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ORIGINAL ARTICLE

Prevalence of Physical Inactivity and its Effects on Blood Pressure and Metabolic Parameters in a Brazilian Urban Population

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Abstract

Background: Cardiovascular disease is the leading cause of mortality in the world and physical inactivity represents an important risk factor.

Objective: This study aimed to evaluate the prevalence of physical inactivity in the adult population and its effects on blood pressure, blood glucose and lipid profile.

Methods: A population-based cross-sectional study with stratified simple random sampling was conducted in 1,717 adults divided by age groups: 18-39, 40-49, 50-59, 60-69 and ≥ 70 years. The participants answered the physical activity questionnaire and were classified as physically active or inactive. The bootstrap statistical method was used to assess physical activity, associated with lipid profile and blood glucose levels. The level of significance was 5%.

Results: The prevalence of physical inactivity in the general population was 65.8%. There was a significant difference in the group older than 70 years. There was a significant decrease in physical activity in the group with lower educational level, with a significant difference between social classes AB and C. The prevalence of hypertension was 27.5% among physically inactive and 21.4% among active individuals ($p = 0.04$). The prevalence of metabolic syndrome was 26.1% in inactive and 16.7% in the active individuals ($p = 0.007$). Total cholesterol, low-density lipoprotein and triglycerides levels were more elevated in the physically inactive group, which was not observed with high-density lipoprotein levels. Blood glucose was also higher in the inactive group.

Conclusion: This study shows a high prevalence of physical inactivity and a positive correlation between risk factors for cardiovascular disease, mainly blood pressure, glucose and lipids profiles. (Int J Cardiovasc Sci. 2018;31(6)594-602)

Keywords: Exercise; Diabetes Mellitus; Hypertension; Metabolic Syndrome; Risk Assessment.

Introduction

Cardiovascular diseases (CVD) are the leading cause of mortality in high and low-income countries. In the last decades, CVD accounted, on average, for 30% of all deaths in Brazil.[1] A large number of cardiovascular events can be attributed to several risk factors, particularly physical inactivity. According to the World Health Organization (WHO), physical inactivity is the fourth-leading risk factor for global death, responsible for 3.2 million deaths annually, including an estimated 670,000 early deaths (people aged < 60 years).[2] Individuals who are insufficiently active have a 20% to 30% increased risk of all-cause mortality when compared to people who practice at least 150 minutes of moderate-intensity physical activity per week.[2] It is estimated that physical inactivity accounts for 6% to 10% of the world's burden of chronic diseases.[3]

Several studies have shown an inverse association between the practice of regular exercise and the

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risk of disease. The health benefits of moderate or vigorous intensity physical activity include lower risk of developing or dying from chronic diseases, such as type 2 diabetes mellitus (T2DM), hypertension (HT), coronary artery disease (CAD), stroke, kidney disease and some types of cancers.[4-9] Admittedly, physical activity improves lipid profiles and glycemic control; it reduces the risk of developing insulin resistance and glucose intolerance, and it plays an important role in the treatment of hypertension.

The prevalence of physical inactivity in the population is variable, depending of the assessed world region and of age.[10,11] Generally, older adults are more physically inactive than younger adults, showing about 55% versus 23% of inactivity, respectively.[10] About one in every three American adults (30.4%) do not engage in physical activity.[11] However, in Brazil, there is a lack of consistent data on the prevalence of physical inactivity and its effect on clinical and metabolic parameters in the general population at different age groups. Therefore, this study aimed to evaluate the prevalence of physical inactivity in a Brazilian urban adult population stratified by age groups, correlating it to demographic, anthropometric and biochemical parameters.

