



## HEALTH SCIENCES

# Prevalence of metabolic syndrome and its association with risk factors in patients with established atherosclerosis disease

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**Abstract:** Risk factors can lead to clinical conditions, like metabolic syndrome, that predisposes the development of cardiovascular diseases. The aim of this study was to describe the prevalence and which risk factors cause more impact in metabolic syndrome in patients with established atherosclerosis disease. A cross-sectional study was performed as a subanalysis of Programa Alimentação Cardioprotetora Brasileira. Weight, height, waist circumference, blood pressure, lipid profile and fasting glucose were collected. Metabolic syndrome was defined according to the harmonized criteria. Linear regression was used to analyze the association between number of components of metabolic syndrome and risk factors. 82 patients were included and the prevalence of metabolic syndrome was 84.1%. Being overweight was associated with an increase by 0.55 point in diagnostic criteria of metabolic syndrome in crude analysis (95%CI 0.09-1.00) and 0.64 in adjusted analysis (95%CI 0.18-1.09), while former/current smoker status was responsible for raising by 0.48 the number of components of metabolic syndrome, only in adjusted analysis (95%CI 0.04-0.92). Overweight and former/current smoker status are associated with MS, increasing the probability of atherosclerotic events. A healthy lifestyle, that includes avoiding tobacco exposure and proper weight control, must be encouraged in this high-risk population.

**Key words:** cardiovascular diseases, overweight, risk factors, smoking.

## INTRODUCTION

Cardiovascular diseases (CVDs) remain the primary cause of deaths worldwide (World Health Organization 2011). Behavioral risk factors such as tobacco consumption, unhealthy diet and physical inactivity can lead to clinical conditions that predispose CVD development (World Health Organization 2011). Metabolic syndrome (MS) is a clustering of those clinical conditions and has been extensively studied, because it provides a metabolic profile, that is better than to just analyze one parameter (Cornier et

al. 2008). Mostly, the criteria for MS diagnosis are hypertriglyceridemia, high blood pressure, abdominal obesity, increasing fasting glucose and low levels of high-density lipoprotein (HDL) (Cornier et al. 2008). Furthermore, some characteristics like gender, age, education and tobacco consumption can influence the risk of MS, not just in its individual components (Yu et al. 2015). A systematic review and meta-analysis identified that risk of CVD death is more than two fold higher in individuals with MS (Mottillo et al. 2010). Besides the identification, control and prevention of MS components, the evaluation of

risk factors is also important. Therefore, the aim of this study was to describe MS prevalence and identify which risk factors cause more impact in MS in a sample of patients with established atherosclerosis disease.

## **MATERIALS AND METHODS**

### **Study design and population**

A cross-sectional study was conducted and represents a sub-analysis of Programa Alimentação Cardioprotetora Brasileira, a randomized, multicenter and national trial, with the purpose to reduce cardiovascular events and risk factors in secondary prevention for CVD, funded by Hospital do Coração (HCor) as part of the Hospitais de Excelência a Serviço do SUS (PROADI-SUS) Program, in partnership with the Brazilian Ministry of Health. The pilot and the protocol studies have been published previously (Weber et al. 2012, 2016). The data presented here was collected from patients in one of the participating centers, Pelotas-RS, at baseline. The study included patients aged 45 years or older, with evidence of established atherosclerosis disease in the preceding 10 years: (a) coronary disease (defined by previous myocardial infarction, stable or unstable angina, history of atherosclerotic stenosis  $\geq 70\%$  of the diameter of any coronary artery on conventional or computed tomographic (CT) coronary angiography, or history of angioplasty, stenting, or coronary artery bypass surgery); (b) previous stroke; (c) peripheral vascular disease (ankle/arm ratio  $< 0.9$  of systolic blood pressure in either leg at rest, angiography or Doppler demonstrating  $> 70\%$  stenosis in a cardiac artery, intermittent claudication, vascular surgery for atherosclerotic disease, amputation due to atherosclerotic disease, or aortic aneurysm). The exclusion criteria were: neurocognitive or psychiatric conditions; life expectancy less than

6 months; pregnancy or lactation; liver failure with history of encephalopathy or anasarca; renal failure with indication for dialysis; congestive heart failure; previous organ transplantation; wheelchair use; or any restrictions to receiving an oral diet. Eligible subjects were selected from cardiology outpatient clinic and teaching hospitals, from August 2013 to December 2014. The local ethics committee (n.287.722) approved the study, and all participants provided written informed consent prior to inclusion.

