

# Prevalence of Metabolic Syndrome in Japanese-Brazilians According to Specific Definitions for Ethnicity

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## Abstract

**Background:** The American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI), revising the National Cholesterol Evaluation Program for Adult Treatment Panel III (NCEP ATP III), and the International Diabetes Federation (IDF) have proposed definitions of metabolic syndrome that take into account waist circumference thresholds according to ethnicity. In this study we estimated the prevalence of metabolic syndrome in a Japanese-Brazilian population using NCEP definitions for Westerners (NCEPwe) and Asians (NCEPas), and IDF for Japanese (IDF).

**Methods:** A total of 650 Japanese-Brazilians living in a developed Brazilian city and aged 30–88 years were included.

**Results:** Metabolic syndrome prevalence according to NCEPwe, NCEPas, and IDF was, respectively, 46.5%, 56.5%, and 48.3%. Only 43.5% of subjects did not have metabolic syndrome by any of the 3 definitions, and 38.3% fulfilled metabolic syndrome criteria for all 3 definitions. Ten percent of subjects were positive for metabolic syndrome based on NCEPas and IDF, but not for NCEPwe. Because IDF requires abdominal obesity as a criterion, the frequency of subjects without metabolic syndrome according to IDF, but with metabolic syndrome by NCEPwe and NCEPas was 8.2%.

**Conclusions:** Independent of the metabolic syndrome definition, Japanese-Brazilians present an elevated metabolic syndrome prevalence, which was higher when using NCEP criteria for Asians, followed by the IDF definition for Japanese.

## Introduction

METABOLIC SYNDROME ENCOMPASSES SEVERAL COMPONENTS that predispose individuals to a higher risk of cardiovascular events, such as coronary artery disease, myocardial infarction, heart failure, and encephalic vascular accident, contributing to increased cardiovascular morbimortality.<sup>1</sup> Patients with metabolic syndrome are also at increased risk of developing type 2 diabetes mellitus (T2DM).<sup>2</sup> An essential component involved in the metabolic syndrome pathophysiology appears to be insulin resistance, with consequent hyperinsulinemia resulting mainly from excessive circulating free fatty acids. Obesity, particularly the visceral variety, has been considered a key component for developing insulin resistance.<sup>3,4</sup>

Asians have a greater tendency than Caucasians to deposit adipose tissue as abdominal visceral fat rather than abdominal subcutaneous fat.<sup>5,6</sup> Probably due to increased intraabdominal fat deposition, Japanese are susceptible to T2DM and cardiovascular disease despite a relatively normal body mass index (BMI).<sup>5,6</sup> Taking this into account, the International Diabetes Institute (IDI), a center that collaborates with the World Health Organization (WHO), proposed specific values to characterize total and abdominal obesity in Asian populations. Subjects with BMI values between 25.0 and 29.9 kg/m<sup>2</sup> and BMI  $\geq$ 30.0 kg/m<sup>2</sup> were classified as I and II degree obesity, respectively, and associated with moderate and severe risk for developing co-morbidities. Central obesity was defined as waist circumference  $\geq$ 90 cm in men and  $\geq$ 80 cm in women.<sup>7</sup>

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In recent years, the definitions commonly used in metabolic syndrome diagnosis have been shown to be not appropriate for Japanese and Asian populations. In recognizing genetic differences in the risk factors for developing metabolic syndrome-related diseases between diverse ethnicities, the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI), revising the National Cholesterol Evaluation Program for Adult Treatment Panel III (NCEP ATP III),<sup>2</sup> and the International Diabetes Federation (IDF)<sup>8</sup> established the same waist circumference cutoff values as proposed by the IDI for Japanese and other Asians to be used as criteria for defining metabolic syndrome in these populations.

