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# Comparison of three criteria for metabolic syndrome among Brazilian university students

Metabolic syndrome

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## Abstract

**Purpose** – This paper aims to compare the prevalence of metabolic syndrome (MetS) on the basis of three criteria. The diagnostic criteria adopted were those of the International Diabetes Federation, the National Cholesterol Education Program – Adult Treatment Panel III and the American Heart Association/National Heart, Lung and Blood Institute.

**Design/methodology/approach** – A transversal study was undertaken with 691 university students in Fortaleza, Brazil, in 2011-2013.

**Findings** – The prevalence of MetS varied considerably according to the criteria used, it being 4.1 per cent for the IDF, 0.7 per cent for the NCEP ATP III and 1.7 per cent for the revised NCEP ATP III. The criteria of the IDF presented reasonable agreement in relation to the NCEP ATP III (0.294) and revised NCEP ATP III (0.334). Moderate agreement was found between the NCEP ATP III/revised NCEP ATP III.

**Originality/value** – There is a need for a universal diagnostic criterion for MetS to obtain uniform and more reliable data for the elaboration of public health policies.

**Keywords** Public health, Diagnosis, Metabolic syndrome X, Students

**Paper type** Research paper



## Introduction

Various entities have proposed formal definitions for metabolic syndrome (MetS) and some deserve to be highlighted, such as the World Health Organization (WHO) ([World Health Organization, 1999](#)), the National Cholesterol Education Program – Adult Treatment Panel III (NCEP ATP III) ([NCEP, 2001](#)), the [International Diabetes Federation \(IDF\) \(2004\)](#) and the American Heart Association/National Heart, Lung and Blood Institute (AHA/NHLBI) ([American Diabetes Association, 2005](#); [Grundy \*et al.\*, 2005](#)). It is worth emphasizing that all the criteria established by these bodies present divergences for the diagnosis of MetS, as well as divergences in their components and in the values for the adopted cut-off point. These bodies, however, tend to prioritize abdominal circumference, insulin resistance, dyslipidemia and systemic arterial hypertension as the main components. In addition to this, it is important to make clear that the existence of more than one criterion for the diagnosis of MetS causes these studies to present distinct prevalence in the same population, which hinders the uniformity and the reliability of the data.

It cannot be denied that the absence of a single gold-standard criterion for the detection of MetS in distinct populations substantially compromises the information regarding its prevalence and, in this manner, may compromise the development of public health policies directed toward the control and early prevention of these risk factors for cardiovascular diseases ([Sociedade Brasileira de Cardiologia, 2005](#)).

The Brazilian Ministry of Health has encouraged the undertaking of research on MetS. Thanks to this, one can find scientific articles on distinct populations, such as adolescents ([Giannini \*et al.\*, 2014](#)), university students ([Freitas \*et al.\*, 2013](#)), older adults ([Saad \*et al.\*, 2014](#)), patients with heart disease ([Nakazone \*et al.\*, 2007](#)), patients with Diabetes Type I ([Santos \*et al.\*, 2009](#)) and in the context of primary health care ([Vanhoni \*et al.\*, 2012](#)) – all aiming only to discover the prevalence of this problem. However, when the issue is the comparison of the diagnostic criteria of MetS, both the number of studies and target populations are fewer: older adults ([Paula \*et al.\*, 2010](#); [Saad \*et al.\*, 2014](#)) and adolescents ([Costa \*et al.\*, 2012](#)).

As has been seen, Brazil lacks studies involving the comparison of the criteria of metabolic syndrome in other populations, such as young university students. The rationale for this would be strong, given that discovering the most relevant or consistent criteria for university students could help in the early detection of a negative predictor for developing chronic conditions. Furthermore, due to the practicality of the criteria, this may be a strategy for encouraging its use in clinical practice.

As a result, taking into account that the issue of MetS is a research priority and that the young Brazilian population needs to be assessed, in the attempt to obtain epidemiological data, for later intervention and adoption of methods for promoting health and preventing ill health, this study's objective was to compare the prevalence of MetS through the use of three diagnostic criteria in a population of Brazilian university students.

## Method

### *Ethical aspects*

This study was approved by the Committee for Ethics in Research with Human Beings, of the Federal University of Ceará, Brazil. All the participants signed the terms of free and informed consent to participate in the study.