### **Variables and measurement instruments**

#### *Anthropometric measurements*

The patients were weighted with a Filizola digital scale model PL 150 (100Kg capacity, 100g precision) and measured with a 100cm height rod (1mm precision) attached to the scale. Waist circumference was obtained by tape measure, at midway between the lowest rib and the iliac crest using an anthropometric tape, with an accuracy of 0.1 cm. Body mass index (BMI) was calculated from weight (kg) divided by squared height (m). Patients were classified according to presence or absence of overweight, according to World Health Organization criteria for subjects under 60 years (overweight  $\geq 25\text{kg/m}^2$ ) or using Pan American Health Organization (PAHO) criteria for elderly (overweight  $\geq 28\text{kg/m}^2$ ) (Peláez et al. 2000, World Health Organization 1995).

#### **Assessment of blood pressure, biomarkers and clinical data**

Blood pressure was assessed by auscultatory method. Total cholesterol, HDL, triglycerides and fasting glucose were determined by automated enzymatic method, using the equipment ROCHE, model INTEGRA COBAS PLUS 400, and low-density lipoprotein (LDL) was estimated by Friedewald equation (Friedewald et al. 1972). Clinical history was collected from patient

records and complemented by interview when necessary.

### Metabolic syndrome definition

Metabolic syndrome was defined according to a harmonizing definition of international organizations (Alberti et al. 2009). In accordance for MS diagnosis, individuals must present three or more of the following criteria: waist circumference  $\geq 94$  cm for men or  $\geq 80$  cm for women; triglycerides  $\geq 150$  mg/dL; HDL  $< 40$  mg/dL for men or  $< 50$  mg/dL for women; systolic blood pressure  $\geq 130$  mmHg or diastolic blood pressure  $\geq 85$  mmHg, or treatment of previously diagnosed hypertension; fasting glucose  $\geq 100$  mg/dL.

### Other variables

Economic levels were categorized according to the Brazilian Criteria of Economic Classification of the Associação Brasileira de Empresas de Pesquisa into groups A, B, C, D and E (Associação Brasileira de Empresas de Pesquisa 2012). Education was evaluated in years studied, divided in the following items: illiterate (no study), elementary school (complete or incomplete), high school (complete or incomplete) and college (complete or incomplete).

### Statistical analysis

Categorical variables were described as absolute and relative frequencies. Differences between presence or absence of MS were evaluated using chi-square test. To analyze the association between number of components of MS and risk factors, crude and adjusted analyses were performed using linear regression model. Potential confounding variables were included in fully adjusted regression models, such as, overweight and education. A p-value  $< 0.05$  was regarded as statistically significant. The analyses were performed using Stata 12.1 (Stata Corp., College Station, Texas, USA).

## RESULTS

A total of 82 patients (54 male and 28 female) were included. The prevalence of MS was 84.1%. Table I shows the characteristics examined in this study according to the presence of MS. Most of the sample were elderly (53.7%), from level C of economic classification (62.0%), and studied until elementary school (83.3%), had family history of CVD (76.8%), were former or current smoker (69.5%) and had overweight (72.0%). There were no significant differences between individuals with and without MS (Table I).

The prevalence of the components of MS are in Table II. All sample had elevated blood pressure, whereas hypertriglyceridemia was the less prevalent component (30.5%) (Table II).

The crude and adjusted coefficients of association between socio-demographic and nutritional characteristics and number of components of MS are presented in Table III. Just overweight ( $p=0.006$ ) and former/current smoker ( $p=0.032$ ) were significantly associated. Overweight was responsible for an increase by 0.55 point in the diagnostic criteria of MS in the crude analysis ( $\beta=0.55$ ; 95%CI 0.09-1.00) and 0.64 in the adjusted ( $\beta=0.64$ ; 95%CI 0.18-1.09), while former/current smoker was responsible for raising by 0.48 the number of components of MS, only in adjusted analysis ( $\beta=0.48$ ; 95%CI 0.04-0.92) (Table III).

## DISCUSSION

The prevalence of MS is increasing worldwide (Alberti et al. 2009). Whereas MS and its components are known as cardiovascular risk factors, is expected that prevalence of this syndrome be higher in patients with CVD than in general population. In Brazil, a systematic review showed that MS was present in almost 30% of the population (De Carvalho Vidigal et al.

