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Level of leisure-time physical activity and its association with the prevalence of metabolic syndrome in adults: a population-based study

Nível de atividade física de lazer e sua associação com a prevalência de síndrome metabólica em adultos: estudo de base populacional

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ABSTRACT: ***Objective:*** To analyze the associations between changes in the level of leisure-time physical activity in adults and the prevalence of metabolic syndrome. ***Methods:*** This is a population-based study conducted with 818 adults aged 20 years or older from Florianópolis, Santa Catarina, Southern Brazil, between 2009 and 2014. We tested the association of maintenance and/or changes in the level of physical activity with the prevalence of metabolic syndrome, adjusted for sociodemographic variables (gender, age, schooling, income, marital status, and ethnicity) and smoking habits. We used logistic regression and estimated the odds ratios (OR) and their respective confidence intervals (95%CI). ***Results:*** The overall prevalence of metabolic syndrome was 30.9% (95%CI 27.2–34.7). Regardless of adjustment variables, adults who ceased to be active and/or remained physically inactive during leisure time in the study period presented, respectively, 108 and 124% higher odds of developing metabolic syndrome (OR=2.08; 95%CI 1.30–3.33 and OR=2.24; 95%CI 1.38–3.65). Women and individuals younger than 45 years showed lower odds of having metabolic syndrome. ***Conclusions:*** This sample presented a significant association between remaining or becoming inactive and a greater chance of developing metabolic syndrome.

Keywords: Metabolic syndrome. Motor activity. Physical exercise. Adult.

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RESUMO: ***Objetivo:*** Analisar as associações entre mudanças do nível de atividade física de lazer em adultos com a prevalência de síndrome metabólica. ***Métodos:*** Estudo de base populacional realizado com 818 adultos de 20 anos ou mais em Florianópolis, Santa Catarina, entre 2009 e 2014. Testou-se a associação da manutenção e/ou mudança do nível de atividade física com a prevalência de síndrome metabólica, ajustada por variáveis sociodemográficas (sexo, idade, escolaridade, renda, estado civil e cor da pele) e tabagismo. Empregou-se regressão logística, estimando-se as razões de chance (OR) e os respectivos intervalos de confiança (IC95%). ***Resultados:*** A prevalência geral de síndrome metabólica foi de 30,9% (IC95% 27,2 – 34,7). Independentemente das variáveis de ajuste, os adultos que deixaram de ser ativos e/ou se mantiveram fisicamente inativos no lazer no período apresentaram, respectivamente, 108 e 124% maiores chances para a síndrome metabólica (OR = 2,08; IC95% 1,30 – 3,33) e (OR = 2,24; IC95% 1,38 – 3,65). As mulheres e os indivíduos com idade inferior a 45 anos apresentaram menores chances para a síndrome metabólica. ***Conclusões:*** Nesta amostra, manter-se inativo ou passar a sê-lo associou-se, significativamente, com maiores chances para a síndrome metabólica.

Palavras-chave: Síndrome metabólica. Atividade física. Exercício físico. Adulto.

INTRODUCTION

Cardiovascular diseases are the main cause of death worldwide[1]. In 2016, they accounted for 30% of the total number of deaths in Brazil[2]. An important factor associated with the incidence of cardiovascular diseases, metabolic syndrome is a clinical condition described as a set of metabolic disorders and cardiovascular risk factors affecting an individual, usually related to central fat deposition and insulin resistance[3].

Individuals diagnosed with metabolic syndrome have twice the chance of presenting cardiovascular diseases compared to those who do not have this syndrome[4].

In the past two decades, the prevalence of metabolic syndrome has increased globally, becoming a public health issue directly related to the rise in obesity and a sedentary lifestyle. Studies indicate that the prevalence of this disease among adults ranges from 20 to 35% throughout the world[4-10].

The regular practice of physical activity has been recommended both for preventing and treating cardiovascular diseases and metabolic syndrome, as it acts in the control of their diagnostic components[11]. The literature provides robust evidence that being physically active is associated with a lower prevalence of metabolic syndrome[11-16].

