

# Prevalence of the metabolic syndrome according to different criteria in the male population during the Blue November Campaign in Natal, RN, Northeastern Brazil

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**Background:** Metabolic syndrome (MetS) is an aggregation of risk factors associated with increased incidence of cardiovascular disease, type 2 diabetes mellitus, and all-cause mortality. Information on MetS prevalence is scarce in the northeast region, Brazil. This study aims to estimate the prevalence of MetS according to different diagnostic criteria in a community sample of men during the November Blue Campaign living in the metropolitan area of Natal, Rio Grande do Norte, Brazil.

**Methods:** This is a cross-sectional study on 500 men aged 40 years or older invited by the Blue November Campaign of 2015, an awareness program aimed at the prevention of male diseases. The evaluation included blood pressure, anthropometric measurements (weight, height, and waist circumference), fasting blood glucose, and blood lipid profile. The diagnosis of MetS was made according to the criteria of International Diabetes Federation (IDF)/American Heart Association (AHA)/National Heart, Lung, and Blood Institute (NHLBI), IDF, and National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATPIII).

**Results:** The prevalence was high by considering the following three criteria: IDF/AHA/NHLBI (66.8%), IDF (60.0%), and NCEP-ATPIII (46.4%). Concordance between diagnostic criteria measured by the kappa statistic ( $k$ ) was excellent between IDF/AHA/NHLBI and IDF ( $k=0.85$ ,  $P<0.0001$ ) and moderate between IDF/AHA/NHLBI and NCEP-ATPIII ( $k=0.59$ ) and IDF and NCEP-ATPIII ( $k=0.54$ ).

**Conclusion:** Prevalence of MetS in the male population was high using the three diagnostic criteria. IDF/AHA/NHLBI and IDF criteria have a high level of agreement, but NCEP-ATPIII criteria identify a lower number of MetS cases.

**Keywords:** metabolic syndrome, preventive medicine, male population

## Introduction

The metabolic syndrome (MetS) is a complex and worldwide epidemic disorder with high socioeconomic impact due to its association with increased morbidity and mortality.<sup>1</sup> The main causes are increasing urbanization, nutrition transition, and reduced physical activity.<sup>1</sup> MetS consists of a cluster of several metabolic and physiological abnormalities, including abdominal obesity, impaired glucose metabolism, hypertriglyceridemia, decreased high-density lipoprotein cholesterol (HDL-C), and arterial hypertension. It is believed that this syndrome increases the risk of type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVDs).<sup>2,3</sup> People with MetS are estimated to have twice the risk of developing CVD compared to healthy individuals and a fivefold increased risk of T2DM.<sup>4</sup>

The Framingham Offspring Study demonstrated that the attributable risk in the population for diabetes associated with MetS was 62% in men and 47% in women with the modified National Cholesterol Education Program (NCEP) criteria.<sup>5</sup> The MetS's pathogenesis remains unclear, as does the establishment of diagnostic criteria. It has been demonstrated clearly that the syndrome is common and that its prevalence is rising worldwide, which is largely a consequence of increasing obesity and sedentary lifestyles. As a result, the MetS is now both a public health issue and a clinical problem.<sup>3</sup> The MetS has an estimated prevalence of 20%–25% in the general population. Its prevalence is greater for older people, reaching 42% in individuals older than 60 years.<sup>6</sup>

One in approximately every four or five adults develops MetS, depending on the environmental conditions and daily lifestyle habits of the country where he/she resides. The prevalence of this syndrome has been estimated to increase with age for individuals older than 50 years,<sup>7</sup> the use of new eating patterns,<sup>8</sup> changes in the work environment,<sup>9</sup> the number of meals during the day,<sup>10</sup> and the duration of sleep<sup>11–14</sup> and in low-income people<sup>15</sup> and smokers.<sup>15</sup> Meanwhile, the prevention and treatment of MetS are based on changes in lifestyle through a multifactor approach based on education, regular physical exercise, and a healthy diet, as well as pharmacological strategies.<sup>16</sup>