There is a significant Japanese population in Brazil. The study of metabolic syndrome prevalence according to different diagnosis criteria is particularly interesting in Japanese-Brazilians because they represent a combination of genetic backgrounds for developing metabolic syndrome and "westernization" of lifestyle. In fact, previous studies have shown a high prevalence of both glucose metabolism disturbances<sup>9</sup> and metabolic syndrome<sup>10</sup> in this population. However, a prior study on metabolic syndrome prevalence in Japanese-Brazilians used metabolic syndrome definitions from both the 1998 WHO criteria and a modified set of 2001 NCEP criteria.<sup>10</sup> The WHO criteria, besides requiring evidence of insulin resistance for metabolic syndrome diagnosis, also included microalbuminuria evaluation and different cutoff values for metabolic syndrome components.<sup>11</sup> Because measures of insulin resistance and microalbuminuria are laborious, these criteria have not been used in more recent metabolic syndrome definitions. In the modified 2001 NCEP definition, investigators used waist circumference values for Japanese; however, glucose cutoff values were  $\geq 110$  mg/dL and hypertension and dyslipidemia drug treatments were not taken into account. In this study, we compare the prevalence of metabolic syndrome in a Japanese-Brazilian population using definitions recently proposed by IDF<sup>8</sup> for Japanese (IDF) and NCEP ATP III<sup>12</sup> revised by the AHA/NHLBI<sup>2</sup> for Westerners (NCEPwe), and Asians (NCEPas).

## Methods

### Subjects

This study included 650 Japanese-Brazilians, 292 men (44.9%) and 358 women (55.1%), aged between 30 and 88 years ( $60.3 \pm 12.5$ ), all residing in the city of Bauru, São Paulo State, Brazil. The participants were invited by mail, announcements on television, and in newspapers. The protocol was approved by the Research Ethics Committee of São Paulo Federal University Clinical Hospital, and all subjects provided written informed consent at the time of their initial visit to the Health Education Clinic of Sacred Heart University, Bauru, São Paulo State.

### Data collection

All data were collected between November, 2005, and February, 2006. The subjects participated in a medical interview and clinical examination. BMI was calculated as weight in kilograms divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ). Waist circumference measurements were taken using a point equidistant between the lower border of the last rib

and the iliac crest. Arterial blood pressure readings were measured with an automatic Omron automatic apparatus (HEM-712C, Omron Health Care Inc., Vernon Hills, IL). Venous blood was obtained after an overnight fast of at least 10 h. Glycemia and lipid fractions were measured using an automation kit system and apparatus from Boehringer-Mannheim<sup>®</sup> (Germany). Results of BMI classification and risk for developing co-morbidities are presented and discussed based on the IDI criteria for Asian populations.<sup>7</sup>

### Definitions of metabolic syndrome

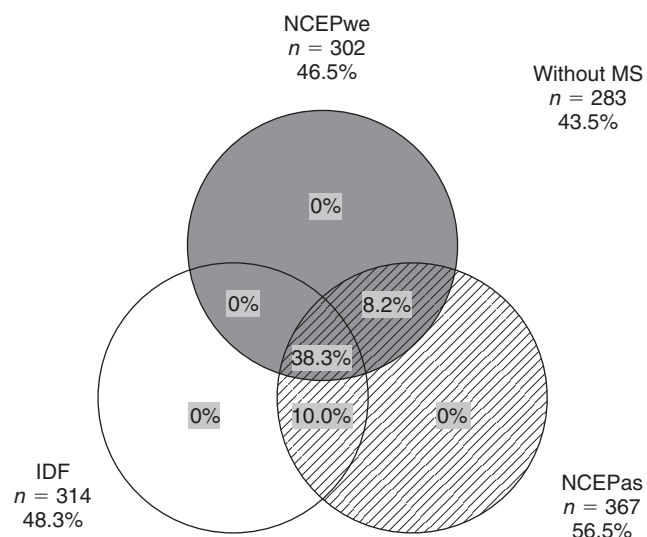
Subjects were considered to have metabolic syndrome according to NCEPwe and NCEPas when 3 or more of the following criteria were present<sup>2</sup>: fasting glycemia  $\geq 100$  mg/dL or under drug treatment for diabetes mellitus; systolic arterial blood pressure (SBP)  $\geq 130$  mmHg and/or diastolic arterial blood pressure (DBP)  $\geq 85$  mmHg or under drug treatment for arterial hypertension; triglycerides (TG)  $\geq 150$  mg/dL or receiving drug treatment for dyslipidemia; high-density lipoprotein cholesterol (HDL-C)  $< 40$  mg/dL in men and  $< 50$  mg/dL in women or under drug treatment for dyslipidemia; waist circumference  $\geq 102$  cm in men and  $\geq 88$  cm in women for NCEPwe, and waist circumference  $\geq 90$  cm in men and  $\geq 80$  cm in women for NCEPas. The IDF definition of metabolic syndrome for Japanese subjects differs from NCEPas only for the requirement for waist circumference to be increased, in addition to the presence of at least 2 of the other criteria.<sup>8</sup>