However, whether changes in the level of physical activity are associated with the prevalence of metabolic syndrome is unclear and became the object of this study. Knowing how variations in the level of physical activity are related to the presence of metabolic syndrome is important, both for clinical recommendations and the definition of population strategies to prevent the disease. Thus, the present study aimed to analyze the association between changes in the level of leisure-time physical activity in adults and the diagnosis of metabolic syndrome.

METHODS

This is a longitudinal epidemiological study linked to the Epifloripa Adulto population-based cohort, which investigated a representative sample of adults from Florianópolis, Santa Catarina, Southern Brazil, between 2009 and 2014. According to data from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE, 2010), the city has an area of 675.409 km², population density of 623.69 inhabitants/km², and municipal human development index (MHDI) of 0.847. In 2009, the start of the study period, the municipality population was 453,281 inhabitants[17].

The sample calculation of Epifloripa 2009 used the following parameters: unknown prevalence (50%), 95% confidence level, 3.5% sampling error, design effect (deff) of 2.0, and 10% increment for potential losses and/or refusals. As the study aimed to test associations, the final sample size was increased by 15%, resulting in 2,016 individuals[11]. The study used a two-stage cluster sampling. The first stage organized the 420 urban census tracts of the city according to income deciles of the head of the family, and 60 tracts were drawn. In the second stage, the sampling units were the households, selected by draw[11].

In 2009, data were collected from 1,720 individuals, who represented 85.3% of the sample initially calculated. All adults aged 20 to 59 years living in the selected households of each tract were considered eligible. We excluded individuals who had a limb amputated, used prostheses, were bedridden, unable to stay in the proper position to have their anthropometric parameters measured, and those incapable of answering the questionnaire. Trained interviewers collected the variables in households. In 2009, refusals were defined as the non-acceptance to participate in the interview, even after clarifications about the research, while losses were considered not finding the individuals in the households selected after four visits. The variables collected in 2009 and used in the present study were ethnicity and level of physical activity. In both waves of the Epifloripa Project (2009 and 2014), pregnant women or those who had a child in the six months prior to the study did not have their blood pressure and anthropometric data measured, since such characteristics interfere in these values[18].

In 2014, the same individuals who participated in the 2009 baseline were contacted by phone and invited to go to the university for data collection and laboratory tests. A total of 818 individuals were evaluated, which represented 47.6% of the sample in relation to the initial data collection. The sample size was standardized in the two waves based on the number of exposure and outcome events so as to limit the analysis results to complete data, excluding the missing data. In 2014, refusals were considered the non-participation in the study, and losses corresponded to not going to the university, even when the individuals scheduled an appointment and expressed an interest in participating in the research, after three attempts to rescheduling.

In the second wave, the information was gathered in nutrition and anthropometric laboratories of the university, with the collection of 30 mL samples of peripheral venous blood by venipuncture, after 8- to 10-h fasting, following a standardized protocol for clinical chemistry tests (blood glucose, triglycerides, and HDL-cholesterol). The concentration of fasting serum glucose was determined by adapting the hexokinase-glucose-6-phosphate

dehydrogenase method using the Flex® Reagent Cartridge GLUC and the Dimension® Clinical Chemistry System (Siemens Healthcare Diagnostics Inc., Newark, United States). The serum concentrations of triglycerides were obtained by an automated endpoint bichromatic enzymatic colorimetric method using cartridge kits (Flex® Reagent Cartridge CHOL and TLG, Newark, United States). HDL-cholesterol was determined by the accelerator selective detergent method (Flex® Reagent Cartridge AHDL, Newark, United States).

The outcome of this study was the presence of metabolic syndrome, defined according to the Joint Interim Statement (JIS) criteria[4]. Metabolic syndrome was diagnosed based on the evaluation of five components (Chart 1). The presence of three of these components or the use of medications for glycemic, dyslipidemia, or blood pressure control (equivalent to having the component in the clinical examination or laboratory test) resulted in a conclusive diagnosis of metabolic syndrome[4], which was dichotomized in the 2014 study (no / yes).