In Brazil, the Ministry of Health's Comprehensive Male Health Care Policy (PNAISH) promotes the improvement of the health conditions of the male population from 25 to 59 years, a preponderant part of the productive force, contributing to the reduction in morbidity and mortality in this population through rational coping of risk factors and facilitating access, actions, and comprehensive health care services.<sup>17</sup> The Blue November Campaign is a part of these actions and includes a set of awareness strategies on the importance of prevention and early diagnosis of diseases that affect the male population, especially the most prevalent.<sup>18</sup>

Considering that MetS represents a higher risk for T2DM and CVD, combined with the scarcity of data in Brazil, this study aims at determining the prevalence of MetS in men living at the metropolitan area of Natal, Rio Grande do Norte, northeast region of Brazil. The community-based sample was taken on the Blue November Campaign of 2015 using the criteria defined by consensus among the International Diabetes Federation (IDF)/American Heart Association (AHA)/National Heart, Lung, and Blood Institute (NHLBI). The prevalence of MetS according to IDF/AHA/NHLBI was compared with the criteria set forth by the IDF and NCEP's Adult Treatment Panel III (NCEP-ATPIII).

## Methods

### Study population

The research was carried out according to the Norms and Ethical Guidelines of the National Health Council Resolution 510/2016 of the Brazilian Ministry of Health and approved by the Research Ethics Committee of the University Hospital Onofre Lopes, Federal University of Rio Grande do Norte, in 2014. The study was a cross-sectional survey based on an urban community sample of men 40 years or older in Natal, Rio Grande do Norte, with the Certificate of Presentation for Ethical Appreciation (CAAE) 25997913.1.0000.5292. The participants were invited between November 2015 and April 2016 through television advertisements, seeking volunteers to take part in the Blue November Campaign of 2015, which is the prevention of male diseases' awareness program, promoted by the University Hospital Onofre Lopes.

A total of 500 men who agreed to participate in the study signed the informed consent form. Then, they were included in the survey, all were submitted to anamnesis, clinical, and laboratorial evaluation, and data were collected on the individual components of the MetS (blood pressure, waist circumference [WC], fasting glucose [FG], HDL-C, triglycerides [TG], and medication history). Also, we measured total cholesterol, low-density lipoprotein cholesterol (LDL-C) and body mass index (BMI).

### Measurements

The blood pressure was measured with a mercury sphygmomanometer applied to the left arm, with the subject in the sitting position. The BMI was calculated by dividing the subject's weight in kilograms by the square of height in meters ( $\text{kg}/\text{m}^2$ ) using an automatic anthropometric scale (Filizola, São Paulo, Brazil) calibrated by INMETRO. WC was measured using an inelastic measuring tape at the midpoint between the iliac crest and the lowest rib, with the patient in the standing position.

Blood samples were drawn from overnight fasting and using automated methods and commercially available assays at the Laboratory of Clinical Analysis of the University Hospital Onofre Lopes. We measured FG by the enzymatic test kit AA and lipid profile (including TG by the enzymatic test kit GOP/PAP AA, total cholesterol by the enzymatic test kit AA, and HDL-C by colorimetric test kit monofase AA plus) with an automated CMD 800 iX1 equipment (Wiener Lab, Rosario, Argentina).

The diagnosis of MetS was established according to the IDF/AHA/NHLBI criteria and compared with the IDF and NCEP-ATPIII criteria. The cutoff used for WC in IDF/AHA/NHLBI

and IDF criteria was that of European ethnicity, according to Table 1.

## Statistical analysis

Prevalence rates are presented with binomial 95% CIs. The kappa statistic was used to analyze concordance between diagnostic criteria. The Chi-square test was used to compare proportions. Significance level was set at  $P < 0.05$ . Stata 11 (Stata Corp., College Station, TX, USA) was used for statistical calculations.

## Results

The present study assessed, on a community-based sample of the male population living in the metropolitan area of Natal, the prevalence of MetS and the agreement between diagnostic criteria, according to the latest criteria, IDF/AHA/NHLBI, compared with the IDF and NCEP-ATP III criteria. During a 6-month period, 500 men aged 43–83 years who participated in a voluntary health examination were assessed. The clinical and demographic characteristics of the study population are presented in Table 2, which showed a mean age of 57.3 years, the WC of 100.4 cm, the serum TG of 189.5 mg/dL, and the FG of 123.2 mg/dL.