### Statistical analysis

Age, weight, height, BMI, and separated components of metabolic syndrome are expressed as mean and standard deviation (SD). Metabolic syndrome prevalence is presented in descriptive form. The nonpaired Student *t*-test was used for comparisons of age and BMI between genders. The prevalence of metabolic syndrome components according to gender and waist circumference was analyzed by the Goodman test for contrasts between and within multinomial populations.<sup>13</sup> All data were evaluated at a *P* level of 5%.

## Results

There was no difference between ages for men and women ( $60.6 \pm 13.3$  and  $60.0 \pm 11.9$  years, respectively). For the 650 study participants, mean body weight was  $61.4 \pm 12.4$  kg, height was  $157 \pm 9$  cm, BMI  $24.6 \pm 3.9$   $\text{kg}/\text{m}^2$ , and waist circumference  $88 \pm 10.4$  cm ( $92.0 \pm 9.9$  for men and  $84.8 \pm 9.6$  for women). SBP and DBP were  $138.2 \pm 21.8$  and  $81.0 \pm 12.0$  mmHg, respectively. Mean values for serum fasting blood glucose, TGs, and HDL-C were  $111.5 \pm 31.9$  mg/dL,  $162.3 \pm 136.2$  mg/dL, and  $53.6 \pm 13.1$  mg/dL ( $49.7 \pm 12.7$  for men and  $56.8 \pm 12.6$  for women), respectively. According to NCEPwe, NCEPas, and IDF definitions, the prevalence of metabolic syndrome was, respectively, 46.5% (men 47.3% and women 45.8%), 56.5% (men 60.6% and women 53.1%), and 48.3% (men 48.6% and women 48.0%). The Venn diagram in Fig. 1 shows that for the 650 Japanese-Brazilians examined, 38.3% had metabolic syndrome according to all 3 definitions, whereas 43.5% did not have metabolic syndrome by all definitions, comprising a concordance of 81.8% among the 3 definitions. The frequency of subjects without metabolic syndrome



**FIG. 1.** Venn diagram displaying the presence or absence of metabolic syndrome (MS) using the definitions of the National Cholesterol Evaluation Program for Adult Treatment Panel III for Westerners (NCEPwe), for Asians (NCEPas), and the International Diabetes Federation (IDF).

according to IDF criteria, but with metabolic syndrome by NCEPwe and NCEPas, was 8.2 %; metabolic syndrome prevalence by IDF and NCEPas, but without metabolic syndrome by NCEPwe, was 10.0%.

Table 1 shows the prevalence of obesity (degrees I or II) in individuals with and without metabolic syndrome according to the different metabolic syndrome definitions. Subjects with metabolic syndrome according to all 3 definitions had a significantly higher (76.7%) prevalence of obesity, followed by individuals with metabolic syndrome by IDF and NCEPas, but not according to NCEPwe (47.7%). The lowest obesity prevalences were found in subjects with metabolic syndrome by NCEPas and NCEPwe, but not by IDF (7.55%), and in individuals without metabolic syndrome by all 3 definitions (18.4%).

In our population, the prevalence of altered metabolic syndrome components was as follows: Waist circumference for Asians, 63.8%; waist circumference for Westerners, 25.7%; arterial pressure, 69.7%; glycemia, 61.5%; HDL-C, 34.6%; and

triglycerides levels, 44.5%. The prevalence of altered metabolic syndrome components was substantially higher in individuals with waist circumferences above the recommended cutoff values for Asians than for those with normal circumferences, except for fasting blood glucose in male individuals (Table 2).

Table 3 shows the prevalence of altered metabolic syndrome components according to the distribution of different waist circumference values stratified by gender. Altered fasting blood glucose or drug treatment prevalence was lower in women than in men at all similar waist circumferences, except for <80 cm. The prevalence of alteration in other metabolic syndrome risk factors was similar between men and women at the different waist circumferences, except for HDL, which was statistically higher in women at ≥85- and <90-cm waist circumferences.

