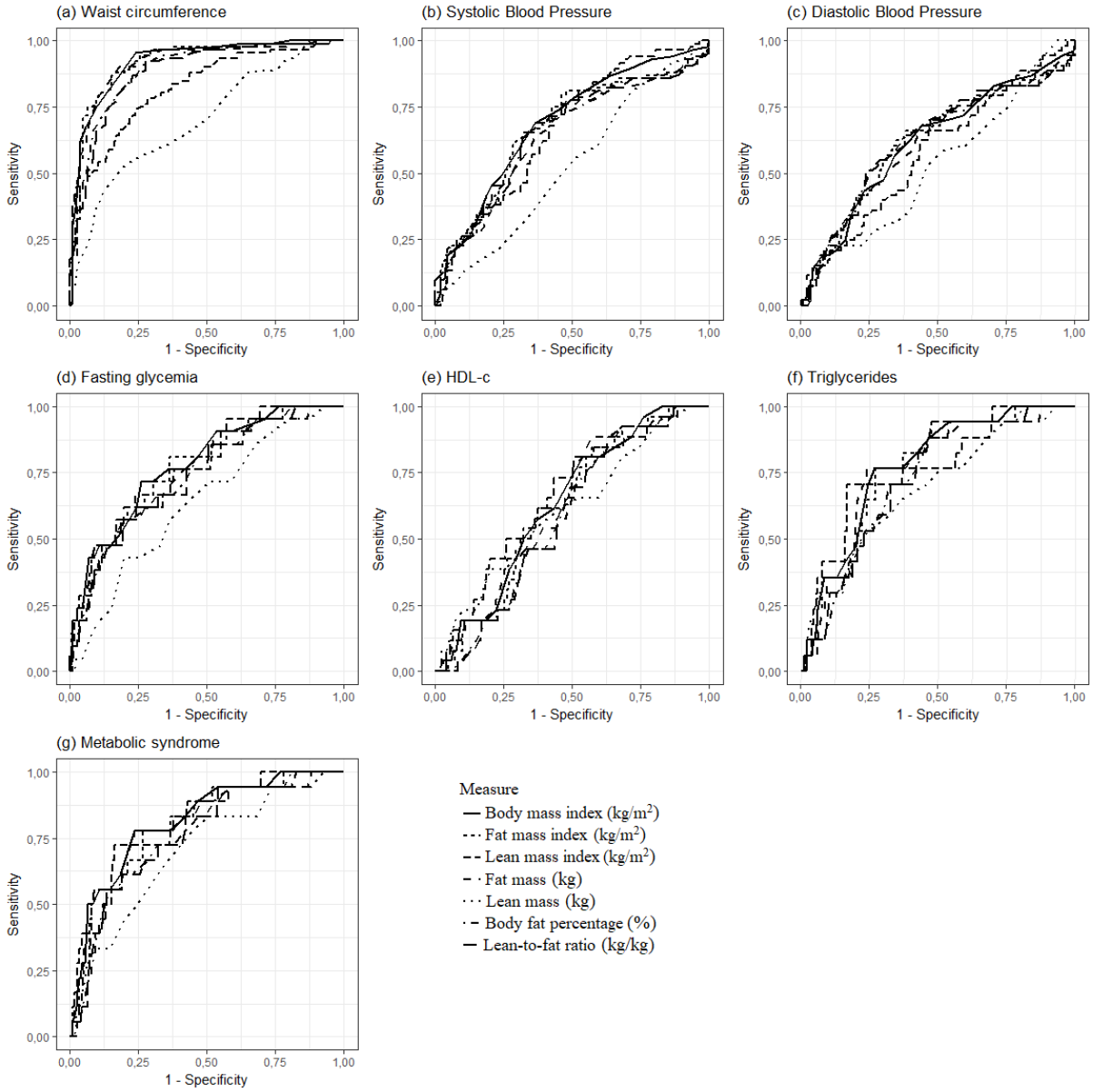

Figure 2. ROC curves to assess the diagnosis of different metabolic syndrome components by body composition parameters

Source: The authors

Corroborating with the visual cues presented in Figure 2, Table 3 brings the values of the area under the ROC curve for assessment of the MS diagnostic sensitivity by body composition parameters.