The prevalence rates among age groups (40–49, 50–59, 60–69, and  $\geq 70$  years) according to the three diagnostic criteria did not find a statistically significant difference, as shown in figure 1. The group of 60–69 years presented the highest prevalence in all criteria, such as IDF/AHA/NHLBI, IDF, and NCEP-ATPIII.

The percentage prevalence of MetS found for the three criteria studied is shown in Table 3. In this study, it was higher using the IDF/AHA/NHLBI criteria (66.8%) followed by the IDF criteria and the NCEP-ATPIII criteria. Concordance analysis of the three diagnostic criteria used for the definition of MetS was analyzed by determining the kappa statistic. The concordance showed excellent agreement between IDF/AHA/NHLBI and IDF criteria (kappa statistic

0.85,  $P < 0.0001$ ) but a moderate agreement between either of those criteria and NCEP-ATPIII criteria (kappa statistic 0.59 and 0.54, respectively).

## Discussion

### MetS and age

The literature shows great variability in the prevalence of MetS among the elderly, which depends greatly on the criteria used for the diagnosis and also the ethnic and regional characteristics of the study population.<sup>19</sup> Park et al,<sup>15</sup> in the United States, showed that the prevalence of MetS increases with advancing age, peak at the sixth decade of life for men and the eighth decade of life for women. The emerging prevalence data suggest that MetS is quite prevalent especially among older people. This effect can be explained largely by age-related rises in blood pressure and glucose.<sup>20</sup>

In Brazil, Nakazone et al,<sup>21</sup> in a follow-up of 200 gender-matched cardiology patients aged 31–50 years in Ribeirão Preto, São Paulo, Brazil, showed the prevalence of MetS as 35.5% by the NCEP-ATPIII criteria and 46% by the IDF criteria. Rigo et al,<sup>22</sup> in a study at Novo Hamburgo, Rio Grande do Sul, Brazil, with 378 elderly individuals aged

