



Is city of residence a factor differentiating Sitting time in adolescents?

A cidade de residência é um fator que diferencia o tempo sentado de adolescentes?

AUTHOR'S

Roberval Emerson Pizano¹

Christiane de Faria Coelho Ravagnani²

Robert Glenn Weaver³

Maria Sylvania de Souza Vitalle⁴

1 Federal Institute of Education, Science and Technology of Mato Grosso, Department of Physical Education, Cáceres, Mato Grosso, Brazil.

2 Federal University of Mato Grosso do Sul, Department of Physical Education, Campo Grande, Mato Grosso do Sul, Brazil.

3 University of South Carolina, Arnold School of Public Health, Department of Exercise Science, Columbia, South Carolina, Estados Unidos.

4 Universidade Federal de São Paulo Departamento de Pediatria- São Paulo, Brasil.

CORRESPONDING

Roberval Emerson Pizano

robervalpizano@hotmail.com

Rua dos Canários, 367, Cidade Alta,

Cáceres, Mato Grosso, Brazil.

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ABSTRACT

The aim of this cross-sectional study was to examine the association between city of residence and other factors related to sitting time in adolescents. Students ($n = 1,089$), between 14 and 18 years, completed self-reported questionnaires to collect data about sitting time, general fitness, physical education and sport participation, socio-economic stratum and householder's education in Botucatu (SP), Cáceres (MT) and São Paulo (SP). The choice of municipalities occurred for convenience and the selection of schools and students was performed randomly. Multi-level mixed linear regression models were used to estimate the relationship between the independent variables and sitting time (min.day⁻¹) during weekdays and weekend days. Hierarchical models were estimated to account for the nested nature of student within schools. Regarding cities of residence, there was no association with sitting time on both weekday (São Paulo, $\beta = 36.87$, CI: 25.6; 233.62 and Cáceres, $\beta = 66.94$, CI: 22.1; 156.01) and weekend (São Paulo, $\beta = 104.01$, CI: 64.5; 138.20 and Cáceres, $\beta = 90.23$, CI: 33.2; 213.64), when compared to Botucatu. Socio economic indicators were related to sitting time in different ways considering week or weekend. Students with higher householder education degrees had more sitting time on weekdays. On weekend students in higher levels of socioeconomic stratum presented less sitting time. Adolescents with very good perception of general fitness had -65.29 minutes of sitting time on weekday and -70.1 minutes of sitting time on weekend. In the present study, city of residence was not related to sitting time in adolescents. However, other factors such as gender, socioeconomic stratum and educational status, participation in sports and physical education and perceptions of fitness were related to students sitting time.

Keywords: Physical fitness; Adolescents; Sedentary lifestyle.

RESUMO

O objetivo deste estudo de cunho transversal foi examinar a associação entre cidades de residência e outros fatores relacionados ao tempo sentado em adolescentes. Estudantes ($n = 1.089$), com idades entre os 14 e 18 anos, responderam a questionários sobre tempo sentado, percepção da aptidão física geral, participação em educação física e participação em esportes, estrato socioeconômico e educação do responsável da família nos municípios de Botucatu (SP), Cáceres (MT) e São Paulo (SP). A escolha dos municípios ocorreu por conveniência e a seleção das escolas e alunos foi realizada de forma randômica. Modelos de regressão linear mista de multiníveis foram utilizados para estimar a relação entre as variáveis independentes e a quantidade de minutos sentados (min/dia) durante a semana e nos dias ao final de semana. Os modelos hierárquicos foram estimados para explicar a natureza aninhada do aluno dentro das escolas. Com relação às cidades de residência, não houve associação com o tempo sentado durante a semana (São Paulo, $\beta = 36,87$, IC: 25,6; 233,62 e Cáceres, $\beta = 66,94$, IC: 22,1; 156,01) e no fim de semana (São Paulo, $\beta = 104,01$, IC: 64,5; 138,20 e Cáceres, $\beta = 90,23$, IC: 33,2; 213,64), quando comparados a Botucatu. Os indicadores socioeconômicos foram relacionados ao tempo sentado de diferentes maneiras, considerando a semana ou o fim de semana. Estudantes que tinham responsável com nível educacional mais alto tiveram mais tempo sentados durante a semana. Nos finais de semana, estudantes com melhor estrato socioeconômico apresentaram menos tempo sentados. Adolescentes com percepção muito boa de aptidão física geral tiveram -65,29 minutos de tempo sentado no dia da semana e -70,1 minutos de tempo sentado no fim de semana. No presente estudo, a cidade de residência não teve relação ao tempo sentado em adolescentes, no entanto, outros fatores, como gênero, estrato socioeconômico e status educacional, participação em esportes e educação física e percepções de aptidão física foram relacionados ao tempo sentado.