Materials and methods

Study design setting, and participants

This study was approved by the Research Ethics Committee of the Medical School (057/2004). All participants were informed about the purpose of the study and provided informed consent before starting it. This was a cross-sectional, population-based study with simple random sampling and stratified by age groups, which was carried out from March 2004 to November 2005 in the urban adult population (≥ 18 years) of São José do Rio Preto, São Paulo, Brazil.[12] The sampling was stratified according to age groups, based on the data provided by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE). At the time the survey, the city had a population of 370,000 inhabitants, predominantly white (82.8%) and with a balanced distribution between men (48.4%) and women (51.6%).[13] The groups were divided by age ranges: 18-39, 40-49, 50-59, 60-69 and ≥ 70 years. The parameters used to calculate the stratum sample sizes were number of inhabitants, expected prevalence of hypertension for each age group, a confidence interval of 95% and a maximum error of 3%.[14]

The city was divided into census sections according to IBGE. In each sector, the number of individuals was determined according to the proportionality of the population. For each region, streets, homes, an adult living for more than six months in a house, who met the inclusion criteria, was randomly chosen. After the visit to the first residence, houses located on alternating sides of the street, after skipping two households, were visited. If the selected individual did not agree to participate, the next-door neighbor was randomly chosen. Exclusion criteria included pregnancy, severe degenerative diseases, incapacitating mental disorders, severe psychiatric diseases or mental disability and bedridden patients.[12]

Interviewers were previously trained and monitored by a field coordinator. The participants answered a questionnaire that included their personal data, income and assets, in order to assess their socioeconomic status, formal education (number of years of schooling), personal and family medical history, lifestyle, awareness of hypertension and diabetes medication being used. After that, body mass index (BMI), pulse rate and blood pressure (BP) were assessed.

Data collection

The BP measurement technique was that standardized by the VII Joint National Committee:[15] 1) measurements were taken with a recently calibrated aneroid sphygmomanometer (Welch Allyn / Tycos) known to be accurate; 2) the cuff was placed so that the lower edge was 3 cm above the elbow crease and the bladder was centered over the brachial artery; 3) a standard, a large, and a small bladder were available for thicker and thinner arms, respectively; 4) the arm was bare and supported, with the blood pressure cuff positioned at the heart level 6) phase I and V (disappearance) Korotkoff sounds were used to identify systolic and diastolic BP, respectively; 7) the pressure was rapidly increased to 30 mmHg above the level at which the radial pulse was extinguished; 8) a cuff deflation rate of 2 mmHg per beat was used; 9) a minimum of 1-minute intervals were recommended between readings to prevent venous congestion; 10) BP was measured in both arms to detect possible differences due to peripheral vascular disease; in this case, the higher value was taken. Arterial hypertension was defined as systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg or with the use of antihypertensive medications. For individuals with borderline BP values, a new measurement was taken on a different day at the same hour of the last measurement.

The socioeconomic status was divided into classes A, B, C, D and E, and later into groups AB, C and DE (based on family income and assets). Groups AB had a monthly income higher than 10 minimum wages; Group C, between 3 and 5 minimum wages; and Groups DE, lower than 3 minimum wages.[12,16] Formal education was defined by the number of years of study, considering two levels: Level 1: 0-11 school years; and Level 2: > 11 school years, including university degrees.[12]

The short version of the International Physical Activity Questionnaire was used to assess the overall physical activity (OPA), including work-related physical activity (WPA), transport-related physical activity (TPA), domestic activities (DA) and leisure time physical activity (LTPA). The level of physical activity was classified as physically active individuals (PA), who performed more than 150 minutes of physical activity per week (including manual labor jobs, walking, running, swimming and cycling) and physically inactive individuals (PI), who performed < 150 minutes per week.

