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Original Research

Association of sedentary behavior and metabolic syndrome

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ABSTRACT

Objectives: To examine the association of sedentary behavior (SB) with metabolic syndrome (MetS) in adults, as well as to identify the impact of physical inactivity and economic condition on such association.
Study design: This is a cross-sectional study.
Methods: This study was conducted in the city of Bauru, São Paulo State, Brazil ($n = 970$). Television (TV) viewing and physical activity (PA) were assessed by questionnaire. MetS was assessed via medical records. Descriptive statistics and binary logistic regression were used in data analyses.
Results: Participants with moderate TV viewing were associated with MetS when compared with low TV viewing group, even after adjustments for age, sex, economic status, smoking, and PA (odds ratio [OR] = 1.49 [95% confidence interval {CI}: 1.01–2.20]). The fully adjusted model showed an association between high exposure to TV viewing with MetS (OR = 1.77 [95%CI: 1.11–2.82]). The combination of physical inactivity and high TV viewing boosted the likelihood of having MetS (OR = 1.89 [95%CI: 1.08–3.29]).
Conclusion: The results of the present study suggest that moderate and high TV viewing time is associated with the presence of MetS, mainly in insufficiently active adults and those living in lower economic condition.

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Introduction

Metabolic syndrome (MetS) is a cluster of cardiovascular risk factors, including abdominal obesity, dyslipidemia, elevated blood pressure, and impaired glucose metabolism or insulin resistance.[1] It has been associated with cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), and mortality for several causes.[1–4] Because of the high prevalence worldwide, MetS is considered a major public health problem.[5]

The benefits of physical activity (PA) on cardiovascular and metabolic risk factors are well established.[6–9] On the other hand, sedentary behavior (SB), defined as any waking behavior characterized by an energy expenditure $\leq$ 1.5 metabolic equivalents while in a sitting or reclining posture,[10] has been associated with deleterious health outcomes, such as CVD,[11] T2DM,[12,13] depression,[14] some types of cancer,[15] and specific and all-cause mortality.[12]

The association of SB with MetS has been investigated in previous studies. In a cross-sectional analysis, Wijndaele et al.[16] found a positive association between time spent in sedentary activities and MetS risk score. Total and average time spent in SB were also positively associated with MetS and its individual components.[17] On the other hand, studies have shown that PA can attenuate or even eliminate, the detrimental effects of too much sitting.[18,19] In addition, sociodemographic characteristics, such as economic status, may play an important role in this association.[20]

Although evidence of the association of SB with MetS has been increasing recently, there are no data from developing countries, as well as it is not clear if the association between SB and MetS would be boosted by variables such as insufficient PA and low economic condition. Therefore, the aim of this study is to examine the association of SB with MetS in adults, as well as to identify the impact of physical inactivity and economic condition on this association.

Methods

Sample

The present study uses baseline measurements of an ongoing cohort study carried out with adults from the Brazilian National Health System (NHS). This cross-sectional study was conducted from August to December 2010 in Bauru, a Brazilian city (366,992 inhabitants and human development index of 0.801) located in the central region of São Paulo State, the most industrialized state in Brazil. The Department of Health of Bauru (subordinated to the NHS) administrates primary care services in the city, which is composed of 17 basic healthcare units (BHU). BHUs are small primary healthcare centers, in which a wide variety of health professionals (e.g. general practitioners, gynecologists, obstetricians, psychiatrists, dentists, and nurses) offer health services of low complexity (e.g. medical consultations, medicine prescription, and vaccinations) to the population of a specific region of the city. All services are free of charge, characterized as primary health care (more complex cases are directed to hospitals linked to the NHS).

Each BHU keeps records of all patients throughout the years, and based on these records, the researchers randomly selected 970 adults in five BHUs (194 in each BHU). The biggest BHU in each geographical region of the city (north, south, west, east, and downtown) was selected. Researchers contacted these adults by telephone to verify inclusion criteria: (i) age $\geq$50 years; (ii) registered for at least one year at the BHU; and (iii) active healthcare service registration (at least one medical visit in the previous 6 months). Participants who fulfilled the inclusion criteria were invited to a face-to-face interview and physical examination at the BHU of origin.