Table 3. Area under the ROC curve for assessment of the diagnosis of different metabolic syndrome components by body composition parameters

	WC (cm)	SBP (mmHg)	DBP (mmHg)	GLY (mm/dL)	HDL-c (mm/dL)	TG (mm/dL)	MS
Body Mass Index (kg/m²)	0.92	0.69	0.62	0.78	0.63	0.77	0.81
Lean body mass (kg)	0.70	0.53	0.53	0.64	0.61	0.69	0.70
Fat body mass (kg)	0.92	0.65	0.62	0.76	0.63	0.76	0.80
Body mass percentage (%)	0.89	0.65	0.63	0.74	0.59	0.73	0.76
Lean mass index (kg/m²)	0.82	0.67	0.58	0.76	0.66	0.76	0.81
Fat mass index (kg/m²)	0.92	0.67	0.62	0.77	0.62	0.76	0.80
Lean-to-fat ratio (kg /kg)	0.88	0.66	0.62	0.74	0.59	0.72	0.76

Note: WC=Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; GLY: fasting glycemia; HDL-c=TG = triglycerides; MS=metabolic syndrome
Source: The authors

Finally, Table 4 displays the cutoff values of body composition parameters that maximize the sum of sensitivity and specificity, and, consequently, minimize the discrimination error between different metabolic syndrome components.

Table 4. Optimum cutoff points for diagnosis of different metabolic syndrome components by body composition parameters

	WC (cm)	SBP (mmHg)	DBP (mmHg)	GLY (mm/dL)	HDL-c (mm/dL)	TG (mm/dL)	MS
Body Mass Index (kg/m²)	28.00	29.00	29.00	33.00	28.00	33.00	34.00
Lean body mass (kg)	45.00	39.00	49.00	47.00	47.00	44.00	43.00
Fat body mass (kg)	29.00	26.00	28.00	37.00	26.00	37.00	37.00
Body fat percentage (%)	38.00	41.00	43.00	46.00	35.00	40.00	46.00
Lean mass index (kg/m²)	17.02	16.62	16.94	18.33	16.71	18.33	18.33
Fat mass index (kg/m²)	11.92	10.22	12.70	13.06	10.11	14.48	14.48
Lean-to-fat ratio (kg/kg)	0.65	0.73	0.85	0.94	0.58	0.73	1.05

Note: WC = waist circumference; SBP = systolic blood pressure; PAD = diastolic blood pressure; GLY = fasting glycemia; HDL-c = TG = triglycerides; MS = metabolic syndrome.
Source: The authors

Discussion

The objective of the present study was to assess and discriminate LFR, LMI and FMI with MS components in adult women according to nutritional status. In this aspect, the findings indicate that an increased nutritional status (overweight degree) promotes changes in usual and unusual body composition parameters, as well as in MS components.

The body mass variable differed between the five groups. In this sense, a difference in the BMI classification was detected between groups and can be considered as a worldwide-known predictor for excessive body mass, being used to identify nutritional status in population studies[15]. This study indicates that, as the nutritional status increases, changes in anthropometric, hemodynamic, body composition values, as well as biochemical markers are observed.

According to researches[16,17], WC has been proved to be an indicator of mortality in the general population. From this perspective, these changes can harm one's health, that is, cause non-communicable chronic diseases that are responsible for raising morbimortalities all around the world.

In addition, unusual body composition markers (LMI, FMI and LFR) differed between the five groups. There is evidence that unusual markers[7] (LMI and FMI) can provide relevant

information about body compartments, regardless of height, while LFR is a predictor for sarcopenic obesity and increased cardiometabolic risk, which are present when individuals have excessive body fat combined with loss of LBM[9,18].

