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Low levels of physical activity and metabolic syndrome: cross-sectional study in the Brazilian public health system

Baixos níveis de atividade física e síndrome metabólica: estudo transversal com usuários do sistema público de saúde brasileiro

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Abstract *This study investigated whether low levels of physical activity in different domains is associated with risk factors for the occurrence of metabolic syndrome or metabolic syndrome itself. Habitual physical activity level was assessed among 963 participants, aged 50 years old or more, using Baecke's questionnaire. Risk factors for metabolic syndrome followed the recommendations of "The IDF Consensus Worldwide Definition of the Metabolic Syndrome". All the participants were users of the Brazilian Public Healthcare System. The prevalence of metabolic syndrome was 30.9%. Participants with lower levels of physical activity in leisure-time had higher chances of occurrence of diabetes mellitus, hypercholesterolemia and metabolic syndrome. Occurrence of arterial hypertension was associated with lower levels of sports activities. It was found high rates of risk indicators for the occurrence of metabolic syndrome, as well as for diseases alone as hypertension, diabetes mellitus, hypercholesterolemia, and obesity. Lower involvement in physical activity in different domains increases the prevalence of risk factors for metabolic syndrome.*
Key words *Motor activity, Metabolic Syndrome X, Unified Health System, Epidemiology*

Resumo *Este estudo investigou se baixos níveis de atividade física em diferentes domínios está associado a fatores de risco para a ocorrência da síndrome metabólica ou a síndrome metabólica em si. Nível de atividade física habitual foi avaliada entre 963 participantes, com idade igual ou superior a 50 anos, usando o questionário de Baecke. Fatores de risco para síndrome metabólica seguiram as recomendações do "The IDF Consensus Worldwide Definition of the Metabolic Syndrome". Todos os participantes eram usuários do sistema público de saúde brasileiro. A prevalência de síndrome metabólica foi de 30.9%. Participantes com menores níveis de atividade física no lazer tiveram maiores chances de ocorrência de diabetes mellitus, hipercolesterolemia e síndrome metabólica. Ocorrência de hipertensão arterial foi associada com menores níveis de atividades esportivas. Foram encontradas altas taxas de indicadores de risco para a ocorrência da síndrome metabólica, assim como para doenças isoladas, como hipertensão arterial, diabetes mellitus, hipercolesterolemia e obesidade. Menores engajamento com a prática de atividades físicas em diferentes domínios aumenta a prevalência de fatores de risco para a síndrome metabólica.*
Palavras-chave *Atividade motora, Síndrome X Metabólica, Sistema Único de Saúde, Epidemiologia*

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Introduction

The metabolic syndrome (MetS) is a complex disorder represented by a cluster of metabolic abnormalities that are commonly associated with obesity, high blood pressure, dyslipidemia, hyperglycemia and hyperinsulinemia. Besides being defined by several interconnected factors, MetS increases by two to four times the risk of stroke, three to four times the risk of myocardial infarction, and twice the risk of dying from such an event compared with those without the syndrome[1]. Thus, recognized worldwide as a major public health and clinical problem by increasing risk of chronic diseases[2], its prevention is considered a fundamental goal of public health.

Global prevalence of MetS varies depending on the region and composition of the population studied[3]. In general, it's estimated that one-quarter of the world's adult population has the MetS[4]. In Brazil, studies have found lower prevalence, but no less alarming, ranging from 6.7%[5] and 7.6%[6]. Thus, prevalence of MetS is different according to regions and populations and also related to several clinical definitions proposed and used in studies worldwide[1].

Despite being characterized as a multifactorial disease, the main factors for the occurrence of MetS are genetic[7], inflammatory[8], dietary patterns and lifestyle[9], and the last two are potentially modifiable. Compliance with the current recommendations[1], increasing the total volume of moderate-intensity physical activity and to maintain good cardiorespiratory and muscular fitness appears to markedly decrease the likelihood of developing the MetS, especially in high-risk groups[10]. However, studies on this subject are not well explored in Brazilian population, especially among users of the public healthcare system.

Nevertheless, the aim of this study was to determine whether associations between risk factors for the occurrence of MetS / MetS itself and physical inactivity among adult users of the public healthcare system in Brazil.