The study protocol was reviewed and approved by the Ethics Committee from São Paulo State University, Bauru, Brazil, and all participants provided written consent to participate in the study.

Metabolic syndrome

MetS was defined according to the criteria established by the National Cholesterol Education Program Adult Treatment Panel III : three or more of the following risk factors such as high blood pressure $\geq$ 130 mmHg systolic or $\geq$ 85 mmHg diastolic; central obesity (waist circumference > 102 cm for men and >88 cm for women); high triglycerides ($\geq$150 mg/dL); low high-density lipoprotein (HDL) cholesterol (<40 mg/dL for men and <50 mg/dL for women); and high fasting plasma glucose ($\geq$100 mg/dL) or drug treatment for these conditions.

Blood pressure was measured using a standard mercury brachial artery sphygmomanometer and stethoscope. Waist circumference was measured with the subject standing and at the maximum point of normal expiration. Results of HDL-cholesterol, fasting glucose, and triglycerides, or its respective chronic condition diagnosis (dyslipidemia, diabetes, and hypertension) were obtained from medical records. All blood exams scheduled by the BHUs were analyzed in a private laboratory following standard procedures. All the assessments (blood pressure, waist circumference, and medical records analysis) were performed by the researchers.

PA and television viewing assessment

Information regarding PA and television (TV) viewing were assessed by the Baecke questionnaire,[21] which comprises 16 questions scored on a 5-point Likert scale, ranging from never to always/very often, and addresses three domains of PA: occupational, sports participation, and leisure-time. Overall PA score was calculated following the questionnaire instructions and taking into account the three domains. Participants classified in the top quartile (25% more active) of overall PA were identified as 'physically active'.[22–24]

We assessed TV viewing time using one question in the leisure-time section of the questionnaire: 'During leisure time I watch television', with the following possibilities of answers: 'never', 'seldom', 'sometimes', 'often', or 'very often'. Although the questionnaire provides five options of answers, we opted to categorize as three variables because of the few cases in some of the groups (e.g. never and very often). Therefore, the following categories were created: 'never and seldom' (low TV viewing), 'sometimes' (moderate TV viewing), and 'often and very often' (high TV viewing).[25,26]

Covariates

In the present study, health status and sociodemographic and behavioral covariates were considered potential confounders (used to adjust the multivariable models). Sociodemographic variables were sex (male or female), chronological age, and economic status. Health status variables were composed of body mass index (BMI) and history of arrhythmia and myocardial infarction. BMI was calculated using measurements of weight and height collected during the face-to-face interview and physical examination. The behavioral variables used were smoking status (categorized as 'yes' and 'no') and PA.

Statistical analyses

Mean values and standard deviations summarized the numerical variables. Analysis of variance one-way was used for the comparisons between groups of TV viewing. Categorical variables were expressed as rates and compared using the Chi-squared test (Yates's correction was applied in 2 × 2 contingency tables). Significant associations were further analyzed by the binary logistic regression, which generated values of odds ratio (OR) and 95% confidence intervals (95% CIs). Three multivariable models were created to adjust analyses by age, sex, economic status, smoking, PA, BMI, history of arrhythmia, and myocardial infarction. The Hosmer–Lemeshow goodness-of-fit test was used to determine how well the model fitted the data (non-significant results indicated an adequate fit). All analyses were performed in SPSS (version 18.0, SPSS Inc., Chicago, IL, USA), and statistical significance (*P*-value) was set at 0.05.

Results

Characteristics of the sample according to categories of TV viewing are described in Table 1. High frequency of TV viewing was reported by 21.6% of the participants, which was associated with age (*P*-value = 0.025), economic status (*P*-value = 0.003), hypertension (*P*-value = 0.001), MetS (*P*-value = 0.004), male sex (*P*-value = 0.034), and lower PA score (*P*-value = 0.001).

When further analyzing the association between MetS and TV viewing in three multivariable models, we found that participants with moderate TV viewing had 49% higher likelihood of having MetS (OR = 1.49 [95%CI: 1.01–2.20]), when compared with low TV viewing group, even after adjustments for age, sex, economic status, smoking, and PA. Regarding the group reporting high exposure to TV viewing, the occurrence of MetS was 77% higher (OR = 1.77 [95%CI: 1.11–2.82]) when compared to low TV viewing group, even after adjustments for age, sex, economic status, smoking, PA, BMI, history of arrhythmia, and history of myocardial infarction (Table 2).