Palavras-chave: Aptidão física; Adolescentes; Estilo de vida sedentário.

Introduction

Sedentary behavior (SB) is defined as any waking time characterized by energy expenditure of ≤ 1.5 metabolic equivalents (METs). Examples of sedentary behavior include sitting at a desk, riding in a vehicle, or watching television¹. A growing body of epidemiological evidence has linked sedentary behavior to a variety of health risks including an increased risk of chronic diseases and all-cause mortality^{2,3}.

In a systematic review of the literature, Carson et al.⁴ suggested that higher durations/frequencies of screen time and television (TV) viewing were associated with various harms to health such as an unfavorable body composition, higher clustered cardiometabolic risk scores, lower physical fitness, lowered self-esteem and pro-social behavior, and worse academic performance. These associations have also shown that sedentary behaviors have the potential to influence risk of disease, independent of physical activity level^{2,3}.

Several studies report that children and adolescents spend the majority of their leisure time engaging in sedentary pursuits like watching television or playing video games^{5,6}. In a recent study of Brazilian adolescents, Rezende et al.⁷ showed that the prevalence of adolescents that watched at least two hours of television per day was 61.8%, with similar rates for females and males 59.0% and 64.5%, respectively. The high prevalence of television viewing among Brazilian adolescents justify the need for more research on the prevalence and correlates of television viewing⁷.

Most studies with adolescents identify sedentary behavior as screen time on TV, cell phones, computers and video games⁴. However, this represents only part of the total time spent by young people in sedentary behavior, excluding activities such as sitting in school, reading in home and commuting. In addition to sitting time (ST) encompassing more activities related to sedentary behavior, it is associated with all-cause mortality such as myocardial infarction and coronary heart disease⁸.

Sedentary behavior is determined by different and complex factors. Evidence from studies in different countries show that age, racial/ethnic group, educational attainment, gender, income, and city of residence are all related to sedentary activity^{5,9,10}. Besides that, the locality and the social and physical environment in which people live are recognized as potentially powerful influences on the time adolescent spend sedentary¹¹.

Studies addressing sedentary behavior in adolescents living in cities with different size are scarce and

the much of the evidence on the relationship of environmental factors with sedentary behavior comes from studies in Australia⁹, Canada¹² and the USA^{3,5}, not from South America. There are data in Brazil collected in different cities, as reviewed by Guerra et al.¹³, but they hardly identify the relationship between the city of residence. Besides that, each city in Brazil has their own public policies for physical activity and leisure time that can influence on citizen's lifestyle.

Therefore, the aim of this study was to examine the association between city of residence and other factors related to sitting time in adolescents.

Methods

This cross-sectional study occurred in the Brazilian municipalities with different population sizes: São Paulo (large city), Botucatu (medium city) and Cáceres (small city). São Paulo is the state capital, with a population of approximately 12,000,000 inhabitants, 60% of white ethnic, Municipal-level Human Development Index (IDHM) of 0.805 and ranked as 28th among the most developed Brazilian cities according to Botucatu, a municipality in the interior of São Paulo State, with a population of approximately 140,000 inhabitants, approximately 77% of white ethnic, IDHM of 0.800 and ranked as 40th among the most developed municipalities in the country. Cáceres, in the State of Mato Grosso, has approximately 90,000 inhabitants, approximately 58% of brown people, IDHM of 0.790 and is ranked as the 1,665th most developed city in Brazil. São Paulo and Botucatu have, on average, relatively higher family incomes and educational level than families in Cáceres¹⁴.