### *Study outline*

This is a sectional study undertaken with students of a public and federal university of the city of Fortaleza, Ceará, Brazil, during the period 2011-2013.

### *Population and sample*

At the time of the research, the study locale had approximately 20,000 university students. On the basis of a formula for infinite populations, a sample was extracted of approximately 1000 subjects of the population (Hulley *et al.*, 2008).

The following participated in the study: university students aged  $\geq 18$  years, independent of sex, studying on courses of various areas of knowledge (sciences, technology, agrarian sciences, health, the human sciences and the exact sciences). Women who were pregnant and/or breast-feeding and young people whose questionnaires were incomplete, were excluded. The study's final sample culminated in 691 participants.

### *Measurements*

In the data collection, the participants filled out a questionnaire with socio-demographic information and information related to lifestyle habits. On a separate occasion, they were examined by nurses who were specialists in diabetology for the collection of anthropometric data and venipuncture.

To infer the diagnosis of MetS, three criteria were employed: the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (NCEP-ATP III), modified NCEP ATP III (review undertaken by the American Heart Association) and criteria of IDF.

Both the NCEP-ATP III and the modified NCEP-ATP III consider the need for  $\geq 3$  components: abdominal circumference  $> 102$  cm (men's) and  $> 88$  cm (women), arterial pressure  $\geq 130/85$  mmHg, triglycerides  $\geq 150$  mg/dl, high density lipoprotein cholesterol  $< 40$  mg/dl (men's) e  $< 50$  mg/dl (women) and the values of fasting glycemia of  $\geq 110$  mg/dl for the NCEP ATP III and  $\geq 100$  mg/dl for the modified version. The IDF criteria, on the other hand, takes into account the abdominal circumference,  $\geq 90$  cm (men's) and  $\geq 80$  cm (women) and more two components: arterial pressure  $\geq 130/85$  mmHg, triglycerides  $\geq 150$  mg/dl, high density lipoprotein cholesterol  $< 40$  mg/dl (men's) e  $< 50$  mg/dl (women) and fasting glycemia of  $\geq 100$  mg/dl (Grundy *et al.*, 2005).

In addition to the variables above mentioned, the use of oral anti-diabetic medications, anti-hypertensives and/or anti-lipemics was also considered as a component of MetS.

### *Statistical analysis*

The data was typed thrice in an Excel spreadsheet and then exported to the SPSS statistical software, version 16.0 (Chicago; SPSS Inc.). The triple keying was undertaken with the aim of detecting erroneous, incomplete or absent information in the study's database. The analysis of the data was preceded by an exploratory description of the variables.

The normality of the variables was evaluated using the Kolmogorov-Smirnov test. To ascertain the differences between the proportions of the criteria for MetS, Pearson's chi-squared test, Fisher's exact test (when necessary) and Student's *t*-test were used (in accordance with variance analysis) in relation to the quantitative variables. In all the analyses, we adopted a level of statistical significance of 5 per cent. To measure the agreement between the criteria, we used the Kappa test (*k*).

## **Results**

The majority of participants in the study were female (62.7 per cent), single (92 per cent) and in the age range of 20-24 years old (mean and standard deviation of  $21.5 \pm 1.5$  years old, respectively). On average, these students had a monthly family income of US\$1,705 (standard deviation of  $\pm 200$  dollars).

The prevalence of smoking (8.5 per cent), drinking alcohol (6.6 per cent) and arterial hypertension (3 per cent) were low in relation to the values of excess weight (26.4 per cent) and sedentarism (70.2 per cent).

High values for fasting venous blood sugar, triglycerides and LDL-C were found in 12.3, 23 and 5.9 per cent of the participants, respectively. Regarding HDL-C, reduced values were detected in 12 per cent of the students.

Statistically significant differences were ascertained in relation to the anthropometric, clinical and laboratorial variables according to sex. For example, the women presented higher waist circumference values than the men. In their turn, the means for BMI, triglycerides, MDAP, MSAP, LDL-C and HDL-C were similar and low between both sexes (Table I).

The prevalence of MetS varied considerably according to the criteria used; it was 4.1 per cent for that of the IDF, 0.7 per cent for that of the NCEP ATP III and 1.7 per cent for the modified NCEP ATP III. Men were significantly more affected according to the criteria of the IDF ( $p = 0.010$ ) (Figure 1).