Methods

Sample

This project was a cross-sectional study conducted from August 2010 to December 2010 in the city of Bauru (the most industrialized region of the country). Prior to implementation the study was approved by the Ethics Committee Group from Universidade Estadual Paulista, Bauru campus (Process number 1046/46/01/10), and all subjects were asked to sign a standard written consent form. The sample size was estimated based on the percentage of Brazilian population that are covered only by the public health system (60%)[11] and using parameters as 3.8% error (arbitrary because there are no other similar studies), 5% statistical significance and design effect of 50%. A sample size of 960 participants was estimated to be representative (minimum of 192 in each Basic Healthcare Unit [BHU]). The city was stratified into five geographical regions (south, west, north, east and center) and the major BHU from each geographical region was selected.

As inclusion criteria were defined: i) age ≥ 50 years; ii) register for at least one year at the BHU; iii) have active registration of healthcare service (have performed at least one medical visit in the past six months). After that, a list with the number of all medical records that reached the inclusion criteria above was made and a random selection was performed until the minimum number of participants is reached. The final sample size was 963 participants.

Risk Factors for Metabolic Syndrome

MetS was defined as subjects who had presence of any three of the five following risk factors, as defined by Alberti et al.[1]: i) increased waist circumference [population specific (80 cm for women and 94 for men)]; ii) increased triglycerides (> 150 mg / dL or specific treatment to be performing such abnormality); iii) reduced HDL cholesterol (< 40 mg / dL, or is performing a specific treatment for this abnormality); iv) high blood pressure (systolic blood pressure > 130 mmHg or diastolic blood pressure > 85 mmHg or be performing treatment for previously diagnosed arterial hypertension (AH); v) increased fasting glucose (> 100 mg / dL or previous diagnosis of diabetes mellitus (DM) type 2).

To check the occurrence of such factors were performed: anthropometric measurements of waist circumference, ii) verification on the results of specific tests (triglycerides, HDL cholesterol and fasting glucose) registered on the medical record of the patient and performed in the 12 months preceding the interview, and finally iii) consultation on any chronic disease diagnosis properly recorded by the physician in the clinical record.

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Habitual Physical Activity

The level of PA was estimated using the questionnaire developed by Baecke et al.[12], which considers three domains of PA: Occupational PA, Sport practice, and Leisure-time PA. The PA level is calculated by specific equations and is expressed as a scores for each PA domain (higher score denotes higher PA) and the sum of all domains constitutes the overall PA. The sample was then divided into quartiles within each domain of PA and participants were classified into four groups[13]: Physically inactive (≤ P25), Moderately Active (< P25 and ≥ P75) and Active (> P75).

Potential confounders

The following data were obtained through interviews and confirmed in medical records: (i) socio-demographic variables (sex, chronological age [structured as categorical variable: < 65 years-old and ≥ 65 years-old]); (ii) smoking habits [categorized as "yes" (current smokers independently of number of cigarettes per day) and "no" (former smokers or never smoked)]; (iii) economic status, assessed by a specific and previously validated Brazilian questionnaire[14], which estimates the family income (dichotomized into either low or high income) and includes the level of formal education; (iv) abdominal obesity, obtained with values of waist circumference (80 cm for women and 94 for men)[15]; (v) general obesity [body mass index (BMI)], calculated using measurements of weight and height and obtained by dividing weight by squared height and defined as BMI ≥ 30 kg/m^2 [16]; (vi) blood pressure was measured in a seated position at rest and values lower than 130/85 mmHg for systolic (SBP) and diastolic blood pressure (DBP) were considered normal, respectively.

Statistical analyzes

Categorical variables were expressed as rates and compared by the chi-square test (Yates's correction was applied in 2x2 contingence tables). Significant associations detected by chi-square test were further analyzed by the binary logistic regression, which generated values of odds ratio (OR) and 95% confidence intervals (CIs). The association between the occurrence of the diseases and physically inactive domains was simultaneously adjusted by potential confounders (Basic Health Care Units, age, sex, smoking habit, economic condition, increased waist circumference, overweight, SBP and DBP). In all adjusted multivariable models, after inclusion of potential confounders, the Hosmer-Lemeshow goodness-of-fit test was used to determine how well the model fit the data (non-significant results indicate an adequate adjustment). All statistical analyses were performed by the software BioEstat (release 5.0) and statistical significance (p-value) was set at 0.05.

