

Prevalence of Metabolic Syndrome in an Elderly Community: Comparison between Three Diagnostic Methods

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Summary

Background: The prevalence of the metabolic syndrome (MS) has shown wide variation in different studies, depending on the population sample and the diagnostic criteria used. The prevalence of MS tends to be higher with the diagnostic criteria of the International Diabetes Federation (IDF).

Objective: To compare the prevalence of MS using different criteria in an elderly community.

Methods: This was a cross-sectional population-based study conducted in the city of Novo Hamburgo - RS - Brazil, in which 378 elderly individuals, aged 60 years or over (252 women and 126 men) participated. The prevalence of MS was estimated using the National Cholesterol Education Program - Adult Treatment Panel III (NCEP ATP III) (2001), the revised NCEP ATP III (2005) and the IDF diagnostic criteria.

Results: The prevalence of MS increased progressively as we used the NCEP ATP III, the revised NCEP ATP III and the IDF criteria, with values of 50.3%, 53.4% and 56.9% respectively. The progressive increase in the prevalence of MS using the three criteria occurred in both genders, with a higher prevalence among women, with rates of 57.1%, 59.9% and 63.5% with the NCEP ATP III, the revised NCEP ATP III, and the IDF criteria, respectively.

Conclusion: The use of the IDF criteria resulted in a higher prevalence of MS in comparison to the prevalence found with the NCEP ATP III criteria and the revised NCEP ATP III criteria. The prevalence of MS was higher among women, regardless of the criteria used. (Arq Bras Cardiol 2009; 93(2) : 80-86)

Key Words: Metabolic syndrome; risk factors; aged, prevalence; abdominal circumference; blood pressure; cholesterol; blood glucose.

Introduction

Cardiovascular diseases currently represent the main cause of death worldwide. It is well known that diabetes mellitus (DM) is closely associated with an increased cardiovascular risk. The metabolic syndrome (MS), characterized by central obesity, dyslipidemia, hyperglycemia and borderline blood pressure, is now one of the greatest challenges to public health throughout the world, due to its association with major risks for cardiovascular diseases and type 2 diabetes. As the MS is a combination of multiple cardiovascular risk factors, the challenge in literature is to find out if the diagnosis of MS entails greater potential cardiovascular risk than the combination of its individual risk factors^{1,2}. Several diagnostic criteria for metabolic syndrome emerged in the last decade, aiming at the early identification of individuals at high risk of developing diabetes and cardiovascular diseases³. With older age, there is greater risk of MS, due to a tendency towards an

increasing prevalence of the syndrome components among the elderly⁴.

The MS was originally defined in 1998 by the criterion of the World Health Organization (WHO), which was based on the elevation of serum glucose levels⁵. From this glucose based concept of MS, used by the WHO, the definition evolved to the criteria of the National Cholesterol Education Program - Adult Treatment Panel III (NCEP ATP III), issued in 2001, in which the glucose is not considered an essential factor, but only a diagnostic component of the MS⁶.

When the relationship between central obesity and cardiovascular risk was confirmed, there was a tendency to give higher diagnostic value to that component of the MS. Therefore, in 2004, the International Diabetes Federation (IDF) issued a new definition of MS, in which central obesity, determined by the measurement of the waist circumference, was essential for the diagnosis^{7,8}. Using this definition, a higher prevalence of MS was observed in most populations, especially among the elderly⁹. In 2005, a revision of the MS diagnostic criteria, conducted by the American Heart Association and the National Heart, Lung, and Blood Institute (AHA / NHLBI), maintained the NCEP ATP III criteria, arguing that these criteria

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did not emphasize a single cause for MS and had easier application, only changing the cutoff point for fasting plasma glucose of 110 to 100 mg/dl, due to some adjustments that were determined by the American Diabetes Association (ADA) in the diagnosis of DM¹⁰. However, the I Brazilian Guidelines for Diagnosis and Treatment of MS-2005 still uses the NCEP ATP III diagnosis criteria of 2001¹¹.