Clinical variables

The BMI was obtained by the weight/height^2 ratio (kg/m^2). A calibrated portable scale was used for weight measurements. Individuals were classified as normal weight (18.5 to 24.9), overweight (25 to 29.9) and obese (≥ 30 kg/m^2).[17]

The diagnosis of type T2DM was established based on the patient's medical history, on hypoglycemic medication and blood glucose measurements.[18]

The levels of blood glucose, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c) and triglycerides (TG) were analyzed after 12 hours of fasting by the colorimetric method. An RXL analyzer and the Dade Behringer reagent were used for the analysis. The low-density lipoprotein cholesterol (LDL-c) levels were calculated using Friedewald formula: LDL-c = TC - (HDL-c + TG /5) for TG < 400mg/dL.[19]

Metabolic syndrome (MetS) was classified according to the following diagnostic criteria: waist circumference (men ≥ 102 cm and women ≥ 88 cm), TG ≥ 150 mg/dL, HDL-c [< 40 mg/dL (for male) and < 50 mg/dL (for female)], BP (Systolic BP ≥ 130 or Diastolic BP ≥ 85 mmHg), fasting blood glucose (≥ 100 mg/dL or T2DM) or specific treatment for these conditions.[20]

Statistical analysis

Statistical analysis was carried out using the Minitab programs version 12.22 and R 2.4.1. Estimated frequency of physical activity according to factors (education, age, gender and socioeconomic status), characteristics (BMI, HT, MetS), and metabolic parameters (cholesterol, HDL-c, LDL-c, TG and blood glucose) was performed by estimation and population association testing by means of the method of weighted least squares. Correction for the weight of the population was made according to the age group: 55.33% for 18-39 years, 18.45% for 40-49 years, 12.29% for 50-59 years, 8.20% for 60-69 years and 5.73% for 70 years or more. The bootstrap statistical method (simulation method of convex combinations with the same weights used for the analysis of frequencies, where 1,000 bootstrap samples are generated for each comparison) was used to assess the physical activity, associated with serum lipid and glucose levels. This method (resampling technique) attempts to accomplish what would be desirable to do in practice if it were possible: to repeat the experiment. The observations are chosen at random and the estimates recalculated for the purpose of improving the final estimate.[21] The level of significance was 5%.

Results

Baseline characteristics

A sample of 1,717 urban adults (≥ 18 years) was evaluated in this study. Table 1 shows the distribution of the studied sample and the prevalence of PI individuals adjusted for the population according to age groups (in years) and the expected number of PI in the population. In the general population, the prevalence of PI individuals was 65.8% (95% CI: 62.2%-69.5%) and 34.2% (95% CI: 30.5%-37.8%) for the PA group. Regarding gender and age range, there was a higher prevalence of PI among women in both age groups 18 to 39 years and ≥ 70 years (women 73.9% and men 56.3%; p = 0.006 and women 83.1% and men 72.7%; p = 0.03, respectively). No differences were found between genders in the other age groups.

Table 2 demonstrates the levels of physical activity estimated for the population and related to demographic data (age, gender, education and socioeconomic status), as well as risk factors (HT, obesity and MetS). Table 2 also shows the prevalence ratios among the studied variables in the PI individuals.

Table 1 - Prevalence of physically inactive individuals according to age groups (in years) and the expected number in the population

Age groups (years)	Sample (n)	CP - PA (%)	CP - PI (%)	Number of inhabitants for each age group	Expected number of PI in the population
18 to 39	220	34.5	65.5	145,938	95,589
40 to 49	395	35.7	64.3	48,637	31,273
50 to 59	449	33.6	66.4	32,416	21,524
60 to 69	375	37.3	62.7	21,602	13,545
≥ 70	278	21.9	78.1 *	15,133	11,819
Total	1,717	34.2	65.8	263,768	173,559

*CP: corrected for population of the city, PA: physically active, PI: physically inactive. * p = 0.03: ≥ 70 group vs all groups.*

Table 2 - Characteristics of the population stratified according to gender, socioeconomic status, formal education, body mass index, hypertension and metabolic syndrome