**Table 2** Characteristics of the study population in Natal, Rio Grande do Norte, at 2015

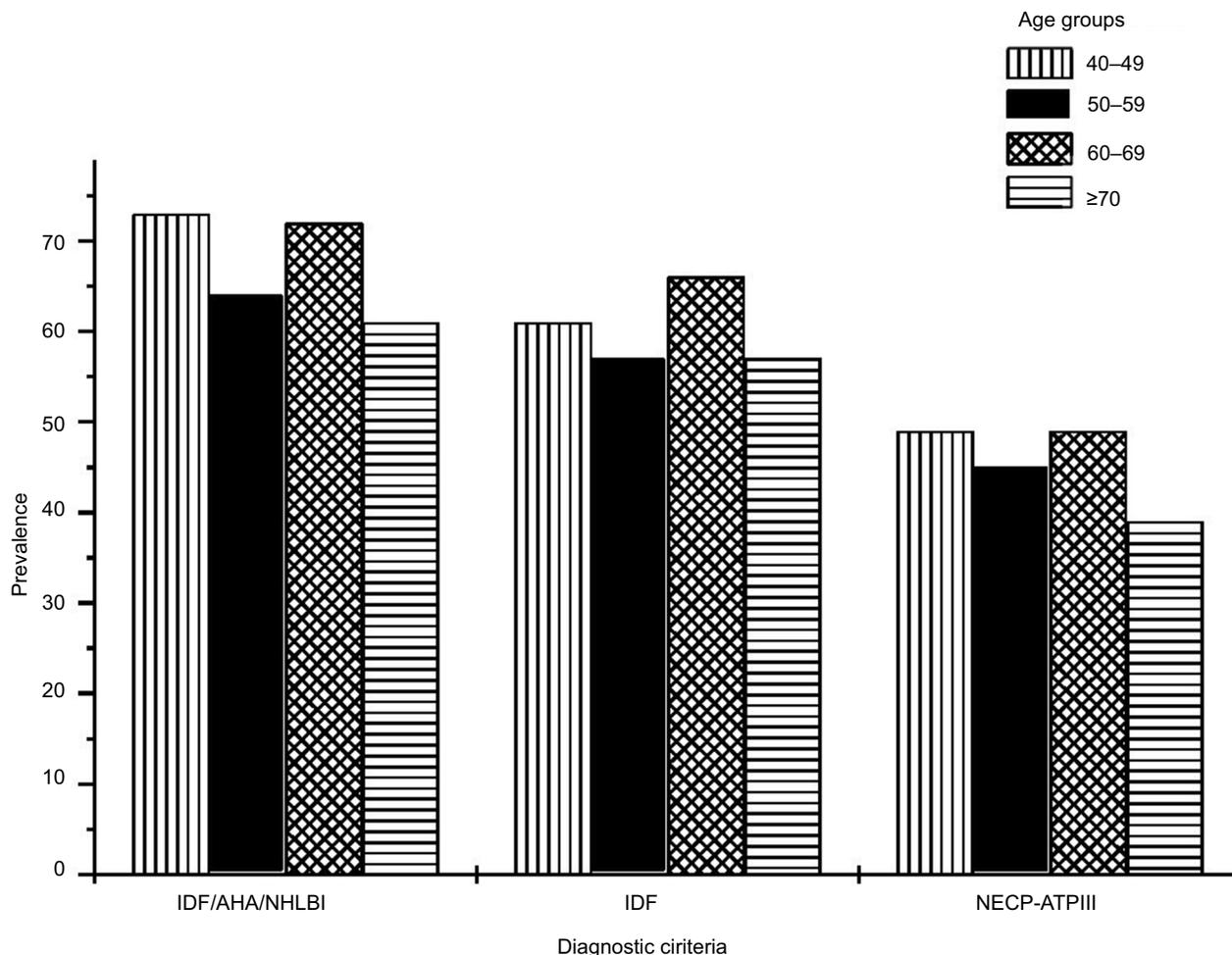
Subject variables	n=500	
	Mean	SD
Age (years)	57.3	6.82
Body mass index (kg/m <sup>2</sup> )	28.2	4.07
Waist circumference (cm)	100.4	10.8
Systolic blood pressure (mmHg)	136.8	20.2
Diastolic blood pressure (mmHg)	85.1	12.7
Total cholesterol (mg/dL)	217.8	44.6
HDL-C (mg/dL)	44.7	11.9
LDL-C (mg/dL)	136.7	35.8
Triglycerides (mg/dL)	189.5	126.2
Fasting glucose (mg/dL)	123.2	75.1

**Abbreviations:** HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

**Table 1** Definitions and diagnostic criteria for MetS

Components	IDF/AHA/NHLBI	IDF	NCEP-ATPIII
Blood pressure	$\geq 130/85$ mmHg or SAH treatment	$\geq 130/85$ mmHg or SAH treatment	$\geq 130/85$ mmHg
WC	$\geq 94$ cm + ethnicity-specific values	$\geq 94$ cm + ethnicity-specific values	$> 102$ cm
FG	$\geq 100$ mg/dL	$\geq 100$ mg/dL	$\geq 110$ mg/dL
TG	$\geq 150$ mg/dL	$\geq 150$ mg/dL	$\geq 150$ mg/dL
HDL-C	$< 40$ mg/dL	$< 40$ mg/dL	$< 40$ mg/dL
MetS criterion	$\geq 3$ components	WC +2 components	$\geq 3$ components

**Abbreviations:** AHA, American Heart Association; FG, fasting glucose; HDL-C, high-density lipoprotein cholesterol; IDF, International Diabetes Federation; MetS, metabolic syndrome; NCEP-ATPIII, National Cholesterol Education Program's Adult Treatment Panel III; NHLBI, National Heart, Lung, and Blood Institute; SAH, systemic arterial hypertension; TG, triglycerides; WC, waist circumference.



**Figure 1** Prevalence of metabolic syndrome by age range according to different diagnostic criteria in the male population older than 40 years in Natal, Rio Grande do Norte. **Abbreviations:** AHA, American Heart Association; IDF, International Diabetes Federation; NCEP-ATPIII, National Cholesterol Education Program's Adult Treatment Panel III; NHLBI, National Heart, Lung, and Blood Institute.