Chart 1. Analytical table representing the variables used in this study.

Metabolic syndrome (outcome)	
Diagnostic components	Reference values
Waist circumference	≥90 cm for men and ≥80 cm for women
Triglycerides	≥150 mg/dL
HDL-cholesterol	<40 mg/dL for men and <50 mg/dL for women
Fasting blood glucose	≥100 mg/dL and/or diagnosis of diabetes mellitus
Systemic blood pressure	SBP≥130 mmHg and/or DBP≥85 mmHg
Metabolic syndrome	no/yes
Level of physical activity (exposure)	
Variables	Categories
Physically active during leisure time	no/yes
Changes in the level of physical activity between 2009 and 2014	active–active, active–inactive, inactive–active, inactive–inactive
Sociodemographic variables and smoking habits (control variables)	
Variables	Categories
Gender	male; female
Age group	25–44 years; 45–65 years
Schooling	elementary/high/vocational school; higher education
Household income	Per capita (in quartiles)
Marital status	married/living with a partner; single/divorced/widowed
Self-reported ethnicity	white; black/multiracial
Smoking	no/yes

HDL: high-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure.

The control variables included in the study were sociodemographic characteristics and smoking habits (Chart 1). We defined non-smokers as individuals who reported never having smoked and smokers as those who declared having smoked and/or smoking currently. These variables were considered possible confounding factors, based on the literature[11,19].

The level of physical activity was assessed using the questionnaire of the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico* – VIGITEL)[20,21] in the 2009 and 2014 waves. The reproducibility of VIGITEL questions about physical activity is high (kappa coefficient of 0.80 and 0.78 for active and inactive individuals during leisure time, respectively)[22] compared to the original VIGITEL interview. The questionnaire consisted of five questions about leisure-time physical activity, covering the practice of physical activity or sport in the previous three months, the modality, the weekly frequency, and the duration of the activity[23].

The individuals considered physically active during leisure time were those who reported practicing mild and moderate physical activities for at least 30 minutes on five or more days of the week or who practiced vigorous activities for at least 20 minutes on three or more days of the week. Walking, walking on a treadmill, weight training, water aerobics, gymnastics in general, swimming, martial arts, cycling, and volleyball were classified as mild or moderate activities. Running, running on a treadmill, aerobic exercises, soccer, basketball, and tennis were considered vigorous activities[22]. The changes in the level of physical activity variable were categorized into four groups (Chart 1), according to the levels identified in the 2009 and 2014 waves.

This study adopted the logistic regression model. All regression results were expressed as odds ratios (OR) with their respective 95% confidence intervals. We performed the χ^2 test to determine the prevalence of metabolic syndrome according to categories of independent variables. The adjusted analysis used the forward method, including the variables one by one in the following order: metabolic syndrome (outcome), changes in the level of physical activity (main exposure), sociodemographic characteristics, and smoking habits.

The analyses took into account the complex sampling process and were all performed in the software Stata 13.0 (Stata Corporation LP, College Station, United States). The Human Research Ethics Committee of Universidade Federal de Santa Catarina (UFSC) and Universidade do Estado de Santa Catarina (UDESC) approved Epifloripa Adulto, under protocols No. 351/2008 and No. 724,824/2014. All participants were informed about the objectives of the study and asked to read and sign the Informed Consent Form.

RESULTS

The study sample analysis involved 818 adults. The groups with a lower prevalence of metabolic syndrome were women, younger individuals, those who were single/divorced/

widowed, better educated, black or multiracial, non-smokers, and who remained active between 2009 and 2014 (Table 1). The overall prevalence of metabolic syndrome in the study was 30.9% (95%CI 27.2–34.7) (Table 2).

In the crude analysis, single, divorced, and widowed individuals were associated with lower odds of developing metabolic syndrome. Older men, less-educated adults, smokers,

Table 1. Comparison of sample characteristics in the first wave (2009), the second wave (2014), and in adults diagnosed with metabolic syndrome from Florianópolis, SC.