Figs. 1 and 2 show the relationship between TV viewing and MetS stratified by PA and economic status, respectively. The combination of physical inactivity and high TV viewing had double the likelihood of having MetS (OR = 1.89 [95%CI: 1.08–3.29]), even after adjustments for confounders. Moreover, the combination of low economic status with moderate (OR = 1.85 [95%CI: 1.18–2.89]) or high TV viewing [OR = 2.32 (95%CI: 1.37–3.94)] revealed a significant association with the higher occurrence of MetS, independent of potential confounders.

Table 1 – Characteristics of the sample according to television viewing frequency.

Variables	Overall sample (n = 970)	Television viewing			*P*-value[a]
		Low (n = 142)	Moderate (n = 618)	High (n = 210)	
Numerical [mean +/− SD]					
Age (years)	64.75 ± 9.08	63.53 ± 9.56	64.58 ± 8.94	66.09 ± 9.05	**0.025**
Weight (kg)	72.91 ± 15.53	70.38 ± 15.06	73.20 ± 15.40	73.73 ± 16.09	0.103
Height (cm)	157.36 ± 8.40	157.01 ± 8.01	157.27 ± 8.50	157.86 ± 8.40	0.591
BMI (kg/m^2)	29.43 ± 5.85	28.54 ± 5.76	29.61 ± 5.97	29.51 ± 5.53	0.147
Economic status score	17.77 ± 5.46	16.55 ± 5.67	17.78 ± 5.29	18.58 ± 5.69	0.003
Physical activity score	7.05 ± 1.53	7.45 ± 1.58	7.17 ± 1.44	6.40 ± 1.60	≤0.001
Categorical [n (%)]					*P*-value[b]
Sex (female)	709 (73.1)	109 (76.8)	461 (74.6)	139 (66.2)	0.034
Hypertension (yes)	747 (77.0)	98 (69.0)	470 (76.1)	179 (85.2)	0.001
Diabetes mellitus (yes)	276 (28.5)	37 (26.1)	177 (28.6)	62 (29.5)	0.767
Hypercholesterolemia (yes)	314 (32.4)	47 (33.1)	186 (30.1)	81 (38.6)	0.075
History of arrhythmia (yes)	105 (10.8)	12 (8.5)	64 (10.4)	29 (13.8)	0.234
History of myocardial infarction (yes)	48 (4.9)	5 (3.5)	32 (5.2)	11 (5.2)	0.697
Current smoker (yes)	131 (13.5)	25 (17.6)	76 (12.3)	30 (14.3)	0.232
Overweight/obesity (yes)	775 (80.1)	105 (75.0)	505 (81.7)	165 (78.9)	0.176
Economic status (low)	788 (81.2)	121 (85.2)	508 (82.2)	159 (75.7)	0.049
Physically active (yes)	245 (25.3)	59 (41.5)	161 (26.1)	25 (11.9)	≤0.001
Metabolic syndrome (yes)	439 (45.3)	48 (33.8)	282 (45.6)	109 (51.9)	0.004

BMI, body mass index; SD, standard deviation.
[a] One-way analysis of variance.
[b] Chi-squared test.

Table 2 – Odds ratios and 95% confidence intervals for MetS, according to television viewing categories.

Television viewing categories	N	Cases	Prevalence (%)	Model 1[a]	Model 2[b]	Model 3[c]
				OR [95% CI]	OR [95% CI]	OR [95% CI]
Low	142	48	33.8	1.00 [Referent]	1.00 [Referent]	1.00 [Referent]
Moderate	618	282	45.6	1.60 [1.09–2.35]	1.49 [1.01–2.20]	1.43 [0.96–2.12]
High	210	109	51.9	2.10 [1.34–3.28]	1.82 [1.15–2.88]	1.77 [1.11–2.82]
p for trend	–	–	–	0.005	0.036	0.054
H-L				0.038	0.579	0.317

MetS, metabolic syndrome; OR, odds ratio; CI, confidence interval; *H-L*, Hosmer–Lemeshow test; *n*, sample size; Cases, individuals with metabolic syndrome.