By the IDF criteria, the abdominal circumference (AC) component is essential and has stricter values. However, in elderly patients, higher values of AC have been linked to lower values of BMI, when compared to what is observed in young adults¹².

The elderly are the population group with the highest prevalence of cardiovascular events. Therefore, determining the prevalence of MS among them is of great importance for establishing risk control measures. Moreover, there is greater risk for cognitive deficits among patients with MS, especially when blood glucose is a component of the MS¹³. There is also a two-fold higher risk for depression among women with MS, according to the revised NCEP criteria¹⁴. The scarcity of data on the prevalence of MS in our population, especially among the elderly, helps to justify the importance of this study.

Methods

Study participants were the elderly group allocated in the second stage of the "cross-sectional study on aging in Novo Hamburgo - RS - Brazil." Data were collected from January to July 2005. The first stage of the study was conducted in 2001, consisting of a random sample of 426 elderly patients: the sample size was estimated at 376 individuals for a confidence interval of 95% to a maximum acceptable difference of 5%, estimating a real prevalence of 50% in a population of 17,000 elderly individuals, with control adjustments for economic class, gender, age and area of residence, following the proportionality found in data from the IBGE 2000 Census, from a total of 17,101 city residents aged over 60 years.

For the second stage of the study, in 2005, there was an attempt to contact all participants of the first stage by phone or letter. The process of probability sampling applied in the two phases of the study (2001 and 2005) used the same criteria, controlled for age, sex, place of residence and economic class, which allowed the two populations to be homogeneous. Of the 426 elderly individuals, 16 had died, according to information from relatives, and 80 were not found. Of the remaining 330, 173 agreed to participate, and those who replaced the missing individuals were selected by the same criteria used in the first phase. After the replacement, 379 seniors accepted to participate in the study (127 men and 252 women), signing an informed consent form. For this study, 378 participants who had complete data in the database were included. The project was approved by the ethics committee of the Hospital St. Luke of the Catholic University of Rio Grande do Sul, Brazil.

An interview about the medical history of diseases and prior use of drugs, and a metabolic and functional assessment were conducted at the FEEVALE University Center. The metabolic-functional evaluation consisted of the measurement of weight, height, waist circumference and blood pressure by trained researchers. The weight and height were assessed

on a Welmy anthropometrical scale (Welmy™, Brazil). The BMI was calculated from weight in kilograms divided by the square of height in meters. The waist circumference was measured with tape, with the midpoint located between the last rib and the iliac crests, at the end of expiration, with the patient in a standing position. Blood pressure was measured twice in the left arm, with the patient in a sitting position, after 10 minutes of rest, with a previously calibrated aneroid sphygmomanometer, and the mean values were used.

The blood samples were taken after a minimum of 12-hour fasting, and they were subsequently analyzed in the Laboratory of Biomedicine at the FEEVALE University Center. Serum glucose, total cholesterol, HDL and triglycerides levels were measured with Labtest® kits. The samples were analyzed by the enzymatic colorimetric method in semi-automated equipment.

The diagnosis of MS was determined for each participant according to the different diagnostic criteria presented in Table 1. When the elderly patient was using medications to control high blood pressure, cholesterol or triglycerides levels, the presence of that MS component was considered positive, as previously established by the IDF and the NCEP ATP III definitions^{6,7,15}. The cutoff point used for AC, by the IDF criteria, was the same used for the European ethnic group, because the population descended from Europeans. In the NCEP ATP III criteria revised by the AHA/NHLBI the cutoff point for fasting plasma glucose was reduced from 110 mg/dL to 100mg/dL¹⁰.

Statistical procedures

We used the statistical program SPSS 13.0 (Chicago, IL) for data analysis. Continuous data were presented as mean \pm standard deviation or median (AIQ: P25 to P75), and categorical data as number and percentage. The tests which resulted in an alpha error of less than 0.05, double-tailed, were considered significant. For the analysis of the observed prevalence, we used the Z test for proportions. To compare the MS prevalence among men and women, we used the chi-square test.

