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Metabolic syndrome: physical inactivity and socioeconomic inequalities among non-institutionalized Brazilian elderly

Síndrome metabólica: inatividade física e desigualdades socioeconômicas entre idosos brasileiros não institucionalizados

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ABSTRACT: ***Objective:*** Evaluate the association between Metabolic Syndrome (MetS), physical activity and socioeconomic conditions among non-institutionalized elderly individuals. ***Methodology:*** Cross-sectional study with, elderly individuals (≥ 60) living in the city of São Paulo. MetS was evaluated by means of the National Cholesterol Education Program criteria, the Adult Treatment Panel III. Descriptive and bivariate analyses were performed, followed by multiple logistic regression with a 5% significance level. An attributable fraction (AF) and a proportional attributable fraction (PAF) were calculated in relation to physical activity. The magnitude of the socioeconomic inequalities was evaluated using the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII). ***Results:*** The prevalence of MetS was 40.1%, and 23.3% of the individuals had at least one MetS' component. Physically inactive elderly had higher chances of having MetS. The prevalence of MetS was higher among those with lower education levels in both absolute and relative terms. AF and PAF were significant among the inactive individuals and for the total population. ***Conclusion:*** This study demonstrated that physical activity and schooling are significantly associated with MetS, highlighting the importance of these factors for the control of this syndrome.

Keywords: Metabolic syndrome. Physical activity. Socioeconomic Factors. Elderly.

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RESUMO: ***Objetivo:*** Avaliar a associação da síndrome metabólica (SM) com a atividade física e as condições socioeconômicas entre idosos não institucionalizados. ***Metodologia:*** Estudo transversal com idosos (≥ 60) não institucionalizados e residentes na cidade de São Paulo (SP). A SM foi classificada com base nos critérios da National Cholesterol Education Program Adult Treatment Panel III. Realizou-se analise descritiva e bivariada seguida por regressão logística múltipla com nível de significância de 5%. Calcularam-se a fração atribuível (FA) e a fração atribuível proporcional (FAP) e determinou-se a magnitude das desigualdades por meio do índice absoluto de desigualdade e pelo índice relativo de desigualdade. ***Resultados:*** A prevalência de SM foi de 40,1%, e 23,3% dos idosos apresentavam pelo menos um componente da síndrome. A chance de SM foi maior entre os idosos fisicamente inativos. Idosos menos escolarizados apresentaram prevalências de SM significativamente maiores em termos absolutos e relativos. As FA e FAP entre os inativos e na população foram significativos. ***Conclusão:*** Este estudo demonstrou que a prática de atividade física e a escolaridade são fatores significativamente associados à SM, reforçando a importância desses fatores para o controle dessa síndrome.

Palavras-chave: Síndrome metabólica. Atividade física. Fatores socioeconômicos. Idoso.

INTRODUCTION

Metabolic syndrome (MetS) is a challenging clinical condition for public health[1]. It is characterized by a set of pathophysiological changes that simultaneously act to increase the risk of developing cardiovascular diseases (CVD), type 2 diabetes mellitus (DM)[2] and death (NCEP-ATP III 2001). Individuals affected by this syndrome are twice as likely to develop CVD and five times more likely to develop DM compared to those without MetS[1]. The elderly is the group with the highest prevalence of unfavorable cardiovascular outcomes[3-5].

Recent studies show an increasing evolution of MetS, with prevalence ranging from 25% in countries in the Middle East[6] to 50.2% in India[7]. In Brazil, the review presented by Vidigal et al.[8] showed a prevalence of 29.6% (14.9–65.3%). Recently, Vieira et al.[9] found a prevalence of 32% among adults and elderly residents in the city of São Paulo (SP).

MetS is a widely studied condition, but there are different criteria that define it[1,10,11]. Among them, the most widely used is the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) 2001[11], as it is more accessible for clinical practice and epidemiological research[12,13] and because it is considered to be a better risk predictor of cardiovascular events when compared to other criteria[4,14]. In Brazil, this is the criterion proposed by the I Brazilian Guideline for the Diagnosis and Treatment of Metabolic Syndrome[15]. In this criterion, the syndrome is defined as the presence of three or more of the following criteria: central obesity, arterial hypertension, insulin resistance, low high-density lipoprotein (HDL) and high triglyceride (TG). These components come from modifiable risk factors (*ex.*, sedentary behavior, unhealthy eating, physical inactivity) that result in the accumulation of adipose tissue and the progression of obesity[16].