[a] Model 1: adjusted for age and sex.

[b] Model 2: adjusted for all variables in Model 1 plus economic status, smoking status, and physical activity.

[c] Model 3: adjusted for all variables in Model 2 plus body mass index, history of arrhythmia, and history of myocardial infarction.

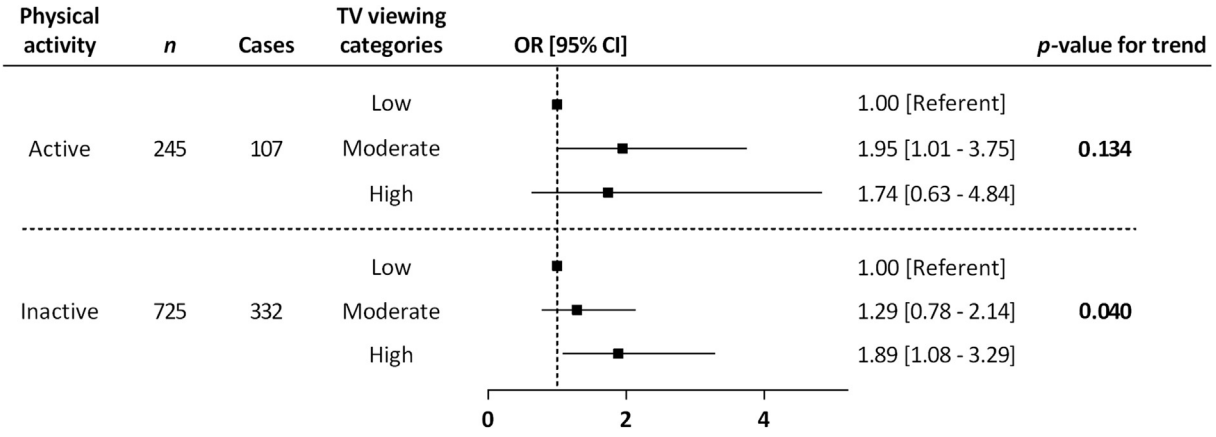

Fig. 1 – Odds ratio (OR) and 95% confidence intervals (CIs) for MetS, stratified by physical activity. Adjustments for age, sex, body mass index, economic status, smoking status, history of arrhythmia, and history of myocardial infarction. Hosmer–Lemeshow test was >0.05 for both groups. MetS, metabolic syndrome.

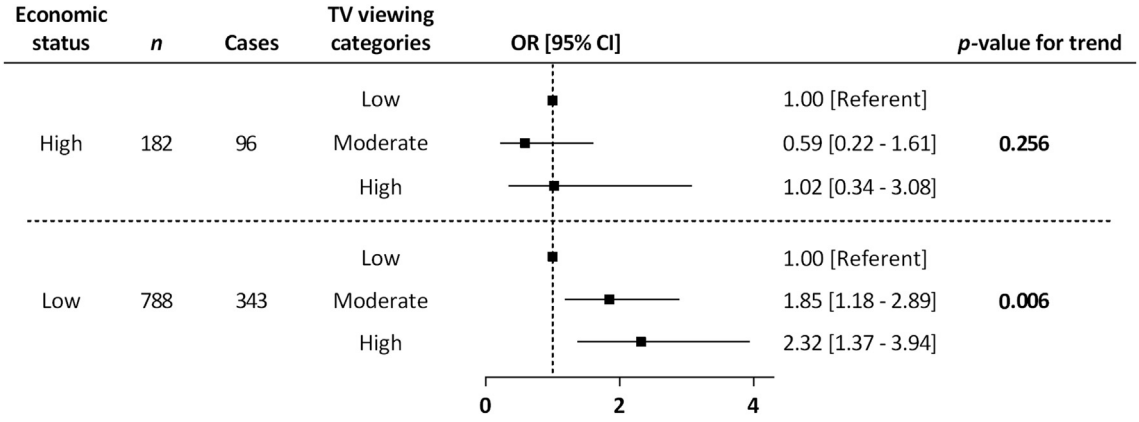

Fig. 2 – Odds ratio (OR) and 95% confidence intervals (CIs) for MetS, stratified by economic status. Adjustments for age, sex, body mass index, physical activity, smoking status, history of arrhythmia, and history of myocardial infarction. Hosmer–Lemeshow test was >0.05 for both groups. MetS, metabolic syndrome.