Results

This sample was composed of 963 patients from five BHU in Bauru – SP, being 26.6% male (n = 256) and 73.4% female (n = 707). Mean age was 65 ± 9 years (ranging from 50 to 96 years old). Regardless of the region of collection, the prevalent economic status in the sample was the low one, comprehending 83.2% of all of the assessed participants (n = 801). 13.2% of the participants reported to be current smokers (n = 127) and 33.7% were former smokers (n = 325). Mean score for occupational PA was 3.56 ± 1.71 (ranging from 0.63 to 9.38), for sport practice was 1.35 ± 0.55 (ranging from 0.75 to 3.82) and for leisure time PA was 2.88 ± 0.76 (ranging from 1.00 to 4.75).

There were high rates of AH (76.8% [74.1% to 79.5%]), DM (28.6% [25, 7% to 31.4%]), hypercholesterolemia (32.7% [29.7% to 35.6%]) and abdominal obesity (87.7% [85.7% to 89.8%]). The prevalence of MetS was 33.6% (30.66 to 36.63), with no significant difference between different economic status (low income: 33.3%; high income: 35.2%; p-value= 0.649).

Comparing sexes, there were no statistical differences between men and women regarding to all diseases, however, older people (over 65 years-old) had a higher incidence of AH when compared to younger participants (81.1% versus 73,4%, respectively [p-value = 0.006]); the same pattern was not observed for DM and hypercholesterolemia. On the other hand, participants with overweight / obesity and abdominal obesity had higher occurrence of all diseases analyzed.

Table 1 shows associations between levels of PA in different domains and diseases analyzed. We found that, even after robust adjustment for potential confounders, lower level of PA in leisure-time was significantly associated with a higher prevalence of DM (OR = 1.82 [1.22-2.71]) and hypercholesterolemia (OR = 1.82 [1.25-2.66]). However, AH was only associated with lower levels of sport practice (OR = 1.67 [1.05-2.65]).

Table 1. Association between physical activity domains and chronic diseases (Brazil, n = 963).

PA Domains	Arterial Hypertension		Diabetes mellitus		Hypercholesterolemia	
	N (%)	OR (95%CI)	N (%)	OR (95%CI)	N (%)	OR (95%CI)
Occupational						
Physically inactive	197 (82,1)	---	85 (35,4)	1.32 (0.84-2.08)	69 (28,8)	---
Moderately Active	353 (73,4)	---	124 (25,8)	0.90 (0.62-1.30)	171 (35,6)	---
Active	190 (78,5)	---	66 (27,3)	1.00	75 (31)	---
	p-value = 0,357		p-value = 0,049	p-value = 0,390* (71,1%)**	p-value = 0,604	
Sports						
Physically inactive	194 (79,8)	**1.67 (1.05-2.65)**	79 (32,5)	---	91 (37,4)	---
Moderately Active	372 (77,7)	1.47 (0.99-2.18)	125 (26,1)	---	150 (31,3)	---
Active	174 (72,2)	1.00	71 (29,5)	---	74 (30,7)	---
	p-value = 0,047	p-value = 0,368* (79,6%)**	p-value = 0,455		p-value = 0,113	
Leisure-time						
Physically inactive	189 (82,9)	1.43 (0.90-2.28)	85 (37,3)	**1.82 (1.22-2.71)**	93 (40,8)	**1.82 (1.25-2.66)**
Moderately Active	310 (77,1)	1.13 (0.78-1.64)	118 (29,4)	1.35 (0.95-1.92)	137 (34,1)	**1.41 (1.01-1.96)**
Active	241 (72,4)	1.00	72 (21,6)	1.00	85 (25,5)	1.00
	p-value = 0,004	p-value = 0,843* (78,3%)**	p-value = 0,001	p-value = 0,253* (71,8%)**	p-value = 0,001	p-value = 0,894* (67,9%)**

Notes: OR = odds ratio; 95% CI = confidence interval of 95%; * = Hosmer-Lemeshow; ** = Percentage of how much the model can explain the behavior of the outcome; Models adjusted simultaneously for: BHU, sex, age, smoking, economic status, SBP, DBP, BMI and WC.