Results

Study participants were 378 elderly individuals, 126 men and 252 women. The clinical characteristics of the population are shown in Table 2. Women had lower BMI and WC values than men. Blood pressure and blood glucose showed similar values for both genders. Regarding the lipid profile, total cholesterol, LDL-cholesterol and HDL-cholesterol levels were higher in women than in men. Median values of serum triglycerides were lower among men.

The prevalence of components according to different criteria for metabolic syndrome is shown in Figure 1. For those components that are common to all three criteria, the prevalence of the component hypertension among all elderly participants was 84%, compared to 81% among men and 86% among women. High levels of triglycerides, or the use of specific medication to treat hypertriglyceridaemia, were present in 34% of men and 38% of women, whereas a low HDL cholesterol level was present in 56% of men and 72% of women. The increased AC, by the NCEP/ATP III and the revised NCEP/ATP III criteria, was present in 29% of men and 56% of women, whereas by the IDF criteria it was present

in 56% of men and 77% of women. The component blood glucose ≥ 110 mg/dl or the diagnosis of diabetes was present in 14% of men and 17% of women, whereas the measurement of serum glucose ≥ 100 mg/dl or a previous diagnosis of diabetes was present in 27% of men and 26 % of women.

Table 1 - Diagnostic criteria of the metabolic syndrome

Components	ATP III	ATP III Rev	IDF
	Presence of 3 or more components	presence of 3 or more components	Abdominal C. (required) + 2 components
Abdominal C. (cm)			
Men	>102	>102	≥ 94 (European ethnicity)
Women	>88	>88	≥ 80
Blood Pressure (mmHg)	$\geq 130/85$	$\geq 130/85$	$\geq 130/85$
Glucose (mg/dl)	≥ 110	≥ 100	≥ 100
Triglycerides (mg/dl)	≥ 150	≥ 150	≥ 150
HDL Cholesterol (mg/dl)			
Men	< 40	< 40	< 40
Women	< 50	< 50	< 50

ATP III - Diagnostic Criteria of the Adult Treatment Panel III⁶; ATP III Rev - Diagnostic Criteria of the Adult Treatment Panel III revised by the American Heart Association and the National Heart, Lung, and Blood Institute¹⁰; IDF - Diagnostic Criteria of the International Diabetes Federation⁷; Abdominal C. - waist circumference.

The prevalence of MS and the clinical characteristics of participants with and without this diagnosis, according to different criteria, are presented in Table 3. We observed a progressive increase in the prevalence of MS using the NCEP ATP III, the revised NCEP ATP III and the IDF criteria,

Table 2 - Characteristics of the study population by gender

Characteristics	Men (126)	Women (252)	p
Age (years)	69 \pm 6	68 \pm 6	0.19
BMI (kg/m ²)	27.2 \pm 4.2	28.7 \pm 5.2	0.001
Abdominal waist circ. (cm)	96.4 \pm 11.1	90.6 \pm 11.7	<0.001
Blood pressure (mmHg)			
Systolic	143 \pm 26	144 \pm 24	0.76
Diastolic	83 \pm 12	84 \pm 14	0.52
Glucose (mg/dl)	96 \pm 38	95 \pm 38	0.82
Lipid Profile (mg/dl)			
Total cholesterol	186 \pm 45	213 \pm 50	<0.001
LDL cholesterol	117 \pm 42	136 \pm 43	<0.001
HDL cholesterol	40 \pm 13	45 \pm 10	<0.001
Triglycerides	114 (88 a 170)	129 (100 a 179)	0.06*

Data expressed as mean \pm standard deviation or median (AIQ: P25 to P75); * Variables were log transformed prior to analysis.