		N	CP (95% CI)	PI (%)	PA (%)	PI prevalence ratio	p-value
Gender	Male (M)	837	48.4 (44.6-52.2)	60.1	39.9	PI F/M: 1.19	0.003
	Female (F)	880	51.6 (47.8-55.4)	71.2	28.8		
Socioeconomic status	AB	376	19.8 (17.0-22.7)	58.0	42.0	AB/DE: 1.13	
	C	719	43.2 (39.4-47.0)	69.7	30.3	C/AB: 1.20	0.03
	DE	622	37.0 (33.2-40.7)	65.7	34.3	C/DE: 1.06	
Schooling	< 11 Years	1225	60.7 (56.9-64.5)	69.5	30.5	PI < 11y/> 11y: 1.15	0.02
	> 11 Years	492	39.3 (35.5-43.1)	60.2	39.8		
BMI	Normal Weight	676	44.6 (40.7-48.4)	64.5	35.5	N/Ob: 0.94	
	Overweight	645	33.2 (29.7-36.7)	65.8	34.2	N/Over: 0.98	NS
	Obesity	396	22.2 (19.1-25.4)	68.7	31.5	Over/Ob: 0.96	
Blood pressure	Hypertensive	762	25.4 (22.8-27.9)	27.5	21.4	PI HT/PA HT: 1.28	0.04
	Normotensive	955	74.6 (72.2-77.4)	72.5	78.6		
MetS	with MetS	467	22.7 (19.4-26.0)	26.1	16.7	PI MetS/PA MetS:1.56	0.007
	without MetS	902	77.3 (72.2-79.0)	73.9	83.3		

The socioeconomic status is divided into 3 grouped social classes (AB, C and DE). All the data were corrected for the total population of the city. The statistical analysis was performed by estimation and population association testing by means of the method of weighted least squares. CI: confidence interval, CP: corrected for population of the city, BMI: body mass index, MetS: metabolic syndrome, PI: physically inactive, PA: physically active, N: normal weight, Ob: obesity; Over: overweight, NT: normotensive, HT: hypertensive.

The prevalence of PI individuals was higher among women as compared with men, with a prevalence ratio of 1.19 (p = 0.003). There was a lower prevalence of PI in class AB, in comparison with class C (p = 0.03). The prevalence rate of PI among those with lower educational levels when compared with those with higher educational level was 1.15 (95% CI: 1.02 to 1.31%) (p = 0.02). There was no difference regarding PI prevalence ratios in the groups of evaluated BMI (table 2).

Hypertension

The corrected prevalence of HT in the studied population was 25.4% (95% CI: 22.8%-27.9%). The PI/PA prevalence ratio was 1.28 (95% CI: 1.01-1.64) (p = 0.04) showing a lower prevalence of HT in active subjects (table 2).

Metabolic syndrome

The corrected prevalence of MetS for the studied population was 22.7%. The sedentary/active prevalence ratio was 1.56 (95% CI:1.10-2.23; p = 0.007) (table 2).

Biochemical data (TC, LDL-c, HDL-c, TG, glucose) and the presence of MetS were evaluated in 1,369 subjects who completed the examinations.

Lipid profile and blood glucose

The bootstrap statistical method was used to assess the physical activity, associated with serum lipids and blood glucose levels. The levels of total cholesterol, LDL-c and TG were higher in the physically inactive than in physically active individuals (189.1 ± 1.8 vs 183.3 ± 3.1 mg/dL; 116.5 ± 1.4 vs 111.6 ± 2.6 mg/dL and 134.8 ± 4.2 vs 126.5 ± 0.9 mg/dL, respectively). The images demonstrate a rightward shift of the curve, with a tendency for higher plasma levels of these lipoproteins in physically inactive subjects (Figure 1, panels A, C and D for TC, LDL-c and TG, respectively). For HDL-c, the curves are practically superimposed (46.3 ± 0.7 mg/dL in the physically inactive and 46.9 ± 1.0 mg/dL in the active individuals) (Figure 1, Panel B). Concerning blood glucose, sedentary individuals showed a rightward shift of the curve, which demonstrated a clear tendency for higher levels of glucose in the physically inactive group (84.1 ± 1.2 mg/dL for PI and 79.4 ± 0.9 mg/dL for PA) (Figure 2).