The principal grouping of components of MetS identified, independent of the criteria used, was high waist circumference, triglycerides and blood pressure, namely, IDF (46.0 per cent), modified NCEP ATP III (50.0 per cent) and NCEP ATP III (100.0 per cent).

The findings of the kappa index showed a moderate diagnostic agreement among the criteria of the NCEP ATP III and the modified NCEP ATP III (0.584). Regarding the criteria of the IDF, the general agreement in relation to the NCEP ATP III (0.294) and modified NCEP ATP III (0.334) was reasonable in both cases.

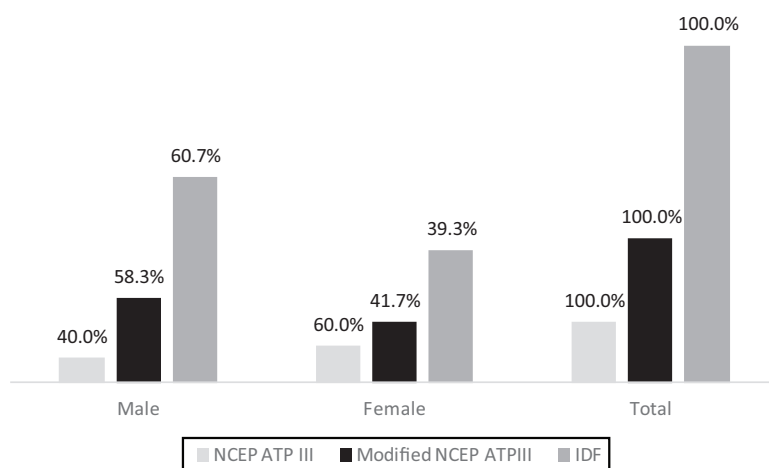
Through the criteria of the IDF, it was possible to identify a higher percentage of subjects with at least one component of MetS (32.1 per cent) in relation to the other criteria compared in the study's sample (Figure 2).

We sought to associate the type of criteria and the students' area of knowledge. The university students with the highest quantity of cases of MetS were those on courses in the area of the Human Sciences ( $p = 0.035$ ), in accordance with the NCEP-ATP III criteria (Table II).

**Table I.**  
Distribution of the anthropometric, clinical and laboratorial variables, by sex of university students; Fortaleza, CE, Brazil, 2011/2013 (n = 691)

Variables	Total	Sex		<i>p</i> value <sup>†</sup>
		Female <sup>a</sup>	Male <sup>b</sup>	
Characteristics	Mean ± MSE <sup>‡</sup>	Mean ± MSE <sup>‡</sup>	Mean ± MSE <sup>‡</sup>	
Age	21.50 ± 0.172	21.40 ± 0.193	21.66 ± 0.327	0.470
Height	1.65 ± 0.034	1.60 ± 0.029	1.73 ± 0.040	< 0.0001
Weight	64.17 ± 0.518	58.28 ± 0.480	74.04 ± 0.828	< 0.0001
BMI	23.27 ± 0.143	22.57 ± 0.170	24.43 ± 0.242	< 0.0001
AC	94.50 ± 0.133	90.35 ± 0.121	99.45 ± 0.233	< 0.0001
MSAP	109.61 ± 0.447	104.51 ± 0.456	118.16 ± 0.632	< 0.0001
MDAP	71.06 ± 0.323	68.44 ± 0.379	75.45 ± 0.474	< 0.0001
Glycemia	88.61 ± 0.405	88.24 ± 0.490	89.21 ± 0.705	0.245
Triglycerides	127.30 ± 1.232	122.38 ± 1.526	135.40 ± 1.980	< 0.0001
HDL-C	53.74 ± 0.296	56.45 ± 0.374	49.27 ± 0.334	< 0.0001
LDL-C	74.62 ± 1.278	70.65 ± 1.618	81.19 ± 2.024	< 0.0001