**Discussion**

In this study we evaluated the prevalence of metabolic syndrome according to 3 different definitions in a population of Japanese-Brazilians living in a Brazilian city. Although there are several definitions of metabolic syndrome, we compared 3 widely used ones. These 3 are based on relatively similar components with differences in either cutoff values for waist circumference (NCEPwe ≠ NCEPas = IDF) or the requirement for abdominal obesity as 1 criterion (IDF). The main finding of this study is that, independent of the metabolic syndrome definition used, Japanese-Brazilians present an elevated metabolic syndrome prevalence (NCEPwe, 46.5%; NCEPas, 56.5%; and IDF, 48.3%).

The greatest metabolic syndrome prevalence was observed using NCEPas criteria, because it possesses lower cutoff values for waist circumference, similar to IDF. In contrast to IDF, however, NCEPas does not require the abdominal obesity component. Although in the NCEPwe definition the cutoff values for waist circumference are higher, metabolic syndrome prevalence was similar between IDF and NCEPwe definitions because NCEPwe does not require abdominal obesity to be present. The higher prevalence of metabolic syndrome by NCEPas than by IDF emphasizes that other components of metabolic syndrome may be present in the absence of abdominal obesity. It is important to point out that we measured waist circumference at the point midway between the inferior margin of the ribs and the superior border of the iliac crest, as recommended by IDF.<sup>8</sup>

**TABLE 1.** PREVALENCE OF OBESITY (BMI ≥25.0 kg/m<sup>2</sup>) ACCORDING TO THE DIFFERENT DEFINITIONS OF METABOLIC SYNDROME

	IDF (+) NCEPas (+) NCEPwe (+)	IDF (+) NCEPas (+) NCEPwe (-)	IDF (-) NCEPas (+) NCEPwe (+)	IDF (-) NCEPas (-) NCEPwe (-)
Subjects (n)	249	65	53	283
Obesity prevalence (%)	76.7	47.7 <sup>a</sup>	7.55 <sup>a,b</sup>	18.4 <sup>a,b</sup>

Goodman test.

<sup>a</sup>P < 0.01 vs IDF (+), NCEPas (+), and NCEPwe (+).

<sup>b</sup>P < 0.01 vs IDF (+), NCEPas (+), and NCEPwe (-)

Abbreviations: BMI, body mass index; IDF, International Diabetes Federation; NCEPas, National Cholesterol Evaluation Program definition for Asians; NCEPwe, National Cholesterol Evaluation Program definition for Westerners.

TABLE 2. PREVALENCE OF ALTERATION IN THE METABOLIC SYNDROME COMPONENTS IN THE PRESENCE AND ABSENCE OF CENTRAL ADIPOSITY

	Men		Women	
	Waist circumference (cm)		Waist circumference (cm)	
	<90	≥90	<80	≥80
Number (%)	124 (42.5%)	168 (57.5%)	111 (31.0%)	247 (69.0%)
Age (years, mean ± SD)	62.7 ± 13.6	59.0 ± 12.9 <sup>a</sup>	56.8 ± 12.8	61.5 ± 11.2 <sup>a</sup>
BMI (kg/m <sup>2</sup> , mean ± SD)	22.3 ± 2.2	27.6 ± 3.2 <sup>a</sup>	20.6 ± 1.9	25.6 ± 3.4 <sup>a</sup>
Arterial hypertension or DT (%)	68.5	79.8 <sup>a</sup>	45.0 <sup>b</sup>	74.5 <sup>a</sup>
FBG ≥100 mg/dL or DT (%)	68.5	78.0	42.3 <sup>b</sup>	55.5 <sup>a,c</sup>
HDL-C (men <40 and women <50 mg/dL) or DT (%)	24.2	40.5 <sup>a</sup>	25.2	40.1 <sup>a</sup>
TG (≥150 mg/dL) or DT (%)	38.7	61.9 <sup>a</sup>	22.5 <sup>b</sup>	45.3 <sup>a,c</sup>

Arterial hypertension, systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg. Goodman test for statistical analysis of the other variables. Student *t*-test for age and BMI comparisons.

<sup>a</sup>*P* < 0.05 vs. normal waist circumference.

<sup>b</sup>*P* < 0.05 vs. men with normal waist circumference (<90 cm).

<sup>c</sup>Versus men with increased waist circumference (≥90 cm).

Abbreviations: SD, standard deviation; BMI, body mass index; DT, drug treatment for the respective condition; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides.