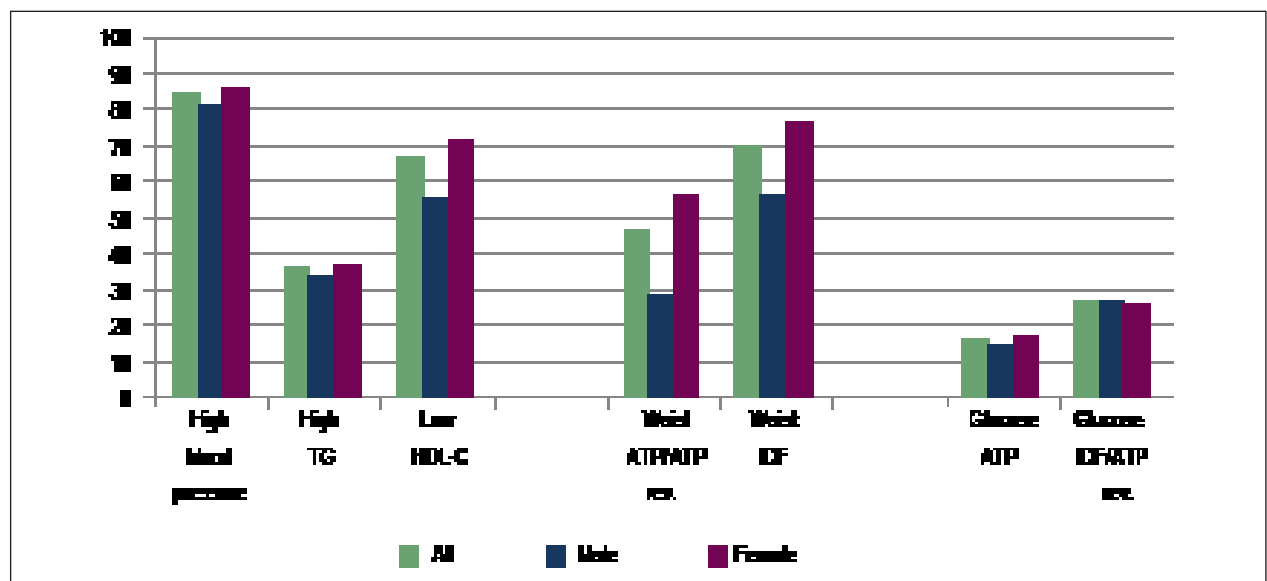


Figure 1 - Prevalence of the metabolic syndrome components in the population [high blood pressure: systolic pressure ≥ 130 mmHg or diastolic pressure ≥ 85 mmHg or use of antihypertensive drugs; high TG: serum triglycerides ≥ 150 mg/dL or use of specific medication to treat hypertriglyceridemia; low HDL-C: HDL-cholesterol < 40 mg/dL in men and < 50 mg/dL in women or use of specific medication to increase HDL-C; Waist ATP/ATP rev.: high abdominal waist by the criteria of the National Cholesterol Education Program (NCEP ATPIII) and the NCEP ATPIII revised by the American Heart Association and the National Heart, Lung, and Blood Institute: > 102 for men and > 88 for women; Waist IDF: abdominal waist high by the International Diabetes Federation criteria ≥ 94 cm for men and ≥ 80 cm for women, specific values for the European ethnicity; Glucose ATP: high blood glucose by the NCEP ATPIII criteria — fasting plasma glucose ≥ 110 mg/dL or previously diagnosed type 2 diabetes; Glucose IDF /ATP rev.: high blood glucose by the IDF and the revised NCEP ATPII criteria — fasting plasma glucose ≥ 100 mg/dL or previously diagnosed type 2 diabetes].