>60 years, estimated the prevalence of MetS as 56.9, 53.4, and 50.3%, by the IDF, NCEP-ATPIII reviewed by AHA/NHLBI, and NCEP-ATPIII criteria, respectively. In a study, conducted by Saad et al,<sup>19</sup> of elderly population treated at the Outpatient Clinic of Internal Medicine and Geriatrics of Fundação Municipal de Saúde de Niterói, Rio de Janeiro, Brazil, the prevalence of MetS in males was 69.8, 60.3, 58.7, and 44.4% according to the Joint Interim Statement (JIS), IDF, World Health Organization (WHO), and NCEP-ATPIII criteria, respectively.

Kelliny et al<sup>23</sup> surveyed a sample representative of the general population aged 25–64 years in Seychelles, Africa, and found the prevalence of MetS in men to be 33.5% by the IDF criteria, 33.4% by the WHO criteria, and 31.9% by the NCEP-ATPIII criteria.

## MetS and criteria

MetS is a widely prevalent and multifactorial disorder and has been given several names such as insulin resistance (IR)

syndrome, plurimetabolic syndrome, Reaven's syndrome, syndrome X, and the deadly quartet.<sup>7</sup> There are various MetS definitions. The first formal definition of the MetS was proposed in 1998, by a consultation group for the definition of diabetes on behalf of the WHO.<sup>3</sup> A different criterion was proposed by the NCEP-ATPIII in 2001 establishing that, for the diagnosis of MetS, an individual must have at least three of the following five criteria: central obesity measured by WC (>102 cm), hypertriglyceridemia, low HDL-C, hypertension ( $\geq 130/85$  mmHg), and fasting hyperglycemia ( $\geq 110$  mg/dL).<sup>16</sup>

In 2005, the IDF produced another set of criteria for use both in epidemiology and in clinical practice worldwide, with the aims of identifying people with MetS, to clarify the nature of the syndrome and to focus on therapeutic strategies to reduce the long-term risk of CVD. The IDF established that, for the diagnosis of MetS, an individual must have central obesity, measured by the WC, with ethnicity-specific values as one required component and two other components

**Table 3** Prevalence of MetS according to different diagnostic criteria in the male population older than 40 years in Natal, Rio Grande do Norte

Criterion	Prevalence (%)	95% CI	
IDF/AHA/NHLBI	66.8	62.4	70.9
IDF	60.0	55.6	64.2
NCEP-ATPIII	46.4	42.0	50.9

**Abbreviations:** AHA, American Heart Association; IDF, International Diabetes Federation; MetS, metabolic syndrome; NCEP-ATPIII, National Cholesterol Education Program's Adult Treatment Panel III; NHLBI, National Heart, Lung, and Blood Institute.

(hypertriglyceridemia or low HDL-C or hypertension or fasting hyperglycemia) ( $\geq 100$  mg/dL).<sup>24</sup>

In 2009, both the IDF and AHA/NHLBI agreed that abdominal obesity should not be a prerequisite for diagnosis but that it should be one of the five criteria, so that the presence of any three of the following five risk factors constitutes a diagnosis of MetS: increased WC with ethnicity-specific reference values (eg, WC men  $\geq 94$  cm and women  $\geq 80$  cm in Caucasians), elevated TG ( $\geq 150$  mg/dL or 1.7 mmol/L) or drug treatment for elevated TG, decreased HDL-C ( $< 40$  mg/dL or 1.03 mmol/L in males;  $< 50$  mg/dL or 1.29 mmol/L in females) or drug treatment for reduced HDL-C, elevated FG ( $\geq 100$  mg/dL or 5.6 mmol/L) or drug treatment for elevated glucose, and elevated blood pressure ( $\geq 130/85$  mm Hg) or use of antihypertensive drugs in a patient with a history of hypertension.<sup>3</sup> In this study, the higher prevalence by the IDF/AHA/NHLBI and IDF criteria was probably due to the lower cutoff of WC and fasting glycemia established by them.<sup>3</sup>