For this study, the municipalities were divided into five geographic regions: north, south, east, west and central. In each region one school was randomly selected for data collection and invited to participate in the study. Recruitment and consent of schools occurred from April to May 2015, via face-to-face meetings with the school principals. A list of eligible schools was created from which schools were randomly selected until five consented to participate in each municipality. After schools agreed to participate, about 10 classrooms by school were randomly selected and students were recruited after clarification about the procedures and objectives of the study. As inclusion research criteria, only adolescents who were 14 to 18 years old and who did not present physical problems that made it impossible to perform physical activity were included. Participation was voluntary and no individual identification information was exposed.

All the schools, parents and students participants gave their assent/consent before participation in the study.

All surveys were administered to adolescents in their classrooms at the beginning of the school day. Surveys were administered by 11 trained members of the data collection team. A pilot study ($n = 14$ adolescents, 14-18 years of age) was conducted in order to verify the pertinence of the items, language, clarity and objectivity of the general questionnaire questions. No problems or inconsistencies were found in the instruments. Data collection was completed between October and December of 2015. All data collection procedures are in accordance with Resolution CNS / MS 466/2012 that regulates studies in humans and were approved by the Research Ethics Committee of the Federal University of São Paulo under No. 0685/2015.

Boys and girls, between the ages of 14 and 18 years enrolled in a state public high school participated in the research. Adolescents completed a Brazilian self-reported questionnaire to collect data about age, gender, socio-economic stratum (SES), and householder's education (HED)¹⁵. Participants were divided into three age groups: 14-15 years, 16 years and 17-18 years. The questionnaire Criteria of Economic Classification Brazil developed by the Brazilian Association of Research Company (ABEP)¹⁵ contains estimations for total Brazil and macro regions based on national probabilistic studies and represents characteristics of households from the lower to higher social-economic strata: D-E, C2, C1, B2, B1, A. This classification system is based on the quantity of household possessions as TV set, radio, washing machine, car and educational level of householder and the used water and street coating. Each level corresponds to an approximate value of family income in US dollars, as follows: A = US\$6180, B1 = US\$2650, B2 = US\$1349, C1 = US\$734, C2 = US\$446, D/E = US\$194¹⁵. For SES analyses, five groups were considered: D-E-C2, C1, B2, B1 and A.

Householder education was categorized into the following levels: no schooling/incomplete elementary school (IES), elementary school diploma/incomplete junior high school (IJS), junior high school diploma/incomplete high school (IHS), high school diploma/incomplete higher education (IRS) and higher education degree (HES). For this study, were considered four groups: IES-IJS, IHS, IRS and HES.

General fitness level was assessed using a single-response item included in the International Fitness Scale¹⁶. About the test-retest reliability of scale, per-

fect agreement was observed in latin adolescents aged 9 to 17.9 years, with Kappa coefficient of 0.81¹⁷. The question states: "Think about your level of physical fitness (compared to your friends) and choose the right option. Your general physical fitness is: very poor, poor, average, good and very good." For this study, we considered very poor and poor as one group.

Physical education and sports participation were collected through two questions developed for this study. Students responded either "yes" or "no" to the two following questions: "Do you attend physical education classes?" This question aimed to understand if the students went to physical education, and "Do you practice sports outside of school hours?"

Students' sitting time was obtained through the International Physical Activity Questionnaire (IPAQ)¹⁸, short version, using the questions "During the last 7 days, how much time did you usually spend sitting on a week day?" and "During the last 7 days, how much time did you usually spend sitting on a weekend day?" This questionnaire has been used extensively with Brazilian adolescents in past studies and has been shown to produce valid and reliable data¹⁹. Consistent with Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire, questionnaires with a daily value above 900 minutes and under 10 minutes were excluded¹⁸. The week day and weekend day responses were analyzed separately and used as dependent variables.

All analyses and multicollinearity test were performed and conducted using the statistical software SPSS for Windows version 21. Interpretations of results were based on significant statistical tests ($p < 0.05$) and model fit statistics.

Multi-level mixed linear regression models were used to estimate the relationship between the independent (i.e., city of residence, participation in physical education, participation in sports, fitness) and dependent variables (i.e., minutes of sedentary time during weekdays and weekend days). Hierarchical models were estimated to account for the nested nature of the data (i.e., students nested within schools). Initially descriptive statistics were calculated for all variables (see Table 1.). A three-step process was undertaken to estimate the relationship between the independent and dependent variables. First, all covariates (i.e., gender, age, SES, householder education) were added as fixed effects to a model (model 1) to account for compositional differences across the three cities. Second, main effect models

were estimated for each independent variable (model 2-5). Third, all covariates, dependent, and independent variables were added to a final model (model 6).