Table 3 - Characteristics of the patients with and without metabolic syndrome by the three diagnostic criteria (n = 378)

	ATP III		ATP III rev		IDF	
	MS+	MS-	MS+	MS-	MS+	MS-
Total of patients	190 (50.3)	188 (49.7)	202 (53.4)	176 (46.6)	215(56.9)	163 (43.1)
Age (years)	68 ±7	69 ±6	68 ±6	70 ±6	68 ±6	69 ±6
BMI (kg/m ²)	30.7 ±4.5	25.6 ±3.8	30.6 ±4.6	25.3 ±3.6	30.7 ±4.1	24.8 ±3.7
Waist Circ. (cm)	98.2 ±10.1	86.8 ±10.5	98.2 ±10.2	86.1 ±10.1	98.4 ±9.3	84.8 ±10.1
Blood Pressure (mmHg)						
Systolic	149 ±22	138 ±26	148 ±22.4	139 ±26.5	149 ±22	137 ±26
Diastolic	85 ±13	81 ±13	85 ±13	82 ±13	86 ±12	80 ±13
Glucose (mg/dl)	103 ±47	87 ±23	103 ±46	86 ±23	101 ±45	87 ±25
Lipid profile (mg/dl)						
Total Cholesterol	209 ±54	198 ±44	209 ±54	198 ±43	207 ±52	200 ±47
LDL cholesterol	130 ±43	129 ±43	130 ±44	130 ±42	131 ±43	129 ±44
HDL cholesterol	39 ±9	47 ±13	40 ±9	47 ±13	40 ±9	48 ±13
Triglycerides	165 (119 to 241)	104 (83 to 128)	163 (115 to 239)	105 (83 to 127)	151 (109 to 214)	108 (86 to 130)

Data expressed in numbers (%), mean ± standard deviation or median (AIQ: P25 to P75). ATP III - Diagnostic Criteria of the Adult Treatment Panel III⁶; ATP III Rev - Diagnostic Criteria of the Adult Treatment Panel III revised by the American Heart Association and the National Heart, Lung, and Blood Institute¹⁰; IDF - Diagnostic Criteria of the International Diabetes Federation⁷; MS - metabolic syndrome; BMI - body mass index.

with values of 50.3%, 53.4% and 56.9%, respectively. When comparing the prevalence of MS among the three criteria using the Z test for proportions, we could only find a significant difference between the diagnosis by the IDF criteria and by the NCEP ATP III criteria (p = 0.0341). However no significant difference was found in a comparison of prevalence between the NCEP ATP III criteria and Revised NCEP ATP III criteria (p = 0.1912), or between the latter and the IDF criteria (p = 0.1708).

It was observed that the BMI, regardless of the criteria used, was on average 30 kg/m² for the elderly with MS and 25 kg/m² for those without MS. In relation to the various components of MS, similar differences also occurred among the elderly with and without this diagnosis, independent of the criterion used.

Table 4 shows the prevalence of MS, by gender and age groups, according to the three criteria evaluated in the study. The progressive increase in the prevalence of MS using the NCEP ATP III, the revised NCEP ATP III and the IDF criteria occurred in both genders. When separated by gender, there was a higher prevalence of MS among women, with rates of 57.1%, 59.9% and 63.5% respectively. In the sample, we identified a relative risk for the diagnosis of MS in women compared to men of 1.57 (confidence interval CI 1.21 to 2.02) with the NCEP ATP III, of 1.48 (CI 1, 17 to 1.87) with the revised NCEP ATP III, and of 1.45 (CI 1.17 to 1.81) with the IDF criteria, all of them with p < 0.001. Among men the difference between the prevalence of MS by the various criteria occurred only in the age group of 70 to 79 years.

Discussion

The prevalence of MS in this representative sample of elderly individuals in the community was very high. Moreover, there was a progressive increase in the prevalence using the criteria of the NCEP ATP III, the revised NCEP ATP III and IDF, up to 43.3% among men and 63.5% among women with the latter criteria.

In the literature, we found a wide variation in the prevalence of MS in the elderly, probably depending on the profile of the population and the criteria used, ranging from 11.3% in women and 12.5% in men aged over 70 years, using the NCEP ATP III criteria in a French representative study of the population, and up to 69% in a Greek study, also population-based, conducted among the elderly, using the IDF criteria^{16,17}.