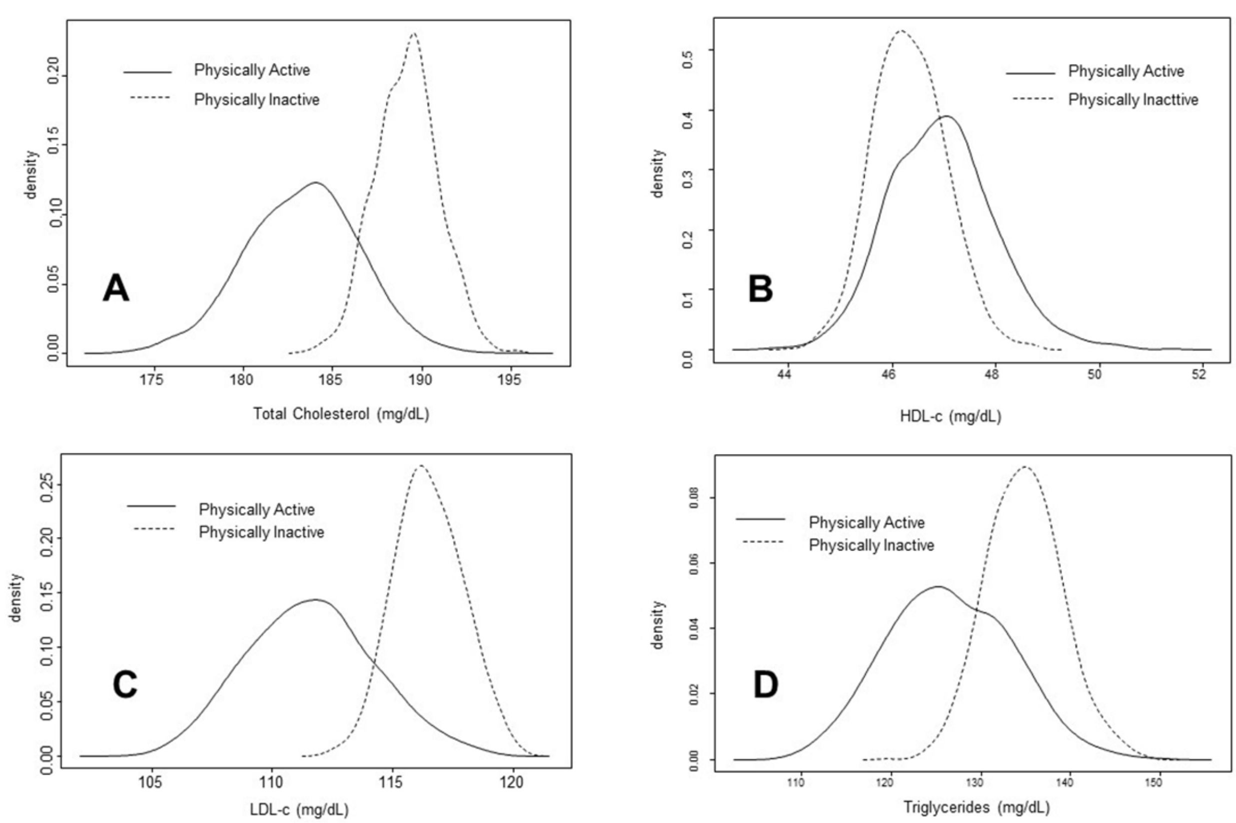

Figure 1 - Distribution of lipid parameters in relation to physical activity. The figure shows the following panels: total cholesterol level (A), HDL-c (B), LDL-c (C), TG (D) in relation to physical activity levels (physically active or inactive). The levels of total cholesterol, LDL-c and TG were higher in physically inactive individuals than in physically active ones (189 vs. 183 mg/dL; 116 vs. 111 mg/dL and 134 vs. 126 mg/dL, respectively) (Panels 1A, 1C and 1D). For HDL-c, the curves are practically superimposed (46.3 mg/dL in physically inactive individuals and 46.9 mg/dL in active ones) (Panel 1B). HDL-c: high density lipoprotein; LDL-c: low density lipoprotein; TG: triglycerides.