In the United States, Ford et al<sup>26</sup> showed the prevalence of MetS in participants of the National Health and Nutrition Examination Survey, according to the JIS definition, to be higher with the JIS-94 definition (60.1%) than with the JIS-102 definition (59.3%) in men aged between 60 and 69 years. Alkerwi et al<sup>25</sup> found a prevalence of MetS in Luxembourg, according to the JIS definition, estimated from the ORISCAV-LUX study, also higher with the JIS-94 definition (68.3%) than with the JIS-102 definition (60.4%) in men aged between 60 and 69 years. The use of lower cutoff points of WCs is beneficial, as it raises the risk level for cardiometabolic disease among those identified as having the MetS<sup>27</sup> and then indicates the need for early cardiovascular risk reduction. This approach implies a large impact on preventive strategies and health care resources.

The different prevalence values for MetS found in these studies indicate the need to strongly consider the population ethnic aspects and regional habits. The findings demonstrate the difficulty in having a diagnostic criterion that is accurate,

sensitive, and specific and that can be useful for assessing the general population, overcoming the limitations of regional specificities. Oliveira et al<sup>28</sup> showed the prevalence of MetS in the population with rheumatoid arthritis treated at the Rheumatology Outpatient Clinic of Hospital Universitário Walter Cantídio of Universidade Federal do Ceará, Ceará, Brazil, to be 53.4% by the IDF criteria and 50% by the NCEP-ATPIII criteria. Xi et al<sup>29</sup> used data from the China Health and Nutrition Surveys in 2009 to describe the prevalence of MetS in China and showed that the prevalence in men according to revised NCEP-ATPIII criteria for Asians was 20.9%, according to IDF criteria was 16.2%, and according to the Chinese Diabetes Society criteria was 12.2%.

## MetS in Brazil

Similar to what has been found in Western countries, the prevalence of MetS is rapidly increasing in developing countries. In Brazil, studies estimating the prevalence of MetS for urban regions in the southeast reported 29.8% in 2007<sup>30</sup> and 25.4% in 2008<sup>31</sup> by the NCEP-ATPIII criteria, 35.5 and 46.0% in 2007<sup>21</sup> by the NCEP-ATPIII and IDF criteria respectively, 34.0% in 2011<sup>32</sup> by IDF criteria, 35.9 and 43.2% in 2011<sup>33</sup> by the NCEP-ATPIII and IDF criteria, respectively, and 45.2, 64.1, 69.1, and 51.9% in 2014<sup>19</sup> by the NCEP-ATPIII, IDF, Joint Interim Statement (JIS), and WHO criteria, respectively. According to the Brazilian region, the prevalences have been estimated as follows: in the Northeast, 50% by the NCEP-ATPIII criteria and 53.4% by the IDF criteria in 2016;<sup>28</sup> in the South, 50.3% by the ATPIII criteria, 53.4% by ATPIII reviewed by the AHA/NHLBI criteria, and 56.9% by the IDF criteria in 2009;<sup>22</sup> and in the Midwest region, 32.0% by the harmonized MetS criteria<sup>3</sup> in 2012.<sup>34</sup> In a rural population of southeastern Brazil, the MetS was found in 21.6% in 2007<sup>35</sup> and 14.9% in 2011<sup>36</sup> by the NCEP-ATPIII criteria, and in the northeastern region, the MetS was found in 24.8% by the NCEP-ATPIII criteria in 2006.<sup>37</sup> Among the indigenous population in the north, the MetS was found 34% by the NCEP-ATPIII and 43% by the IDF criteria in 2009,<sup>38</sup> and in the midwest region, the MetS was found 66.1% by the IDF/AHA/NHLBI criteria in 2015.<sup>39</sup>