Discussion

The present study provides evidence that TV viewing is associated with MetS, independent of potential confounders, including PA. This association seems to be stronger in physically inactive people, as well as in people with low economic status.

The underlying mechanisms that could explain the association of TV viewing with MetS and other chronic conditions are a complex phenomenon. However, there are many possible explanations. Sitting is a behavior that leads to less

muscular contraction and reduced energy expenditure,[27] it is associated with unhealthy dietary habits[28] and, consequently, overweight and obesity.[29] In addition to an unhealthy food consumption during TV viewing time,[30] people tend to ignore internal satiety signals and rely on external signals, such as the end of a TV show, as to when they should stop eating.[31] All these possible mechanisms, repeated multiple times each day, may trigger pathogenic pathways involved in MetS, including insulin resistance, inflammation, abnormal glucose, fat metabolism, and other chronic diseases.[29,32]

Our stratified analysis, by PA and economic status, showed that among those less active and those in the lower economic stratum, the association of TV viewing and MetS remained significant, while there was no significance in those being active or in the high socio-economic stratum. In fact, these results are in accordance with previous studies.[18,33] Ekelund et al.[18] found that high levels of PA may attenuate the detrimental effects associated with TV viewing, and it seems to be a protective factor to the presence of MetS.[34] Similarly, Dunstan et al.[33] have shown that adults meeting the PA guidelines (≥2.5h per week) had reduced prevalence of components of MetS. In addition, the combination of inactivity (<2.5h per week) and high sedentary time (>14h per week watching TV) was associated with increased prevalence of MetS.[33]

Although people with lower income may have higher caloric expenditure at work, they tend to spend more time in sedentary activities during leisure-time, such as TV viewing.[35,36] This result may be explained by lack of options for leisure-time activities among the poorest, as well as the higher physical demand in labor activities of low-income people requires rest during leisure-time. However, previous findings from a meta-analysis, including 83 cross-sectional and 24 prospective studies, suggest that TV viewing and its relationship with income is inconclusive.[37]

Data regarding the association of SB, especially TV viewing, with health outcomes are available in the literature; however, most of the studies come from developed countries, such as United States, Australia, Canada, Germany, United Kingdom, and Japan.[38] To the best of our knowledge, this is the first study to evaluate the association between TV viewing and MetS in a clinical population from a developing country. These results reinforce the need for public health efforts targeting both behaviors at the same time, decrease of time spent in sedentary activities, and increase of PA among adults. Moreover, if reducing sitting time is not optional (i.e. work tasks that require a long period of sitting), people must be encouraged to meet PA guidelines to mitigate the deleterious effect of too much sitting on health outcomes, such as MetS.

Several limitations should be addressed in the present study. One of the primary limitations was the cross-sectional study design. This type of study design limits our ability to support a cause-effect relationship. Further, the generalizability of our results may be limited due to the sample size and specific population examined (adults from the Brazilian NHS). Owing to the limited research in developing nations regarding this association, more studies should be conducted to better understand this relationship. In addition, we were not able to examine the influence of diet as this information was not included in baseline assessments and therefore could not be controlled for in the analysis. The self-reported TV viewing time and PA, as well as the PA categorization, can also be considered limitations due to reporting bias and possible misclassifications, resulting in an overestimation or underestimation of the association of TV viewing and MetS. Finally, TV viewing may not be the best measure of overall SB, as it represents only a small portion of this behavior.

Conclusion

The results of the present study suggest that higher TV viewing time is associated with the presence of MetS, especially among inactive adults and those with lower household income. Future research in developing countries should use prospective study designs to address the cause-effect relationship of TV viewing and MetS.

Author statements

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Ethical approval

The study was reviewed and approved by the Ethics Committee from São Paulo State University, Bauru, Brazil, and all participants provided written consent to participate in the study.

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Competing interest

None declared.

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