In a geriatric service in Turkey, the prevalence of MS among the 1,255 subjects aged 65 years or over was 24% by the NCEP ATP III criteria¹⁸. In a study conducted in the Colombian city of Bogota that involved patients selected from a treatment clinic of hypertensive patients, aged 40 or over, using the NCEP ATP III criteria, the prevalence was 19% among men and 30% among women¹⁹. In the city of Oporto, Portugal, among a representative sample of adults in the city, the prevalence was 35% in men and 33% in women, also using the NCEP ATP III criteria²⁰. In Italy, a cohort population-based study conducted in a representative sample of elderly individuals aged over 65 years living in the community, found a prevalence of MS of 33% in men and 20% in women by the NCEP ATP III criteria²¹.

Table 4 - Prevalence of metabolic syndrome by the three diagnostic criteria according to gender and age groups.

Age group (years)	Men (n = 126)				Women (n = 252)			
	n	ATPIII	ATP III rev.	IDF	n	ATPIII	ATP III rev.	IDF
60 – 69	72	29 (40,3)	29 (40,3)	28 (38,9)	160	93 (58,1)	99 (61,9)	106 (66,3)
70 – 79	43	11 (25,6)	16 (37,2)	21 (48,8)	86	48 (55,8)	48 (55,8)	51 (59,3)
≥ 80	11	6 (54,5)	6 (54,5)	6 (54,5)	6	3 (50,0)	4 (66,7)	3 (50,0)
Total	126	46 (36,5)	51 (40,4)	55 (43,6)	252	144 (57,1)	151 (59,9)	160 (63,5)

Data expressed in numbers (%); ATP III - Diagnostic Criteria of the Adult Treatment Panel III⁶; ATP III Rev - diagnostic criteria of the Adult Treatment Panel III revised by the American Heart Association and the National Heart, Lung, and Blood Institute¹⁰; IDF - diagnostic criteria of the International Diabetes Federation⁷.

In the population aged over 60, in China, a high prevalence of MS (54% in women and 35% in men) was found using the IDF criteria, whereas by the NCEP ATP III criteria these rates were reduced to 39% and 18%, respectively²². Among a community group of Australians over 70 years, of European ethnicity, the prevalence of MS by the IDF criteria was 36% in men and 46% in women⁹. Among the Italians living in Florence, aged over 60 years, there was also a higher prevalence of MS by the IDF criteria (52.8%) in comparison to the revised NCEP criteria (33.1%)²³.

A cross-sectional study, with 7 years of monitoring, conducted in Londrina, Paraná, assessed the association of MS by the NCEP ATP III criteria and abdominal obesity with cardiovascular risk in elderly women. Of the 516 elderly women included in the study, aged between 60 and 84 years, 206 (39.9%) had the diagnosis of MS. In the period, there were 94 (18.2%) cardiovascular events (48 fatal and 46 non-fatal). After adjusting for confounding variables, the metabolic syndrome and waist-hip ratio above the 75th percentile (> 0.98) were predictors of outcomes, with hazard ratios (HR) of 1.66 and 1.72, respectively. The increased AC (> 96 cm) was not a statistically significant predictor (HR 1.37, $p = 0.12$)²⁴.

We can see, therefore, a wide variation in the prevalence of MS in different populations, indicating the need for local studies to define the prevalence in different populations and ethnic groups. When compared to other population-based studies, in this study there was a high prevalence of MS.

In the literature we found a trend of increasing prevalence of MS when using the IDF criteria. Determining the impact of an increase in diagnoses of MS on the incidence of coronary events in older people is fundamental, but this was not the objective of this study. In a population-based study involving adults aged 18 to 65 years, the IDF and the NCEP ATP III diagnostic criteria were compared as predictors of cardiovascular outcomes in 10 years. In that study, it is interesting to note that the NCEP ATP III criteria had a higher predictive value for cardiovascular risk than the IDF criteria in the German population, although more cases of MS were diagnosed by the latter criteria²⁵. Therefore, which diagnostic criteria estimate better the risk of cardiovascular events in the elderly is yet to be defined.