**Table I. Sociodemographic, clinical and anthropometric characteristics of patients with established atherosclerosis disease in Pelotas, RS, 2013-2014.**

Variables	N (%)	Metabolic syndrome N(%)		*p
		YES	NO	
Gender				
Male	54 (65.9)	44 (63.8)	10 (76.9)	0.359
Female	28 (34.1)	25 (36.2)	3 (23.1)	
Age				
Adults	38 (46.3)	32 (46.4)	6 (46.2)	0.988
Elderly	44 (53.7)	37 (53.6)	7 (53.9)	
Economic levels				
A/B	13 (18.1)	10 (17.0)	3 (23.1)	0.873
C	47 (65.3)	39 (66.1)	8 (61.5)	
D/E	12 (16.7)	10 (17.0)	2 (15.4)	
Education				
Illiterate	19 (26.8)	14 (24.1)	5 (38.5)	0.122
Elementary school	44 (62.0)	39 (67.2)	5 (38.5)	
High school/College	8 (11.3)	5 (8.6)	3 (23.9)	
Family history of CVD				
No	19 (23.2)	16 (23.2)	3 (23.1)	0.993
Yes	63 (76.8)	53 (76.8)	10 (76.9)	
Former/current smoker				
No	25 (30.5)	20 (29.0)	5 (30.5)	0.496
Yes	57 (69.5)	49 (71.0)	8 (61.5)	
Overweight				
No	23 (28.1)	17 (24.6)	6 (46.2)	0.113
Yes	59 (72.0)	52 (75.4)	7 (53.9)	

\* Chi-squared test. CVD-cardiovascular diseases.

2013). In our sample, MS was diagnosed in 84.1%, similar to a study performed in Brazilian cardiac patients (Quirino et al. 2014).

Previous studies demonstrated that the prevalence of MS was different among some variables, such as gender, age, education, BMI and levels of physical activity (Deedwania et al. 2014, Moreira et al. 2014, Yu et al. 2015). In this study, prevalence of MS was similar

among distinct sociodemographic, clinical and anthropometric characteristics.

Regarding the components of MS, the order of prevalence was elevated blood pressure (100%), abdominal obesity (86.6%), low HDL (78.0%), increased fasting glucose (75.6%) and hypertriglyceridemia (30.5%) (Table II). The reason for all patients presented hypertension could be through 1) hypertension is the leading cause of CVD (World Health Organization 2011);

**Table II. Prevalence of components of the metabolic syndrome in patients with established atherosclerosis disease in Pelotas, RS, 2013-2014.**

Components	Prevalence
Elevated blood pressure	100%
Abdominal obesity	86.6%
Low HDL	78.0%
Increased fasting glucose	75.6%
Hypertriglyceridemia	30.5%

**HDL- low density lipoprotein.**

2) as shown before, the majority of our sample was composed by elderly (with a mean age of 61.0 years) and aging is responsible for artery stiffness, that predispose to hypertension (Lee & Oh 2010).

Previous studies tried to identify the influence of some risk factors in the prevalence of MS. Yu et al. (2015) and Tachebele et al. (2014) demonstrated that women have a higher risk of developing MS, whereas Sobko et al. (2014) found that male were at increased risk. This could be explained through the age of people in study, since the prevalence of MS increases with menopause and depending of the age of women, the prevalence can change (Jouyandeh et al. 2013). Despite prevalence of MS in this study was not different between gender and did not affect the number of components of MS, it is important to remind that MS was present in 89.3% of women and 81.5% of men.

Regarding education and economic levels, there is not a consensus in literature (Marotta et al. 2007, Moreira et al. 2014, Sobko et al. 2014, Yu et al. 2015, Zhan et al. 2012). In a study with hypertensive adults, individuals graduated from high school or above were 1.30 more likely to have MS (Yu et al. 2015). On the other hand, in a study performed with elderly, the odds ratio for MS was 0.28 for people in the highest education group (Marotta et al. 2007). Zhan et al.

(2012) identified that individuals of middle and higher levels of household monthly income had a protective effect for MS. In a study performed in Brazil, no significant difference in social classes was found (Moreira et al. 2014). Alkerwi et al. (2012) showed that only family history of diabetes and hypertension were associated with MS, while previous myocardial infarction and cerebrovascular accident in family were not associated, similar to the results of this work.