## MetS and lifestyle

Kesse-Guyot et al<sup>8</sup> showed that the increased prevalence of MetS worldwide had been attributed to changes in lifestyle, particularly regarding new eating patterns and sedentarism. The study by Straif et al<sup>9</sup> found the growth in MetS prevalence due to the working hours that once occurred during daytime being extended in the last decades for a large number of

services and production areas. Knutson et al<sup>10</sup> reported that meals more often breakfast, lunch, and dinner and snacks in the intervals lead to better appetite control, greater effect of postprandial thermogenesis, largest mobilization of lipids due to repeated stimulation of the sympathetic nervous system, lower elevation in plasma glucose, and less variation in insulin levels and C-peptide, therefore maintaining the control of MetS. Wu et al<sup>11</sup> demonstrated that reduced sleep time (<6 h/day) was positively associated with MetS, while Gangwisch et al,<sup>12</sup> Meier-Ewert et al,<sup>13</sup> and Stamatakis and Punjabi<sup>14</sup> observed that decreased sleep duration has been linked to several metabolic disorders, such as glucose intolerance, IR, dyslipidemia, hypertension, and systemic inflammatory processes. Park et al<sup>15</sup> showed that the prevalence is higher in low-income people (mainly women), smokers, and sedentary men. The scientific literature supports the beneficial effects of low-calorie diet associated with physical exercise, reinforcing the importance of changing lifestyle in the management of MetS.<sup>40</sup>

## MetS and concordance analysis

Similar results of this study, about concordance analysis, were also observed in Brazil, where Saad et al<sup>19</sup> found a very good concordance between IDF and JIS ( $k=0.89$ ) and moderate concordance between IDF and NCEP-ATPIII ( $k=0.55$ ), NCEP-ATPIII and JIS ( $k=0.53$ ), WHO and NCEP-ATPIII ( $k=0.51$ ), WHO and IDF ( $k=0.47$ ), and WHO and JIS ( $k=0.45$ ). Alkerwi et al<sup>25</sup> in Luxembourg showed excellent concordance between JIS-94/80 and IDF ( $k=0.93$ ), between JIS-94/80 and NCEP-ATPIII ( $k=0.91$ ), and between IDF and NCEP-ATPIII ( $k=0.84$ ) criteria, but in the United States, the agreement was  $k=0.92$  between the NCEP-ATPIII and IDF criteria in postmenopausal women,<sup>26</sup> and in 2008, Kelliny et al<sup>23</sup> in Africa found excellent agreement between NCEP-ATPIII and IDF ( $k=0.82$ ) and moderate agreement between WHO and IDF ( $k=0.61$ ) and between WHO and NCEP-ATPIII ( $k=0.59$ ).

The difference in concordance between the MetS diagnostic criteria in different populations is probably due to ethnic characteristics, dietary habits, and lifestyle, thus making it difficult to use a single diagnostic criterion for all populations. Substantial socioeconomic and demographic changes that have occurred in the Brazilian population over the past decades have been associated with a deterioration of the metabolic profile because of adverse changes in lifestyle habits. Although the MetS has been a feature of urban westernized lifestyle, risk factors for CVD are now emerging as a major public health problem in the urban population of developing countries. The main focus of treating MetS is managing the risk factors with lifestyle changes that include losing

weight, following a heart-healthy diet, reducing one's blood pressure, improving one's cholesterol and blood sugar levels, getting more regular physical activity, and quitting smoking. Maintaining a healthy lifestyle is a lifelong commitment. Successfully controlling MetS takes a long-term effort and teamwork with health care providers. At the same time, early diagnosis, prevention, and management of MetS are considered the key approaches to reduce the risk of progression of atherosclerosis and the development of CVD.<sup>7</sup>

## Conclusion

We observed that the prevalence of MetS in the male population was high using the three diagnostic criteria and that IDF/AHA/NHLBI and IDF criteria have a high level of agreement. However, NCEP-ATPIII criteria identify a lower number of MetS cases. It is essential to evaluate the occurrence of MetS and its associated factors in order to contribute to the elaboration of health promotion public policies that have a significant impact on the prevention and treatment of T2DM and CVD.

Limitations of this study can be explained in part by the sample selection criterion, which comprised all the demand served in the Blue November Campaign. The Campaign may contribute to explain the gaps in men's health, addressing the risk factors of men aging in urban settings, poor eating habits, and sedentary lifestyle. While different regions may require further regional studies due to the characteristics of its populations to better assess their prevalence of MetS, main risk factors associated with men aging in urban settings are known and can be identified and intervened. The positive aspect was to note the importance of the Blue November Campaign as an opportunity to propose interventions for men's health care.

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## Disclosure

The authors report no conflicts of interest in this work.

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