Variables	Epifloripa (2009)	Epifloripa (2014)	
	(n=1,720)	Analyzed (n=818)	Diagnosed with MS (n=253)
	%	% (95%CI)	%
Gender			
Female	55.8	57.3 (54.4–60.2)	27.2*
Male	44.2	42.7	36.1
Age group (years)			
25–44	54.2	47.6	20.5
45–65	45.8	52.4 (46.3–58.3)	40.3*
Marital status			
Married/partner	60.6	72.0	33.2
Single/divorced/widowed	39.4	28.0 (24.3–32.0)	25.2*
Per capita income (quartiles)			
R$ 480 to R$ 2,499	25.6	23.5	33.2
R$ 2,500 to R$ 3,999	24.6	22.2	35.4
R$ 4,000 to R$ 7,999	27.2	28.8	27.1
≥ R$ 8,000	22.7	25.5 (20.5–31.3)	29.2
Schooling (level)			
Higher education	43.1	46.9	25.3
Elementary/high/vocational school	56.9	53.1 (46.1–59.9)	35.5*
Ethnicity			
White	89.6	91.4	30.8
Black/multiracial	10.4	8.6 (5.5–13.0)	29.7

Continue...

Table 1. Continuation.

Variables	Epifloripa (2009)	Epifloripa (2014)	
	(n=1,720)	Analyzed (n=818)	Diagnosed with MS (n=253)
	%	% (95%CI)	%
Smoking			
No	56.8	54.2	27.3
Yes	43.2	45.8 (41.2–50.3)	35.4*
Physically active during leisure time			
No	53.1	48.0	33.7
Yes	46.9	52.0 (47.0–56.9)	28.1*
Changes in the level of physical activity			
Active–active		33.2 (29.3–37.3)	23.5*
Active–inactive		14.5	37.1
Inactive–active		18.8	23.4
Inactive–inactive		33.5	39.9

*p<0.05 for the comparison between the participants analyzed with and without metabolic syndrome; MS: metabolic syndrome; 95%CI: 95% confidence interval.

Table 2. Description of metabolic syndrome diagnostic components and overall prevalence in adults from Florianópolis, SC.

Variables	n	% (95%CI)
Waist circumference (WC≥90 cm M and WC≥80 cm F) (n=818)		
Normal	408	49.9
High	410	50.1 (45.6–54.5)
Blood pressure (SBP<130 mmHg/DBP<85 mmHg) (n=818)		
Normal	274	33.5
High	544	66.5 (62.3–70.5)
Blood glucose (≥100 mg/dL) (n=697)		
Normal	580	83.2
High	117	16.8 (13.6–20.5)

Continue...

Table 2. Continuation.

Variables	n	% (95%CI)
Triglycerides (≥150 mg/dL) (n=697)		
Normal	556	79.8
High	141	20.2 (17.0–23.7)
HDL (<40 mg/dL M and <50 mg/dL F) (n=697)		
Normal	436	62.6
Low	261	37.4 (32.5–42.6)
Metabolic syndrome (n=818)		
No	565	69.1
Yes	253	30.9 (27.2–34.7)

95%CI: 95% confidence interval; WC: waist circumference; M: male; F: female; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL: high-density lipoprotein.

and individuals who remained or became physically inactive presented a greater chance of having metabolic syndrome (Table 3).

In the adjusted analysis, the only variables that remained significantly associated with metabolic syndrome were gender, age group, and changes in the level of physical activity. Men were 76% more likely to develop metabolic syndrome than women (OR=1.76; 95%CI 1.29–2.39). The odds of presenting metabolic syndrome were 178% higher in older individuals (≥45 years) compared to younger ones (OR=2.78; 95%CI 1.97–3.91). In the study period, ceasing to be active and/or remaining physically inactive during leisure time represented, respectively, 108 (OR=2.08; 95%CI 1.30–3.33) and 124% (OR=2.24; 95%CI 1.38–3.65) higher odds of developing metabolic syndrome in comparison with individuals who continued to be active in the same interval (Table 3). Per capita income showed no association with metabolic syndrome, be it in the crude, adjusted, or trend analysis.