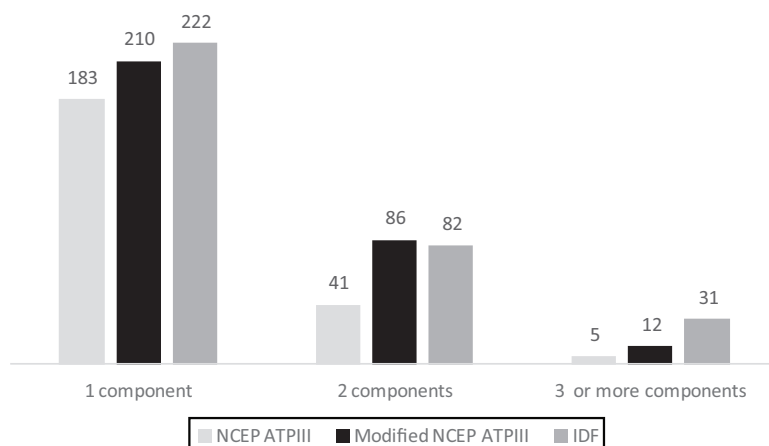
**Notes:** BMI – Body Mass Index; AC – abdominal circumference; MSAP – mean systolic arterial pressure; MDAP – mean diastolic arterial pressure; HDL-C – high-density lipoprotein cholesterol; LDL-C – low-density lipoprotein cholesterol; <sup>a</sup>n = 468; <sup>b</sup>n = 223; <sup>‡</sup>MSE = mean standard error; <sup>†</sup>Student's *t*-test for equal and unequal variances (*p* significant if < 0.05)



**Notes:** NCEP ATP III - National Cholesterol Education Program – Adult Treatment Panel III; IDF - International Diabetes Federation; NCEP ATP III – male ( $n = 2$ )/female ( $n = 3$ ); Modified NCEP ATP III – male ( $n = 7$ )/female ( $n = 5$ ); IDF – male ( $n = 17$ )/female ( $n = 11$ ); Total – NCEP ATP III ( $n = 5$ ), Modified NCEP ATP III ( $n = 12$ ), IDF ( $n = 28$ ); Fisher’s exact test. IDF ( $p = 0.010$ ), NCEP ATP III ( $p = 0.624$ ), Modified NCEP ATP III ( $p = 0.119$ )

**Source:** Fortaleza, CE, Brazil, 2011/2013

**Figure 1.** Association between the prevalence of metabolic syndrome among Brazilian university students, according to three diagnostic criteria and sex



**Notes:** NCEP ATP III - National Cholesterol Education Program – Adult Treatment Panel III; IDF - International Diabetes Federation

**Source:** Fortaleza, CE, Brazil, 2011/2013

**Figure 2.** Distribution of the number of cases of metabolic syndrome according to three diagnostic criteria

**Discussion**

In the authors' perception, the prevalence of MetS was low in all the criteria used and presented a significant variation. The fact that the sample studied was young and apparently healthy, without harmful habits such as smoking and drinking probably contributed to the low prevalence of MetS.

Regarding the divergence between the criteria, in contrast with our findings, the majority of the publications consulted identified good or moderate agreement between the NCEP ATP III/modified NCEP ATP III and the IDF criteria (Onesi and Ignatius, 2014; Saad *et al.*, 2014; Santos *et al.*, 2009; Vanhoni *et al.*, 2012). However, it is important to emphasize that the NCEP ATP III and modified NCEP ATP III criteria prioritize chronic changes such as dyslipidemia, glycemia and raised arterial blood pressure; while the criteria of the IDF prioritizes abdominal obesity, according to ethnic group, in a more acute character and, therefore, is more common in the young population.

Indeed, previous studies undertaken in populational samples in Portugal, China, Brazil, Nigeria and Colombia have observed the same finding: the IDF criteria presented better performance in terms of sensitivity and positive predictive value in comparison with the others (NCEP ATP III, modified NCEP ATP III, WHO and the American Association of Clinical Endocrinologists [AACE]) (Correia *et al.*, 2006; Zhefang *et al.*, 2014; Saad *et al.*, 2014; Gianinni *et al.*, 2014; Santos *et al.*, 2009; Onesi and Ignatius, 2014; Forero *et al.*, 2013).

In relation to MetS, the divergence – or even the existence of multiple diagnostic criteria, with similar components and different cutoff points – is a problem: given that it hinders the adequate comparison of studies and the elaboration of protocols and consequently specific public health policies (Onesi and Ignatius, 2014; Gianinni *et al.*, 2014). On the other hand, it is increasingly accepted that this is an entity with various components (known and unknown) directly related with cardiovascular risk. Therefore, the undertaking of further research and protocols, in various populations, is important for a conclusion to be drawn.