Regular activity can reduce the chance of developing MetS by 31%[17]. However, an increase in physical inactivity from the age of 40[18,19] and the lower adherence to programs to encourage physical activity among the elderly[17,20] contribute to the expansion of the prevalence of MetS in this group[21].

In addition to factors related to lifestyle, different studies have shown that the occurrence of MetS is associated with socioeconomic inequalities[8,22-27]. These are characterized by the higher prevalence of the syndrome and its components among individuals belonging to the groups in the worst socioeconomic conditions when compared to those in the best conditions[8,25]. When these differences are unjust and avoidable, they are defined as inequities[28].

The most recent report on health conditions issued by the World Health Organization (WHO) in 2018 highlights that the chronic noncommunicable diseases (NCDs) that make up MetS are increasing, and it highlights the need for studies on the risk factors associated with these conditions in order for control measures to be adopted[29]. Although the association between MetS, physical activity[30] and socioeconomic conditions[8] is quite often described, an analysis of the literature reveals that there is a gap in the assessment of factors associated with MetS in developing countries, especially among the elderly, who are in the fastest growing group in the world population and have the highest incidence of the syndrome[1,8,25,31].

Thus, this study was carried out with the objective of evaluating the association of MetS with physical activity and socioeconomic conditions among non-institutionalized Brazilian elderly.

METHODOLOGY

A cross-sectional study was carried out based on data from the Health, Well-Being and Aging (*Saúde, Bem-Estar e Envelhecimento* - SABE) 2010 study.

The SABE study was started in 2000 as a multi-center study developed in seven countries in Latin America (Argentina, Cuba, Uruguay, Barbados, Mexico, Chile and Brazil) and the Caribbean, with the aim of evaluating and comparing the health condition of people 60 years old or older at different stages of aging. In Brazil, the study was conducted in the city of São Paulo, with a representative sample of community-dwelling people aged 60 or over. In 2006, only in Brazil, SABE was transformed into a longitudinal study of multiple cohorts with follow-up at intervals of approximately five years. Information about the study and sampling has been previously published[32].

In 2010, 1,333 elderly people were interviewed and underwent physical examinations. This study included 1,201 individuals and 143 (9.9%) were excluded due to the lack of information on any of the variables of interest. There was no significant difference between those included in this study and those excluded in relation to sex, age, education level and number of self-reported diseases.

DEPENDENT VARIABLE

MetS was classified based on the criteria adopted by the NCEP ATP III[11]. According to this criterion, three or more of the following characteristics are required to determine if it's present:

- abdominal obesity measured by waist circumference (≥ 102 cm for men; ≥ 88 cm for women);
- TG (≥ 150 mg/dL);
- reduction of HDL-cholesterol (<40 mg/dL for men; <50 mg/dL for women);
- increased systolic blood pressure (SBP) (≥ 130 mmHg) and/or diastolic blood pressure (≥ 85 mmHg);
- fasting blood glucose (≥ 110 mg/dL).

INDEPENDENT VARIABLES

The variables considered in the study were: sociodemographic factors (age [60 to 64, 65 to 69, 70 to 74 and 75 or more], sex, marital status [with marital relationship including married or cohabited individuals and no marital relationship including divorced, separated, and single individuals] and education [0 to 3 years (insufficient education), 4 to 7 years (incomplete elementary school) and 8 years or more (completed elementary school or more)])[33,34], health conditions (number of NCDs, depressive symptoms and self-rated health status (good (good and very good) and bad (normal, bad and very bad))) and health behavior (physical activity).

The practice of physical activity was assessed using the reduced version of the International Physical Activity Questionnaire (IPAQ)[35]. This instrument aims to verify what types of physical activity people do as part of their daily lives. The questions relate to their time spent doing physical activity in the last week, including physical activity carried out at work, commuting from place to place, physical activity for leisure, for sport, for exercise or as part of their activities at home or in the garden. Elderly people who performed at least 150 minutes a week of moderate physical activity or 75 minutes a week of vigorous activity were considered to be active, according to WHO recommendations[36].