DISCUSSION

The main findings of this study showed significant associations of the diagnosis of metabolic syndrome with sociodemographic variables (gender and age group) and changes in the level of leisure-time physical activity. We underline that ceasing to be active and/or remaining physically inactive during leisure time was associated with a higher chance of having metabolic syndrome.

In the present study, the overall prevalence of metabolic syndrome in the adult population of Florianópolis was 30.9%. Despite the losses to follow-up between the waves, the

prevalence of metabolic syndrome in this research agrees with that found in national and international studies.

Globally, the mean prevalence of metabolic syndrome in adults ranges from 20 to 35%[5-7,24]. In Brazil, Vidigal et al.[8] revealed a prevalence of 29.6% in adults.

In the present study, we found that individuals who remained inactive between 2009 and 2014 were more likely to develop metabolic syndrome than those who continued to be

Table 3. Prevalence of the outcome according to the categories of variables and crude and adjusted analysis.

Variables	n (%)	Crude analysis OR (95%CI)	Adjusted analysis OR (95%CI)
Gender (n=818)			
Female	128 (27.2)	1.00	1.00
Male	126 (36.1)	1.51 (1.09–2.09)	1.76 (1.29–2.39)
Age group (years) (n=817)			
25 to 44	79 (20.5)	1.00	1.00
45 to 65	179 (40.3)	2.82 (2.07–3.84)	2.78 (1.97–3.91)
Marital status (n=818)			
Married/partner	198 (33.2)	1.00	1.00
Single/divorced/widowed	56 (25.2)	0.67 (0.46–0.98)	0.79 (0.53–1.16)
Schooling (level) (n=815)			
Higher education	92 (25.3)	1.00	1.00
Elementary/high/vocational school	160 (35.5)	1.61 (1.14–2.27)	1.12 (0.78–1.61)
Ethnicity (n=814)			
White	232 (30.8)	1.00	1.00
Black/multiracial	22 (29.7)	0.96 (0.58–1.57)	0.86 (0.49–1.51)
Smoking (n=818)			
No	121 (27.3)	1.00	1.00
Yes	133 (35.4)	1.55 (1.12–2.14)	1.27 (0.88–1.83)
Changes in the level of physical activity (n=818)			
Active–active	63 (23.5)	1.00	1.00
Active–inactive	46 (37.1)	1.98 (1.29–3.03)	2.08 (1.30–3.33)
Inactive–active	37 (23.4)	1.03 (0.63–1.67)	1.17 (0.68–2.02)
Inactive–inactive	107 (39.9)	2.33 (1.50–3.63)	2.24 (1.38–3.65)

OR: odds ratio; 95%CI: 95% confidence interval.

active in the same period. Ceasing to be active also increased the odds of being diagnosed with metabolic syndrome. Thus, individuals who remained physically inactive and, consequently, had higher chances of presenting metabolic syndrome could reduce this percentage by changing their behavior regarding the level of physical activity. Similarly, the probability (percentage) of developing metabolic syndrome among individuals who ceased to be physically active in the same period was very close to that of adults who continued to be inactive, with the first group being associated with metabolic syndrome at the end of the adjusted analysis.

This finding suggests that remaining physically active is a relevant factor in the prevention of metabolic syndrome. The fact that metabolic syndrome was assessed in only one wave of the study (2014) did not affect the analyses, as our intent was not to verify the causal relationship between the level of physical activity and this condition, but how the maintenance or changes in behavior related to the level of physical activity are associated with the prevalence of metabolic syndrome measured at the end of this period.

Our results reinforced the importance – already established in the literature – of practicing physical activities to improve overall health and as a major ally in the prevention and non-pharmacological treatment of metabolic syndrome. The assessment of the level of physical activity divided into four categories according to the maintenance and/or changes in the level of physical activity is the methodological differential of this study compared to other research found in the literature.