Risk factors were also analyzed to understand if they were associated with the number of MS components. Overweight raised the risk of have MS. The association between body weight and prevalence of MS has been demonstrated before, in different ways. In study performed by Yu et al. (2015), the risk of MS was higher in obese subjects. Another study showed that prevalence of MS increases as well BMI rises (Binh et al. 2014). Tachebele et al. (2014) using two diagnosis criteria showed that an abnormal BMI (low or high) provided a higher risk to develop MS. In accordance to the results of this study, Sobko et al. (2014) found a higher risk to MS in individuals with overweight. To highlight the importance of body weight in MS, a longitudinal study concluded that the development of MS was slower in subjects without overweight (Hwang et al. 2007).

In the studying sample, was also found that be former or current smoker increased the risk of develop MS. Tobacco results in some consequences that affect the components of MS, like: impairment of insulin resistance, reduction in HDL levels and function of reverse transport, increase in triglycerides and waist circumference (Chen et al. 2008, Chiolo et al. 2008, Xie et al. 2010, Zong et al. 2015). Wada et al. (2007) observed that the risk of develop MS increased with the smoking number and MS remained for at least 10 years in subjects who smoked 20 or more cigarettes per day. That finding explains the

**Table III. Crude and adjusted analyses for number of components of metabolic syndrome according to sociodemographic, clinical and anthropometric characteristics of patients with established atherosclerosis disease in Pelotas, RS, 2013-2014.**

Variables	Crude analysis		Adjusted analysis	
	Coef. $\beta$ (CI)	p	Coef. $\beta$ (CI)	p
Gender				
Female	Ref		Ref	
Male	-0.08 (-0.53; 0.36)	0.707	-0.0007 (-0.51; 0.51)	0.998
Age				
Adults	Ref		Ref	
Elderly	-0.01 (-0.04; 0.008)	0.21	-0.005 (-0.03; 0.02)	0.704
Economic levels				
A/B	Ref		Ref	
C	0.09 (-0.53; 0.73)	0.753	-0.20 (-0.86; 0.44)	0.526
D/E	0.21 (-0.59; 1.01)	0.602	-0.16 (-1.01; 0.69)	0.706
Education				
Illiterate	Ref		Ref	
Elementary school	0.09 (-0.45; 0.64)	0.729	0.07 (-0.44; 0.60)	0.767
High school/College	-0.50 (-1.34; 0.33)	0.234	-0.43 (-1.25; 0.38)	0.288
Family history of CVD				
No	Ref		Ref	
Yes	0.03 (-0.46; 0.53)	0.890	0.23 (-0.25; 0.72)	0.343
Former/current smoker				
No	Ref		Ref	
Yes	0.37 (-0.08; 0.82)	0.106	0.48 (0.04; 0.92)	0.032*
Overweight				
No	Ref		Ref	
Yes	0.55 (0.09; 1.00)	0.018*	0.64 (0.18; 1.09)	0.006*

\*Test for heterogeneity T test. CI 95%- 95% confidence interval; CVD-cardiovascular diseases;  $\beta$ -regression coefficient.

results of this work, showing that tobacco use brings toxic effects to health for years. Although former smokers have a higher risk for MS than people who never smoked, smoking cessation improves the components of MS (Chen et al. 2008). Weight gain is a potential complication of smoking cessation, and health professionals should be prepared to mitigate it (Hishida et al. 2009).

There are some limitations. First, the sample size was small. Second, a cross-sectional study cannot provide sufficient evidence of causality. Third, studies use different criteria to diagnosis MS, which can difficult the comparison of results.

## CONCLUSION

Overweight and former/current smoker status are associated with MS, increasing the probability of atherosclerotic events. A healthy lifestyle, that includes avoiding tobacco exposure and proper weight control, must be encouraged in this high-risk population.

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Aline Longo, Eduardo Bertoldi, Lúcia Borges and Renata Abib designed the study. Aline Longo and Bruna Ribas collected data. Silvana Orlandi performed the statistical analysis. Aline Longo, Eduardo Bertoldi, Lúcia Borges and Renata Abib wrote the paper. Bernardete Weber is the principal investigator of Programa Alimentação Cardioprotetora Brasileira and contributed also for this manuscript.