In the multivariate-adjusted model, it was possible to detect that participants with lower level of PA in leisure-time had a higher occurrence of DM (OR = 1.79 [1.17-2.72]) and hypercholesterolemia (OR = 1.85 [1.24-2.76]) (Table 2), independent of sport practice and occupational domain.

Finally, Table 3 has indicated that among participants with the lowest percentile of PA in leisure-time domain the occurrence of MetS was higher even after adjustments (OR = 1.48 [1.08-2.05]).

Discussion

This study aimed to examine associations between the occurrence of risk factors for MetS / MetS itself and physical inactivity in different domains among adults users of the public healthcare system in Brazil and found high rates of hypertension, DM, hypercholesterolemia, abdominal obesity and MetS, which were also associated with lower levels of PA.

The prevalence rates of chronic diseases found in our study were higher than those found in other national studies. In our sample, 76.8% of the participants were diagnosed with AH, 28.5% with DM, and 32.7% with hypercholesterolemia. Brazilian research assessing adults by telephone survey found that the frequency of self-reported AH was 52.1% for the age group of 55-64 years and 61.1% for the elderly[17]. Regarding DM, recent and nationally representative data on adults show an increased rate of 3.3% in 1998 to 5.3% in 2008[18]. Relating to hypercholesterolemia, Nascimento Neto[19] found that 21.6% of the general population showed altered cholesterol levels, being 30% among those with 45 years old or more. The three diseases have common risk indicators, such as smoking habits, physical inactivity, unhealthy diet and harmful use of alcohol. In addition, the current epidemic of obesity and the increased access to diagnostic tests are factors that explain most of this increase[20].

The reason for the high prevalence rates of these diseases in our study may partly be explained by the fact that the sample is composed of patients of BHU, sites with high concentration of people with different chronic diseases. In connection with these results, the increased percentage of the population affected by chronic diseases could be better controlled if there were efficient programs related to health education,

Table 2. Multivariate association between physical activity domains and chronic diseases (Brazil, n = 963).

Domains	Arterial Hypertension OR (95% CI)	Diabetes mellitus OR (95% CI)	Hypercholesterolemia OR (95% CI)
Occupational			
Physically inactive	0.98 (0.54-1.78)	1.07 (0.65-1.78)	0.69 (0.42-1.13)
Moderately Active	0.68 (0.44-1.05)	0.86 (0.58-1.26)	1.13 (0.79-1.61)
Active	1.00	1.00	1.00
Sports			
Physically inactive	1.58 (0.96-2.60)	0.95 (0.61-1.47)	1.29 (0.85-1.96)
Moderately Active	1.41 (0.94-2.11)	0.77 (0.53-1.12)	0.91 (0.63-1.29)
Active	1.00	1.00	1.00
Leisure-time			
Physically inactive	1.20 (0.74-1.97)	1.79 (1.17-2.72)	1.85 (1.24-2.76)
Moderately Active	1.05 (0.72-1.54)	1.37 (0.95-1.95)	1.42 (1.02-1.99)
Active	1.00	1.00	1.00
	p-value = 0,927* (79,7%)**	p-value = 0,817* (71,4%)**	p-value = 0,532* (69%)**

Notes: OR = odds ratio; 95% CI = confidence interval of 95%; * = Hosmer-Lemeshow; ** = Percentage of how much the model can explain the behavior of the outcome; Models including three domains of physical activity simultaneously and adjusted for: BHU, sex, age, smoking, economic status, SBP, DBP, BMI and WC.

where strategies for food adequacy and changes in lifestyle could make a difference in preventing future complications and comorbidities, as well as the prospect of minimal economic impact to the health sector[21].

Another important finding was the association between the occurrence of AH, DM and hypercholesterolemia with indicators of general and abdominal obesity, information extensively observed in Brazilian and worldwide researches[22-25]. In developing countries improving economy and social situation, there is an increase in prevalence rates of obesity and factors associated with MetS, and the main causes of this dangerous association are increasing urbanization, nutrition transition, insufficient PA and the easiness of access to and supply of goods and services[26].