However, according to the revised NCEP ATP III,<sup>2</sup> waist circumference should be measured at the top of iliac crest. Therefore, it is possible that metabolic syndrome prevalence using NCEPwe and NCEPas could in fact be higher.

The prevalence of metabolic syndrome in Japanese-Brazilians is considerably higher than reported in the literature. In a recently published study in Japan, the metabolic syndrome prevalence using NCEPas and IDF for Japanese subjects was, respectively, 18.9% in men and 12.9% in women, and 11.4% in men and 11.6% in women, respectively.<sup>14</sup> The prevalence of metabolic syndrome in Japanese-Americans and Japanese living in Japan was evaluated by Yoneda et al.<sup>15</sup> With the revised NCEP III criteria for Wersterners,<sup>2</sup> metabolic

syndrome prevalence in Japanese-Americans was 30.9% in men and 27.7% in women whereas in Japanese it was 13.4% in men and 14.4% in women.<sup>15</sup> The increased prevalence of metabolic syndrome seen in Japanese subjects living outside Japan probably illustrates the importance of lifestyle and its influence on metabolic syndrome development. Obesity, a key etiological factor for metabolic syndrome development, is directly influenced by nutritional habits.<sup>16</sup> As shown by Freire et al.<sup>17</sup> and Sartorelli et al.,<sup>18</sup> the current dietary pattern of Japanese-Brazilians contrasts with the traditional Japanese diet, particularly concerning the higher proportion of fat and refined grains intake and very high consumption of fruits and fruit juices.

TABLE 3. PREVALENCE OF ALTERED METABOLIC SYNDROME COMPONENTS STRATIFIED BY GENDER ACCORDING TO DIFFERENT WAIST CIRCUMFERENCE STRATA

		Waist circumference (cm)			
		<80	≥80 and <85	≥85 and <90	≥90
Number of subjects (%)	M	28 (9.6%)	32 (11.0%)	64 (21.9%)	168 (57.5%)
	F	111 (31.0%)	75 (20.9%)	66 (19.4%)	106 (29.6%)
Age (years, mean ± SD)	M	66 ± 14	61 ± 15	62 ± 13	59 ± 13
	F	57 ± 13 <sup>a</sup>	59 ± 11	60 ± 11	64 ± 11 <sup>a</sup>
Arterial hypertension or DT (%)	M	60.7	62.5	75.0	79.8
	F	45.0	66.7	74.2	80.2
FBG ≥100 mg/dL or DT (%)	M	57.1	65.6	75.0	78.0
	F	42.3	44.0 <sup>a</sup>	57.6 <sup>a</sup>	62.3 <sup>a</sup>
HDL-C (men <40 and women <50 mg/dL) or DT (%)	M	17.9	28.1	25.0	40.5
	F	25.2	38.7	45.5 <sup>a</sup>	37.7
TG (≥150 mg/dL) or DT (%)	M	21.4	43.8	43.8	61.9
	F	22.5	40.0	43.9	50.0

Arterial hypertension, systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg.

<sup>a</sup>*P* < 0.05 vs male; Student *t*-test for age comparison; Goodman test for statistical analysis of the other variables.

Abbreviations: SD, standard deviation; DT, drug treatment for the respective condition; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; M, male; F, female.



Although interesting, the comparison between metabolic syndrome prevalence in Japanese-Brazilians and the native population is difficult because there are only a few studies, some with small sample sizes<sup>19</sup> and others with different criteria for defining metabolic syndrome.<sup>20</sup> Using IDF criteria for a South American population, which have the same waist circumference cutoff values as Asians, a metabolic syndrome prevalence of 17.9% was found in 140 health subjects.<sup>19</sup> With NCEP ATP III using waist circumference cutoff values for Westerners, a metabolic syndrome prevalence of 25.4% was observed in 1,507 individuals from an urban Brazilian population.<sup>20</sup> These prevalences are lower than in our study on Japanese-Brazilians, suggesting genetic factors influence the high metabolic syndrome prevalence of Japanese-Brazilians.