In our sample, we observed a high prevalence of blood pressure $\geq 130 \times 85$ mmHg, with 84% of individuals presenting this diagnostic component of MS. Despite the low cutoff

point, we know that the risk of developing cardiovascular complications varies with the values of blood pressure, and the risk of these conditions increases as blood pressure rises above 110×75 mmHg²⁶. The impact of this single component of MS on cardiovascular risk in the elderly should still be better defined.

The elevation of TG has been independently associated with an increased risk of cardiovascular events²⁷⁻²⁹. In this study, triglyceride levels ≥ 150 mg/dl were present in only 34% of men and 38% of women, despite the apparent high risk profile of the study population.

The prevalence of factor AC had great variations according to the criteria used: NCEP ATP III / revised NCEP ATP III or IDF. As expected, with the lower cutoff point used by the IDF there was a higher prevalence of this component when those criteria were used. Central obesity has been associated with an increased risk of cardiovascular morbidity and mortality. Even among those with normal weight, central adiposity may increase the risk of diabetes, hypertension, atherosclerosis and, among women, also of breast cancer. Furthermore, the increase in waist circumference seems to be a good predictor for the development of hypertension and dyslipidemia³⁰, and it is also associated with the risk of acute myocardial infarction³¹. The association between AC and the values of visceral fat should be characterized for each population, with different cutoff points. As an example, the Japanese and South Asian Indians have higher rates of total and visceral fat, which leads to greater risk of developing diabetes for a given value of BMI, in comparison to the Europeans³². Similar studies indicated the need to use different cut-off points for AC, according to each ethnic group, serving as a theoretical basis for the IDF criteria. It has not been clearly defined yet if these stricter cut-off points better predict the incidence of future cardiovascular events, especially in the elderly, as in this population higher values of AC are associated with lower values of BMI, in comparison to young adults. This finding may be related to the tendency of greater accumulation of abdominal fat in the elderly. Moreover, among the elderly, the AC and the BMI may have an inverse association with mortality¹².

In the sample, the AC was, on average, 12 cm larger among individuals with the diagnosis of MS by the NCEP ATP III / Revised NCEP ATP III criteria, and 14 cm, by the IDF criteria. Despite these differences, the average values of AC were not very high in both genders, which certainly was associated with a reduction in the prevalence of MS, particularly by the

IDF criteria, although a high prevalence has been found. This high prevalence was mainly due to the high frequency of the other components of MS.

Finally, blood glucose ≥ 110 mg/dl or diabetes was present in only 14% of men and 17% of women in this study. When using the revised NCEP ATP III or the IDF criteria, or using the stricter cut-off point for blood glucose (≥ 100 mg/dl), the prevalence increased, as expected, reaching 27% among men and 26% among women. There are evidences that the elevation of serum glucose is associated with increased cardiovascular risk. There is also no doubt about the relationship between the diagnosis of diabetes and glucose intolerance with the atherosclerotic process. In the *Nurses' Health Study*, a 3.17 times increased risk of AMI was observed before the diagnosis of diabetes in a follow up of 20 years³³. A meta-analysis also showed that there is an increased cardiovascular risk associated with the presence of glucose intolerance. Moreover, when comparing individuals who have fasting blood glucose of 75 mg/dl with those who have 110mg/dl, an increase of 33% in the risk of cardiovascular events was observed³⁴. Therefore, we can highlight the importance of the glucose increases in the cardiovascular risk, even in a range previously considered normal.

It is yet to be defined, with follow-up studies, if the higher prevalence of MS found in this study, using the stricter IDF criteria, is actually associated with a better prediction of cardiovascular events than when the NCEP ATP III criteria are used.

In this study, when the population of the elderly was distributed by age and gender, there was loss of power due to the small size of the groups, especially in the age group above 80 years, and, consequently, there was loss in the generalization ability of the compiled data.

Conclusion

The prevalence of the metabolic syndrome among the elderly was more representative in the community using the IDF criteria, followed by the revised NCEP ATP III criteria and NCEP ATP III criteria. Moreover, the prevalence of the metabolic syndrome was always higher among women in the studied population sample, regardless of the criteria used.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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