The number of NCDs was assessed based on the answer to the following question: Has a doctor or nurse ever told you that you have (name of the disease)? The diseases questioned were: heart disease (congestive disease, coronary heart disease or infarction), joint disease (arthritis, rheumatism or arthrosis), stroke, diabetes, high blood pressure and chronic obstructive pulmonary disease.

Depressive symptoms were assessed using the Geriatric Depression Scale in an abbreviated format. Individuals with six or more points on the scale were considered to have depressive symptoms[37].

ANALYSIS OF THE DATA

A descriptive analysis of the sample was performed according to the outcome and all independent variables, followed by a bivariate analysis between MetS and the independent variables. The association between categorical variables was tested using the chi-square test with a Rao-Scott correction[38].

All variables that presented $p < 0.20$ in the bivariate analysis were included in the multiple logistic regression model. The results were presented using odds ratios and respective 95% confidence intervals (CI). Based on the results of the multiple regression model, the attributable fraction (AF) and proportional attributable fraction (PAF) relating to the practice of physical activity were calculated as previously proposed[39-41]. The first, when expressed as a percentage, indicates the proportion of cases that can be attributed to exposure in exposed individuals and in the population. The second represents the proportion of cases of MetS that could have been avoided in those exposed and in the population, if the exposure were eliminated or changed.

The magnitude of inequalities was assessed by means of absolute and relative measures using, respectively, the absolute index of inequality (slope index of inequality - SII) and the relative index of inequality (RII)[42,43], with education used as a measure of socioeconomic position. Each socioeconomic group was assigned a value that corresponds to the midpoint of the cumulative distribution of the socioeconomic position measure[43]. The SII and RII indices were obtained by regressing the health variable over a relative position score, which was obtained by measuring the socioeconomic position in increasing order, from the worst (score equal to zero) to the best socioeconomic situation (score equal to one). The SII is the absolute difference in the prevalence of MetS among the elderly with the highest socioeconomic position (higher level of education) and those with the lowest socioeconomic status (lower level of education). The RII is the prevalence ratio (relative inequality) between groups in the higher and lower socioeconomic position. An SII value below zero and an RII value less than one indicate that the prevalence of MetS is higher among the group in the lowest socioeconomic position. All analyses were performed using the Stata 13.0 program (Stata Corporation, College Station, TX, United States) using the command *survey*, which allows for the consideration of the complex structure of the sampling process. All analyses were performed considering the sample weights.

ETHICAL ASPECTS

The SABE study was approved by the Research Ethics Committee of the School of Public Health of the University of Sao Paulo.

RESULTS

The sample consisted of elderly people aged 60 or over, with a mean age of 70.32 years (95%CI 69.03 - 71.62), with the majority of them being female, in a marital relationship, with 0 to 3 years of study, and regular practice of physical activity.

The prevalence of MetS was 40.1% (95%CI 37.1 - 43.2). Regarding the components associated with the diagnosis of MetS, 23.3% (95%CI 20.8 - 25.9) of the elderly had at least one condition, with the increase in SBP being the most prevalent (66.1%; 95%CI 62.8 - 69.2) (Table 1).

Through the bivariate analysis, it was found that MetS was associated with two sociodemographic conditions (age and sex). The prevalence was higher among the elderly who did not perform physical activity and who had a greater number of chronic diseases (Table 2).

Based on the multiple regression model, it was found that the chance of having MetS was significantly lower among older individuals and among those who were physically active. Physically active individuals were 33% less likely to have MetS when compared to those who were not active. The results showed that more educated individuals had significantly less chances of MetS when compared to those with 0–3 years of study (Table 3). There was no interaction between physical activity and education.

Through the analysis of inequalities using the absolute and relative inequality indices, it was observed that less educated individuals had significantly higher prevalence of MetS in absolute and relative terms [SII = -0.12 (95%CI -0.231; -0.017) and RII = 0.73 (95%CI 0.535 - 0.931)].

Figure 1 shows the AFs and PAFs for the population and among those exposed. From the AF analysis, it can be seen that the difference in the prevalence of MetS between the active and inactive elderly in the population is 3.71% (95%CI 1.53 - 5.88). Among the inactive, the AF was 8.75% (95%CI 3.59 - 13.87). With regard to PAF, 9.27% (95%CI 3.56 - 14.65) of cases of MetS could have been prevented if all of the elderly in the population were active. Among the inactive, 19.9% (95%CI 8.33 - 28.94) of the cases would have been prevented.