In addition, it is worth highlighting that, as body mass increases, there is also an increase in FBM, but in a greater proportion than LBM. This correlation results from diet composition and physical inactivity, which overload the metabolism and raises cardiometabolic risks[9]. In this aspect, as observed in the findings of the present study, as the nutritional status changes (eutrophic, overweight, obesity I, II and III), there is an increase in LFR (kg/kg) (eutrophic: 0.42, overweight: 0.62; obese I: 0.88; obese II: 1.0; and obese III: 1.1, respectively). Despite this, there is evidence that the association is not so direct, as shown by the phenomenon known as "obesity paradox", which presents reduced risk for some diseases/conditions, according to study by Aparicio et al[19].

Other researchers[20] also verified that FMI increases when BMI is high, and that said index can quantify deficiency or excess of FBM. FMI is related to body fat mass in the obese population, which corroborates with the results of the present study. In addition, another study[21] identified similar results in women subdivided by nutritional status. Thus, it is suggested that as BMI values decrease, unusual indexes also regress, and, therefore, they sustain that FMI is a complementary measure for obesity[7]. In addition, our study found a near-perfect correlation between BMI x FMI (r=0.97). Such evidence reinforces the relevance of BMI to identify the nutritional status of people[20].

Parallel to the studies cited, LFR and FMI are components that have been studied in women with polycystic ovary syndrome (PCOS)[22]. In this way, Ezeh[22] evidenced associations with increased fat-to-lean ratio (FLR), presenting itself independently associated with differences in fasting insulin, HOMA-IR and β-HOMA% values between PCOS and control.

Of all MS components, changes in WC and SBP were the most prevalent, reaching 46.7% and 42.6% of the sample, respectively. In addition, hemodynamic parameters increase with senescence and changes in the nutritional status of people (underweight, eutrophic, overweight and obesity)[23]. From this perspective, Lavie et al[16] report that obesity has negative effects on SBP and DBP, more specifically on venous return and artery calibration. Besides, it is noteworthy that recent studies have reported significant differences for anthropometric and hemodynamic variables, factors that exponentially increase the health risk of the population[24,25].

For biochemical measurements, the prevalence of changes in fasting glycemia (10.7%), TG (8.6%) and HDL-c (13.7%) was identified in the obese groups, that is, values above reference levels (NCEP-ATP III)[4]. In this aspect, the data presented reinforce the raise of these markers being greater in obese individuals[24,25]. Such responses suggest that increased body fat, especially at the abdominal level, tends to cause changes in serum lipid variables and hypertriglyceridemia, which increase BP and decrease HDL-c[26] concentrations.

Thus, the present study verified a growing curve for presence of MS according to nutritional status, being: 3.0% for overweight people, 6.5% for people with grade I obesity, 22.6% for people with grade II obesity, and 33.3% for people with grade III obesity, according to previous studies[26-28].

Other studies of great international impact report that MS affects men due to a high concentration of abdominal fat. However, adipose tissue located in the lower body (gynoid fat, gluteofemoral region), present in women, may be a protector against MS. However, with the onset of the climacteric, women tend to have an increase in abdominal fat concentrations, which may cause MS[29,30]. Consequently, it is extremely important to monitor these risk

factors periodically, as well as the implementation of multi-professional programs to combat excessive body mass and reduce changes in cardiometabolic risk parameters[24].

Finally, it is identified in the literature that fat percentage (low, normal and high) can identify changes in the values that compose MS and cardiovascular risk even in people with adequate BMI[20,21]. Therefore, the LMI and FMI equation calls for more in-depth studies, considering that this is a potential epidemiological and clinical tool to define and monitor obesity-related aspects. Moreover, despite the contributions, the present study has limitations as well: a) the sample was recruited by convenience, including participants that had availability and interest in participating in the research; b) the age group was relatively broad; c) the sample was composed of women only.

Conclusions

With these results, it was possible to verify that, according to nutritional status, changes in usual and unusual body composition components are observed in the study population and also in MS components. The analysis of the discriminatory power of usual and unusual body composition components through the ROC curve allows indicating them as moderate predictors of MS components.

Based on the results presented, other studies should assess the usefulness of these (unusual) components together with traditional parameters, aiming at the verification of their predictive value.

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