Discussion

This study assessed various aspects related to overall physical activity in the urban adult population and its importance in the prevention of risk factors for CVD and T2DM. A total of 1,717 individuals of different age groups and sample data adjusted for the population were studied. As expected, a high prevalence of physically inactive subjects was detected (65.8%). Indeed, previous studies have shown a large range in the prevalence of physical inactivity.[11,22-24] In addition, our findings showed prevalence of PI higher than 62% in all age groups, with the highest prevalence in the group > 70 years (78.1%), similar to that of previous studies.[11,24]

The difference between genders showed a high prevalence of PI in women in comparison with men (71.2 and 60.1%, respectively), mainly in the extremes of the age groups. In agreement with our data, studies have shown a greater PI in women (55.5%) as compared with men (42%).[25] The reason for the lower practice of physical activity at those age ranges might be the beginning of the career and/or professional activities for the young individuals, whereas for individuals aged > 70 years, it could be due to the lack of stimulus to perform physical exercise or mobility issues.

Regarding formal education levels, this study clearly showed that PI was 15% higher in the group with lower education. Other authors also showed a higher physical activity rate related to higher educational levels and an inverse association between the educational level and work-related physical activity.[26,27]

According to the socioeconomic level, there was a predominance of PI individuals in all the social classes. However, a significant difference was observed only between classes AB and C. The frequency of PI was 20% higher in class C compared to AB, probably due to increased LTPA in the AB group. Some authors have also reported the prevalence of PI during leisure time, rather than at work, as a risk behavior in relation to cardiorespiratory and metabolic health.[28,29] On the other hand, socioeconomic class DE showed a lower frequency of PI compared to C, due to a large number of workers with higher frequencies of domestic and transport-related physical activities, namely cycling or walking.[30]

Regarding BMI, 55.4% were overweight or obese, although the prevalence of PI in the studied groups was not significantly different. Overweight and obese individuals were probably advised to practice physical exercise, which might have led to the observed results. Interestingly, obese women with high levels of physical activity appear to have staved off the actual development of CAD and CVD.[31] Nonetheless, sedentary individuals have shown a higher risk of increasing BMI over the years.[32]

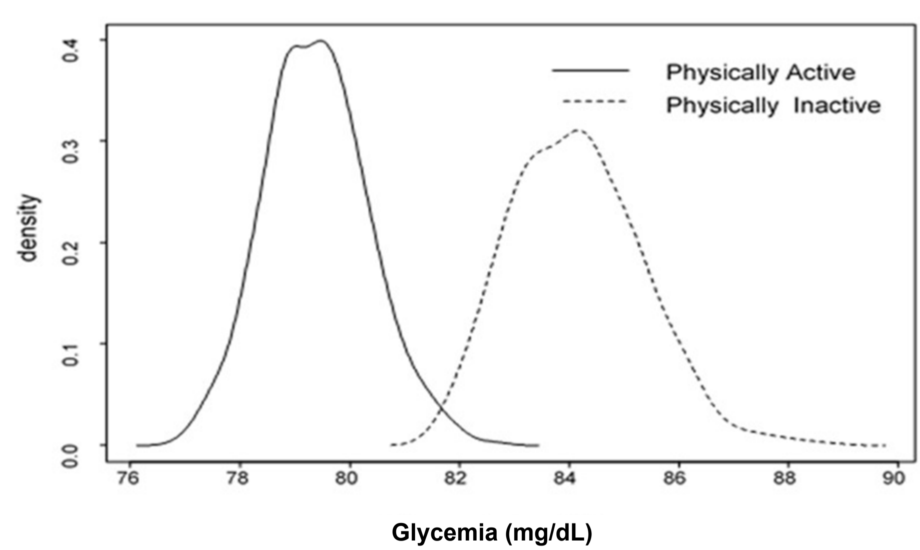

Figure 2 - Distribution of glycemic levels in relation to physical activity. The figure demonstrates a clear tendency for higher levels of glucose in the physically inactive group (84.1 mg/dL vs. 79.4 mg/dL).