Table 1. Prevalence of the components of metabolic syndrome (MetS) and the number of components.

	% (95%CI)
Components of MetS	
Altered waist circumference	50.4 (47.1 - 53.7)
Elevated triglyceride	30.1 (28.5 - 33.8)
Altered blood glucose	28.6 (25.7 - 31.6)
Altered HDL	42.9 (39.6 - 46.3)
Altered DBP	34.0 (30.7 - 37.5)
Altered SBP	66.1 (62.8 - 69.2)
Number of METS components	
0	9.7 (7.8 – 12.0)
1	23.3 (20.8 – 25.9)
2	26.9 (24.1 – 29.9)
3	24.7 (22.1 – 27.5)
4	10.6 (8.9 – 12.5)
5	4.8 (3.7 – 6.1)

95%CI: 95% confidence interval; HDL: high density lipoprotein; DBP: diastolic blood pressure; SBP: systolic blood pressure.

Table 2. Descriptive and bivariate analysis according to the independent variables.

	Total	Metabolic syndrome
	% (95%CI)	% (95%CI)
Sociodemographic		
Sex		
Male	39.3 (36.3 – 42.3)	35.7 (31.4 – 40.3)[a]
Female	60.7 (57.7 – 63.7)	42.9 (38.4 – 47.6)
Age		
60–64	31.6 (23.9 – 40.4)	50.0 (44.9 – 55.1)[c]
65–69	22.8 (15.8 – 31.8)	40.6 (33.9 – 47.7)
70–74	18.2 (14.9 – 22.1)	34.0 (28.7 – 39.7)
75 +	27.4 (21.7 – 33.8)	32.3 (27.9 – 36.9)
Marital status		
No marital relationship	45.5 (41.6 – 49.4)	37.0 (31.6 – 42.8)
Marital relationship	54.5 (50.6 – 58.4)	42.7 (38.3 – 47.1)
Education level		
0-3 years	35.9 (31.2 – 41.0)	43.0 (38.2 – 47.9)
4–7 years	37.0 (33.6 – 40.5)	38.5 (34.2 – 42.9)
8 + years	27.1 (22.2 – 32.6)	38.5 (31.7 – 45.8)
Health behaviors		
Physical activity		
Active	58.3 (53.7 – 62.8)	36.3 (32.3 – 40.5)[c]
Not active	41.7 (37.2 – 46.3)	45.5 (41.5 – 49.5)
Health conditions		
Depressive symptoms		
No	81.4 (78.3 – 84.2)	37.8 (34.6 – 41.1)[a]
Yes	18.6 (15.8 – 21.7)	47.1 (39.9 – 54.4)
Number of diseases (average)	1.63 (1.54 – 1.72)	1.94 (1.80 – 2.08)[c]
Health self-assessment		
Good	49.4 (45.4 – 53.4)	35.6 (31.5 – 40.0)[b]
Poor	50.6 (46.6 – 54.6)	44.6 (40.3 – 49.0)

95%CI: 95% confidence interval; [a]p <0.05; [b]p<0.01; [c]p<0.001.

DISCUSSION

This study used a representative sample of non-institutionalized elderly to evaluate the prevalence of MetS based on the criteria of the NCEP ATP III[11] and to evaluate its association with physical activity and socioeconomic conditions. It was observed that 40% of the population met the criterion for MetS. The main findings demonstrate the existence of socioeconomic inequalities related to MetS and the significance of physical activity as a preventive factor, as demonstrated by the AFs, data hitherto unavailable in the Brazilian literature for the elderly population.

The prevalence found in this study is high, but lower than that observed among elderly people from countries that, like Brazil, are in the process of social and economic development. In Mexico the prevalence was 72.9%, using the criteria of the American Heart Association/National Heart, Lung and Blood Institute[44]. In Ecuador, it was observed that 66.0% of women and 47.1% of men presented the syndrome, according to the criteria of the Joint Interim Statement[45]. On the other hand, in China, a prevalence of 22.8% was demonstrated according to the NCEP ATP III[46] criterion. When compared to the prevalence in developed countries, it appears that the prevalence observed in this study was lower than that observed among women and men aged 60–69 years in the United States, 55.4 and 59.3%, respectively[47]. However, as previously mentioned, it should be noted that the differences between the estimates are also associated with the different criteria used in the studies.