Increases in BMI are also considered measures of risk for co-morbidities.<sup>21</sup> Using the BMI classification for Asians, we analyzed the prevalence of obesity I and II according to the different metabolic syndrome definitions. There was a high prevalence of obesity in those consistently diagnosed with metabolic syndrome by all 3 definitions (76.7%). In those concordant with metabolic syndrome definitions for Asians (NCEP<sub>As</sub> and IDF), but not for Westerners (NCEP<sub>We</sub>), the obesity prevalence was also elevated (47.7%). Obviously, subjects without metabolic syndrome according to the IDF criteria, but with metabolic syndrome by the NCEP<sub>As</sub> and NCEP<sub>We</sub> criteria, presented the lowest obesity prevalence (7.55%), because they did not have increased waist circumference. Because obesity is a fundamental factor for developing metabolic syndrome, these findings suggest that the NCEP<sub>We</sub> criteria should not be applied to Japanese-Brazilians. The 2000 National Nutrition Survey in Japan showed an overweight prevalence (BMI, 25.0–29.9 kg/m<sup>2</sup>) of 24.5% for men and 17.8% for women and an obesity prevalence (BMI, ≥30.0 kg/m<sup>2</sup>) of 2.3% for men and 3.4% for women.<sup>22</sup> If the BMI definition for Asians was taken into account, where those with BMI greater than 25.0 kg/m<sup>2</sup> are considered obese, the same National Nutrition Survey<sup>22</sup> would have shown an obesity prevalence of 26.8% in men and 21.2% in women. Obesity prevalence in our study was 51.7% for men and 35.5% for women (data not shown), which is much higher than in Japanese living in Japan.

As well as BMI, fat distribution also influences the risk of developing co-morbidities and cardiovascular morbimortality.<sup>21,23</sup> In this study, the prevalence of elevated abdominal fat (63.8%) was high. If cutoff values for Westerners had been used, the elevated abdominal fat would have been 25.7%, which is still higher than the abdominal obesity prevalence seen in Japanese living in Japan (7.4%).<sup>24</sup> We showed that abdominal obesity contributed to metabolic abnormalities as the prevalence of altered metabolic syndrome components was substantially higher in individuals with waist circumferences above the recommended cutoff values than for those with normal circumferences. The waist circumference cutoff value as a criteria for metabolic syndrome in Japanese is still a matter of controversy.<sup>25</sup> Our data suggest that the <90-cm cutoff value for men may be high, because we observed a significantly greater prevalence of altered metabolic syndrome components in men than women at normal waist circumference values (<90 cm for men and <80 cm for women). However, when evaluating the prevalence of altered metabolic syndrome components at similar waist circumferences, we observed that men presented a higher prevalence

of altered fast blood glucose or drug treatment than women at all the waist circumference strata except for <80 cm.

The prevalence of altered metabolic syndrome components was high in this study. Reinforcing the environmental influence on the metabolic syndrome pathophysiology, Japanese subjects residing in Japan aged between 30 and 80 years (men 52.3 ± 9.0 and women 53.5 ± 9.0 years old) presented a considerably lower prevalence of altered metabolic syndrome components. Fasting glycemia ≥110 mg/dL was found in 24.8% of men and 10.9% of women, low HDL in 6.6% of men and 9.2% of women, high TGs in 30.4% of men and 9.9% of women, and high blood pressure in 43.9% of men and 34.5% of women.<sup>26</sup> It was alarming to observe that mean fasting glycemia values in our population were higher than the cutoff value of 100 mg/dL for both genders. It was also disconcerting to see that the number of individuals with elevated systemic blood pressure was higher than over 10 years before in first- and second-generation Japanese-Brazilians (first generation, 24.7% in men and 30.7% in women, and second generation, 28.7% in men and 30.9% in women).<sup>27</sup> Furthermore, Japanese-Brazilians present a higher prevalence of systemic arterial hypertension than the general Brazilian population.<sup>28</sup>

In summary, in this study we used 3 different definitions to evaluate metabolic syndrome prevalence in Japanese-Brazilians living in a city of São Paulo State, Brazil. Independent of which definition was used, we found an elevated prevalence of metabolic syndrome in this population. Metabolic syndrome prevalence was highest when using the Asian NCEP criteria, followed by the Japanese IDF definition, with the Westerner NCEP criteria having the lowest prevalence. Additional studies are necessary to characterize the best definition of metabolic syndrome for Japanese subjects living outside Japan and exposed to different lifestyles.

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## Author Disclosure Statement

No competing financial interests exist.

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## Appendix

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