The practice of physical activity by adults, especially during leisure time, provides opportunities for a healthier life, contributing to the improvement of the quality of life. Some works recommend the practice of physical activities, particularly aerobic exercises, such as walking, running, swimming, and cycling, because they act as protective factors against metabolic syndrome[12-14,24]. Studies suggest that being physically active has a direct relationship with a lower percentage of metabolic syndrome. Possibly, this relationship is justified by the increase in muscle mass, decrease in body fat percentage, especially central obesity, glycemic control, and reduction in systemic blood pressure and cardiovascular risk factors in general[12,15,16,24]. Considering that metabolic syndrome is a disease with high prevalence, described as a public health issue, this study contributes to raising the awareness of the population regarding the importance of remaining physically active by indicating that active individuals have a lower association with this diagnosis. Also, in the study period, ceasing to be physically active and remaining inactive had similar relationships with the prevalence of metabolic syndrome. Thus, remaining physically active is as important as not becoming inactive.

The present study revealed that males were associated with higher odds of developing metabolic syndrome. This result agrees with those found in other studies[24-27]. However, the literature has not reached a consensus on the prevalence of metabolic syndrome related to gender. Some studies have found a similar prevalence in both genders or a greater one in women compared to men[28,29]. A possible explanation for this lack of consensus concerning gender is the direct influence of lifestyle on the presence of diagnostic components

responsible for metabolic syndrome. The fact that diagnostic components are affected by and sensitive to lifestyle can contribute to the lack of consensus on the prevalence of metabolic syndrome, considering the distinct lifestyle of men and women.

In the present study, adults from the older age group (45–65 years) had a greater chance of presenting the outcome compared to the younger age group (25–44 years).

The growth in the prevalence of metabolic syndrome with age is widely documented in the literature[5,25,30]. Therefore, the increase in the age group was associated with high percentages of metabolic syndrome among adults. This finding can be explained by the fact that older individuals are less physically active and by the physiological and bodily changes inherent to the aging process, such as the increase in the percentage of body fat, particularly central obesity, the decrease in the percentage of lean mass, and the loss of muscle mass (sarcopenia)[15,16].

Some methodological limitations of this study should be considered. The second wave of Epifloripa Adulto (2014) presented losses compared to the 2009 wave, which may have decreased the representativeness of the sample. This loss to follow-up might be attributed to the fact that, while in the first wave, the interviewers went to the households to gather the information, in the second one, the research subjects were invited to go to the university for data collection. We have no way of determining if the losses between the waves led to changes in the behavior of the associations found.

Despite the longitudinal assessment (2014) of the level of physical activity, metabolic syndrome was evaluated only in the second moment (2014), limiting the longitudinal inferences from the study. We also emphasize that information on eating habits was not collected in the last wave. Thus, diet was not included in the study as one of the possible control variables, which could have influenced the prevalence of metabolic syndrome.

Among the positive points, we can highlight:

- the study addressed not only the relationship between physical activity and metabolic syndrome, which has been established in the literature, but the implications of the changes in the level of physical activity for metabolic syndrome;
- it strengthened the inverse association between the levels of physical activity and the prevalence of metabolic syndrome;
- the fact that metabolic syndrome was assessed (data related to metabolic syndrome diagnostic components were measured) and not just self-reported, which denotes greater reliability of the data collection;
- the sample originated from a population-based epidemiological study and was representative of the adults from Florianópolis in this cohort.

CONCLUSION

Our results suggest an association between remaining or becoming inactive and a greater chance of having metabolic syndrome. On the other hand, women, younger individuals,

and those who remained physically active in the study period showed lower odds of developing metabolic syndrome.

This research provides important contributions to elucidate issues that are not yet clear in the literature regarding the association between changes in the level of physical activity and the prevalence of metabolic syndrome. The findings confirm the beneficial effects of the practice of leisure-time physical activity upon metabolic syndrome. We identified an inverse association between changes in the level of physical activity and metabolic syndrome.

Furthermore, this study can help reinforce and justify public policies and physical activity programs that promote an active lifestyle, explaining the importance of starting the practice of physical activities at any time and maintaining this habit throughout life.

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