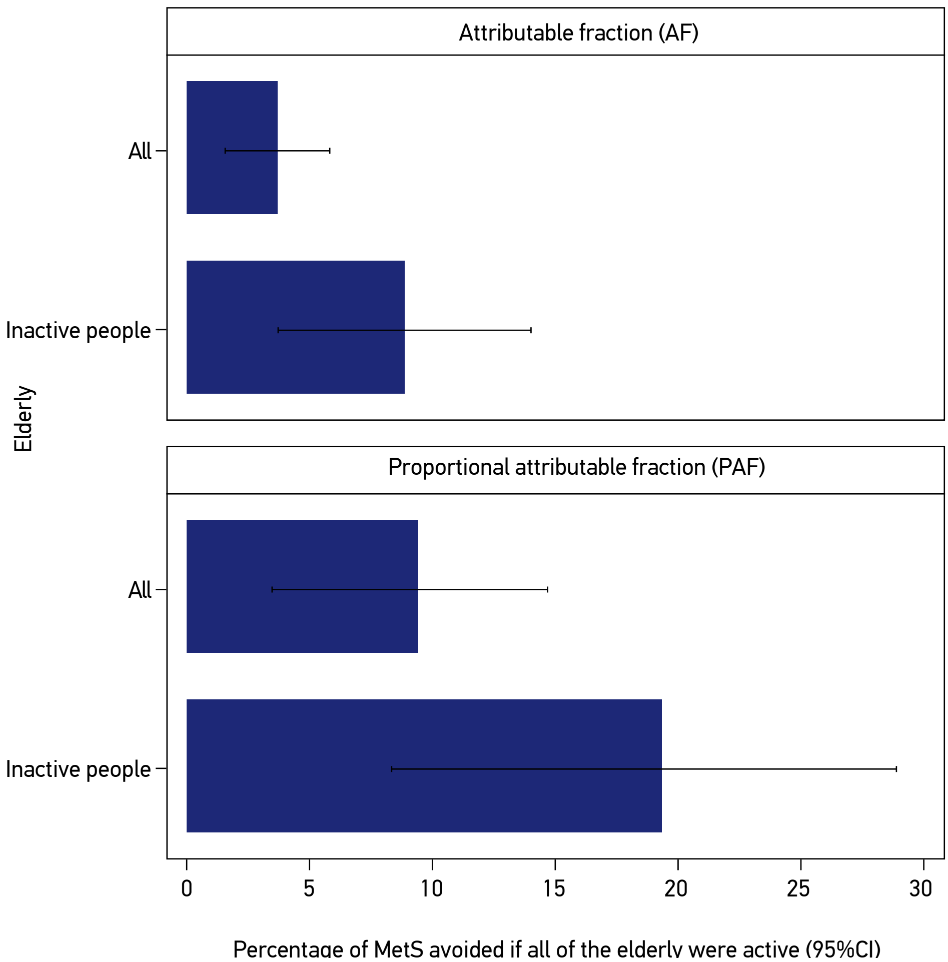
Table 3. Multiple logistic regression model for factors associated with metabolic syndrome.

	Metabolic syndrome	
	OR (95%CI)	p
Sex (male) *		
Female	1.25 (0.90 – 1.74)	0.162
Age (60-64 years old) *		
65–69	0.52 (0.35 – 0.77)	0.001
70–74	0.37 (0.26 – 0.52)	< 0.001
75 +	0.29 (0.21 – 0.40)	< 0.001
Education level (0-3 years)*		
4-7years	0.74 (0.56 – 0.98)	0.036
8 + years	0.69 (0.48 – 0.96)	0.033
Physical activity (no)*		
Active	0.67 (0.53 – 0.84)	0.001
Number of diseases	1.54 (1.37 – 1.73)	< 0.001

95%CI: 95% confidence interval; OR: odds ratio; *reference category.

There is no national estimate of the prevalence of MetS in the literature, especially for the elderly population. The available studies report prevalence rates between 30[48] and 69.8%[49]. The Brazilian population survey that investigated the prevalence of MetS (14.2%) did not estimate the specific prevalence for the elderly population and defined the presence of two or more conditions as MetS, which is different from this study[50].