Another particular finding was the association between lower levels of PA in different domains and the diseases analyzed. After adjustment for potential confounders, lower level of PA in leisure-time was significantly associated with a higher prevalence of DM, hypercholesterolemia and MetS, while the lowest level of sports practice was associated with increased prevalence of AH.

These results are in accordance with Brazilian investigation, which found that physical inactivity was associated with the occurrence of AH, hypercholesterolemia, obesity and clustering of chronic diseases, especially among men[27]. Furthermore, relevant research conducted by Lee et al.[28], which sought to evaluate the impact of physical inactivity on major chronic diseases in the world, found that such behavior is responsi-

Table 3. Multivariate association between physical activity domains and metabolic syndrome (Brazil, n = 963).

Domains	Chi square N (%)	Logistic Regression OR (95%CI)§
Occupational		
Physically inactive	79 (32.9)	---
Moderately Active	166 (34.5)	---
Active	79 (32.6)	---
p-value	0.948	
Sports		
Physically inactive	85 (35)	---
Moderately Active	161 (33.6)	---
Active	78 (32.4)	---
p-value	0.543	
Leisure-time		
Physically inactive	85 (37.3)	**1.48 (1.08 to 2.05)**
Moderately Active	148 (36.8)	**1.56 (1.06 to 2.29)**
Active	91 (27.3)	1.00
p-value	**0.008**	p-valor = 0,183*
Overall		
Physically inactive	78 (32.9)	---
Moderately Active	170 (35)	---
Active	76 (31.7)	---
p-value	0.771	

Notes: OR = odds ratio; 95% CI = confidence interval of 95%; * = Hosmer-Lemeshow; § = Model adjusted simultaneously for: BHU, sex, age, smoking, economic status, sports practice and occupational PA.

ble for 7% of DM cases and 6% of heart disease, in addition to increased mortality rates and decreased life expectancy.

Regarding to MetS, recently published meta-analysis showed that individuals with higher indicators of PA during leisure-time were 20% less likely to develop the syndrome compared to those with lower involvement in this domain of PA[29]. Additionally, Najafian et al.[30] found association between lower levels of PA and the occurrence of the MetS, as well as to inverse relationship between duration of daily walking and MetS.

Exploring the idea that exercise practice may confer tangible benefits for the prevention and reversal of risk factors for MetS, studies with different protocols and intensity of exercises have been undertaken in recent years. Randomized controlled trial with adults found reduction of indicators that cause the MetS, as well as reduction in visceral fat after one year of intervention with high intensity exercises[31]. Additionally, Colombo et al.[32] found significant improvements in WC, BMI, SBP, DBP, and HDL-cholesterol in patients with MetS after twelve weeks of aerobic exercise program with moderate intensity.

Thus, population ageing and rates of obesity increasing lead to key questions: Can PA attenuates the weight gain associated with aging? Can PA prevent the occurrence of metabolic diseases in adults? Current guidelines recommend a daily of 60 minutes of moderate-intensity PA, plus at least two sessions per week of resistance training to ensure substantial and additional health benefits and weight loss[33]. Therefore, evidence suggests that promotion of energy balance, changes in the distribution of body fat and increased muscle mass can to result in better metabolic control[34].

As limitation we have the cross-sectional design that does not allow cause-effect conclusions. In fact, a cohort study has been conducted with this sample and, in the future, it will be possible ratify or not our findings in a longitudinal design.

In conclusion, the present study found high rates of risk factors associated to MetS, as well as for MetS itself and chronic diseases as AH, DM, hypercholesterolemia, and obesity. Furthermore, there was association between lower engagement in PA during leisure-time and higher occurrence of risk factors for MetS.

Collaborations

BC Turi worked collecting data, interpretation of results and paper writing; JS Codogno worked collecting data, interpretation of results and revising paper; RA Fernandes assisted with statistical analysis, interpretation of results and revising paper; HL Monteiro guided the research project, analysis and interpretation of results and final revision of the paper.

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