The predominant grouping of components of MetS in this study, independent of the criteria, was arterial pressure, abdominal circumference and triglycerides. This information was also analyzed in a recent study with 12 cohorts from ten European countries and the USA. In this case, the predominant groupings of components of MetS were glycemia and raised arterial

**Table II.**  
Association between the prevalence of metabolic syndrome according to diagnostic criteria and the areas of knowledge; Fortaleza, CE, Brazil, 2011/2013

Variables	Areas of knowledge n (%)						p value <sup>a</sup>
	Agrarian Sciences (n = 97)	Sciences (n = 125)	Exact Sciences (n = 114)	Human Sciences (n = 140)	Health (n = 104)	Technology (n = 111)	
Criteria							
IDF							0.224
Yes	6 (6.2)	6 (4.8)	1 (0.9)	6 (4.3)	2 (1.9)	7 (6.3)	
No	91 (93.8)	119 (95.2)	113 (99.1)	134 (95.7)	102 (98.1)	104 (93.7)	
NCEP ATP III							0.035
Yes	–	1 (0.8)	–	4 (2.8)	–	–	
No	97 (100.0)	124 (99.2)	114 (100.0)	136 (97.2)	104 (100.0)	111 (100.0)	
Modified NCEP ATP III							0.249
Yes	–	3 (2.4)	2 (1.8)	5 (3.6)	–	2 (1.8)	
No	97 (100.0)	122 (97.6)	112 (98.2)	135 (96.4)	104 (100.0)	109 (98.2)	

**Notes:** IDF – International Diabetes Federation; NCEP ATP III – National Cholesterol Education Program – Adult Treatment Panel III; <sup>a</sup>Chi-squared test (p significant if < 0.05)



pressure/abdominal obesity (12.7 per cent), followed by triglycerides and raised arterial pressure and abdominal obesity (Scuteri *et al.*, 2010).

The convergence around adiposity in cases of MetS is clear. According to academics, the installation of obesity potentializes pre-existent morbid conditions and is determinant for the appearance of the other components of MetS (Schimid Schmid and Schultes, 2011; Lam and Ip, 2010). Due to this, combat against obesity is a priority in confronting the rise of MetS in today's society.

Another of the study's findings was the reduced vulnerability of the university students from the health area in relation to the prevalence of MetS. Some authors have undertaken studies on this issue and, according to their results, assert that this association may exist. The results of one study consulted revealed that the students from the nursing course presented – in general – a healthier lifestyle in comparison with the other students. One of the rationales listed was the set of training and advice for students of nursing specifically geared toward the axis of health promotion (Matos and Albuquerque, 2006).

However, one should ask: is this rationale plausible or questionable? For some authors, neither a high-level of education nor area of training is sufficient to cause behavioral change (Brandão *et al.*, 2011). Regardless of the area of training, what is actually sought is the empowerment of the young in relation to adopting healthy living habits. The time of a person's life when they are at university, in a transition to adult life, is an ideal point for encouraging healthy living habits which will protect them in relation to the chronic diseases.

Our study has some limitations. We adopted only three criteria of the six most common worldwide; as a result, our findings do not enable one to determine which criteria is the best among those in existence. Another point is the fact that the criteria used were not aimed at specific groups of the population. Moreover, the participants were examined only once, a fact that limits the findings in relation to causality and accuracy.

Our findings show the extent to which the prevalence of MetS may be affected, depending on the criteria used. As a result, one can understand the genuine need to have comprehensive universal criteria, which can be used among the young, such as university students. Modern life and the advent of the increase in the chronic conditions have raised the occurrence of metabolic disorders among young people, at increasingly earlier points. This being the case, identifying and encouraging the diagnosis of MetS in these populations would be highly valuable, such that intervention measures might be devised at an early stage.

## Conclusion

The prevalence of MetS varied considerably according to the criteria used; it was 4.1 per cent for the IDF, 0.7 per cent for the NCEP ATP III and 1.7 per cent for the modified NCEP ATP III. The comparison of the criteria used for diagnosing MetS, analyzed using the Kappa test, revealed a reasonable agreement between the IDF/NCEP ATP III and IDF/modified NCEP ATP III and a moderate agreement between the NCEP ATP III/modified NCEP ATP III.

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