Hypertension

In the present study, there was a 28% higher probability of HT in PI individuals. In turn, studies have shown a reduced prevalence of HT related to a higher rate of physical activity.[33,34] Physical activity decreases total peripheral resistance by improving endothelium-dependent relaxation, mainly mediated by a significant increase in vascular nitric oxide (NO) production and/or decrease in NO scavenging by reactive oxygen species (ROS). Moreover, exercise has also been shown to release several cytokines and anti-inflammatory peptides, which in turn increase NO bioavailability by decreasing ROS production. Exercise-related vasodilation was also associated with the growth of new arterioles and the reduction of nervous sympathetic activity.[34]

Metabolic syndrome

It was observed a 56% higher probability of MetS in PI individuals. Several studies have found that the practice of LTPA was associated with a reduction in MetS components.[35-37] Longer duration of daily physical activities leads to a lower prevalence of MetS, especially for the components of central obesity and HDL-c levels.[37] Moreover, a recent study showed that middle-aged individuals with MetS who usually perform physical activity had lower arterial stiffness and more favorable cerebral white matter integrity than their sedentary peers.[38]

Lipid parameters

The analysis of bootstrap in the PI group showed a tendency for higher levels of lipoproteins (TC, LDL-c and TG), when compared with PA subjects. Physical exercise has shown beneficial effects on plasma lipoproteins, such as decrease in TC, LDL-c, and TG levels.[39,40] Spending less time in sedentary behaviors, and having medium levels of intense physical activity may be associated with a more favorable blood lipid profile.[40]

Blood glucose

The bootstrap method curve showed a rightward shift in the PI group, and, consequently, lower glucose levels in the PA group. Data have shown an inverse association between physical activity and blood glucose.[34,35] Studies have demonstrated that improved blood glucose control is due to increased insulin sensitivity and glucose metabolism promoted by physical exercise.[37]

Strengths and limitations

Some limitations of this study should be mentioned. First, the guidelines of the American Diabetes Association[18] recommend the confirmation of hyperglycemia through a second blood glucose measurement, which was not performed in this study. However, epidemiological studies, including NHANES, used almost exclusively a single blood glucose measurement for the diagnosis of T2DM. Second, the interference of antilipemic drugs on lipid values determination was not assessed. Third, the association between physical activity and its benefits in preventing CVD risk and T2DM could be better evaluated in a cohort study rather than a cross-sectional one. Nevertheless, this fact does not invalidate the present study since that its main objective was to evaluate the prevalence of physical inactivity in the urban population. The benefits of physical activity could be better assessed through a cohort study, which is not the goal of this study. On the other hand, this population-based, age-stratified study, is unique as it gathers different demographic, epidemiologic and risk factors involved in the association between physical activity, hypertension and CVD in a single sample with a population assessment calculation, which might be extrapolated to other populations.

Conclusions

This study shows a high rate of physical inactivity in all age groups, higher among women and with differences in the prevalence according to the socioeconomic and educational levels. It also demonstrates a clear association between physical inactivity and the presence of cardiovascular risk factors, mainly hypertension, hyperglycemia and lipid changes, observed by the bootstrap method.

Author contributions

Conception and design of the research: Cipullo JP, Ciorlia LAS, Cesarino CB, Vilela-Martin JF. Acquisition of data: Cipullo JP, Ciorlia LAS, Cesarino CB, Vilela-Martin JF. Analysis and interpretation of the data: Rissardi GGL, Cipullo JP, Giollo Junior LT, Vilela-Martin JF. Writing of the manuscript: Rissardi GGL, Moreira GC, Vilela-Martin JF. Critical revision of the manuscript for intellectual content: Giollo Junior LT, Zanesco A, Vilela-Martin JF.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of the *Pesquisa da Faculdade de Medicina de São José do Rio Preto* (FAMERP) - SP under the protocol number 057/2004. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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