Physical inactivity is the third major risk factor for mortality among the factors proposed by the WHO for the control of CVD[51]. Wu et al.[17] verified that regular activity can reduce the chance of developing METS by 31%. Corroborating these findings, in this study, active elderly presented a 33% less chance of having MetS when compared to non-active elderly individuals. In addition, this study has made an advancement by demonstrating the impact of physical activity as a preventive measure.



CI95%: 95% Confidence Interval

Figure 1. Attributable fraction and proportional attributable fraction to physical inactivity in the prevalence of metabolic syndrome (MetS).

Estimates of proportional AFs demonstrate that prevention strategies aimed at the population and inactive individuals could prevent around 9 and 20% of MetS cases, respectively, if these people were active. Physical activity as a way of preventing NCDs is extremely important, and for this reason, the reduction of physical inactivity was included as one of the goals of the Strategic Action Plan for Coping with Chronic Non-Communicable Diseases in Brazil, which was implemented by the Ministry of Health, and aims to reduce this risk factor by 10% by the year 2025[52,53].

With regard to socioeconomic conditions, results from different studies are consistent in showing a higher prevalence of MetS among people with lower income[54] and educational level[55] and worse occupations[22]. Similarly, in this study, it was observed that elderly people with fewer years of schooling were more likely to have MetS. Additionally, this research contributes to the literature by demonstrating that the magnitude of socioeconomic inequalities was significant from an absolute and relative point of view. Thus, this finding reinforces the proposal of other authors who suggest that socioeconomic condition should be included as a modifiable risk factor in local and global health strategies and policies[51] and reaffirms the theory that there is a socioeconomic and cultural gradient in determining chronic diseases[52,53].

According to Stringhini et al.[51], the impact of socioeconomic conditions on health is similar to that of the six key risk factors adopted by the WHO for the prevention of chronic diseases. It suggests the importance of addressing not only proximal risk factors, but also structural solutions, which involve investment in early childhood education and work incentive programs, which is an economic mechanism to reduce health inequalities.

Literature analysis shows a positive association between MetS and age in the adult population[8,56-59]. However, among the elderly, studies show that there is no association with age[60] or there is a reduction in prevalence with increasing age[61,62]. Longitudinal studies have found that the prevalence of MetS increased with age up to the age range of 60 to 69 years, with a reduction in the older age groups and absence of differences between these age groups[62]. Khosravi-Boroujeni et al.[61] observed an increase in the prevalence of MetS with increasing age up to 75 years, when a decline was observed. In addition, longitudinal analyses of the Japanese population have shown that there is a cohort effect related to the prevalence of MetS in which the younger cohorts have higher prevalences[62].

As such, the results of this study are in accordance with the literature. The age groups above 65 years are less likely to have MetS when compared to the elderly aged 60 to 64 years old, and there was no gradient between higher age groups. Among the reasons for the lower chance of MetS in the older age groups, the reduction in appetite and abdominal obesity associated with age have been proposed[61,63,64]. In addition, premature death due to conditions associated with MetS would lead to the maintenance of a healthier elderly cohort[54,61].

Among the strengths of this study is the use of a representative sample of non-institutionalized elderly people in Brazil's largest city, using criteria that is comparable to other international studies in order to assess the prevalence and factors associated with MetS. In addition, this study was innovative by demonstrating the impact of the practice of activity as a preventive measure. The cross-sectional design and the impossibility of inferring the direction of the associations are among the limitations of the study. The self-reporting of diseases can also be considered one of the limitations, but this measure is considered to be valid[65]. In addition, it is worth noting that in this study only education level was used as a measure of socioeconomic status. Thus, studies using other measures may find different results regarding the magnitude of inequalities, given that each socioeconomic measurement has a way to explain these differences[66, 67].

CONCLUSION

This study demonstrated that the practice of physical activity and education level are factors that are significantly associated with MetS. This association reinforces the role of physical activity as a first-line non-pharmacological treatment to control this condition[68,11] due to its direct relationship with all of the syndrome's components[11]. In addition, the existence of socioeconomic inequalities related to MetS calls attention to the need for prevention policies to be based on approaches that consider these differences, and go beyond the other factors that are commonly explored, since both the practice of physical activity[69] and the other modifiable factors, are disproportionately inaccessible to the nation's poorest people[70].

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