Results

Regarding the losses in the data collection, two of 15 schools were not able to participate in the survey due to school strike. About 10% of students did not fill out the questionnaires correctly and could not be included in the research.

The characteristics of the students across municipalities are presented in Table 1. The study included 1089 youth (52.2% females) with age mean of 16.2y. Approximately 42% of youth were in the lowest SES, 46% had householders with incomplete High School level, 40% were engaged in some type of Sport, 76% had participated in PE classes and almost 50% of the adolescents had good or very good perception of fit-

ness. Overall, Botucatu showed the highest level of students in upper socio economic stratum, higher education degree among their householders as well as the lowest sitting time on weekdays (403.5 ± 191.3 min/day) and weekends (305.3 ± 220.1 min/day). The highest level of sitting weekday time was observed among students from São Paulo (448.8 ± 210.8 min/day). Students from Cáceres presented the lowest socio-economic indicators, more sitting time on weekends (369.0 ± 232.2 min/day) and less participation on PE and sports. Adolescent's self-reported sitting time was higher on weekdays (430.7 ± 202.8 min/day) than on weekend days (341.5 ± 231.4 min/day).

Results from linear regression analysis are presented in Tables 2 and 3. Socioeconomic indicators were related to ST in different ways considering week or weekend. After adjustments for all possible cofounders (model 6), students with the highest householder

Table 1 – Characteristics of participant schools and students.

Municipalities Characteristics	Botucatu		Cáceres		São Paulo		Total	
Gender								
Boys (n, %)	110	45.3%	156	44.2%	254	51.5%	520	47.8%
Girls (n, %)	133	54.7%	197	55.8%	239	48.5%	569	52.2%
Total (n, %)	243	22.3%	353	32.4%	493	45.3%	1089	100%
Age mean (SD)	15.8	(0.9)	16.1	(0.8)	16.0	(0.8)	16.2	(0.7)
Social economic stratum								
D-E, C2 (n, %)	20	8.2%	107	30.3%	74	15.0%	201	18.5%
C1 (n, %)	50	20.7%	73	23.2%	121	25.1%	244	23.5%
B2 (n, %)	89	36.8%	88	28.0%	162	33.6%	339	32.7%
B1 (n, %)	53	21.9%	31	9.9%	76	15.8%	160	15.4%
A (n, %)	30	12.4%	15	4.8%	49	10.2%	94	9.1%
Householder education								
Incomplete junior high school (n, %)	43	19.5%	74	28.5%	103	22.4%	220	23.4%
Junior high school diploma / Incomplete high school 2 (n, %)	46	20.9%	47	18.1%	118	25.7%	211	22.5%
High school diploma / Incomplete higher (n, %)	67	30.5%	88	33.8%	141	30.7%	296	31.5%
Higher education degree (n, %)	64	29.1%	51	19.6%	97	21.1%	212	22.6%
Sports participation								
No (n, %)	144	59.3%	208	58.9%	295	59.8%	647	59.4%
Yes (n, %)	99	40.8%	145	41.0%	198	40.2%	442	40.6%
Participation in physical education								
No (n, %)	50	20.8%	100	32.8%	96	20.1%	246	24.1%
Yes (n, %)	190	79.2%	205	67.2%	381	79.9%	776	75.9%
General fitness								
Very poor, poor	31	12.8%	40	11.3%	61	12.3%	132	12.1%
Average	86	35.4%	105	29.7%	163	33.1%	354	32.5%
Good	92	37.9%	120	34.0%	182	36.9%	394	36.2%
Very good	32	13.2%	49	13.9%	81	16.4%	162	14.9%
Sitting weekday minutes (SD)	403.5	191.3	424.2	196.8	448.8	210.8	430.7	202.8
Sitting weekend minutes (SD)	305.3	220.1	369.0	232.2	342.8	234.6	341.5	231.4

SD = standard deviation.

education degree had more sitting time on weekdays in comparison to the reference (Incomplete junior high school; +51.67; 95%IC: 7.2-96.10) (Table 2). On weekend days, students in higher levels of socioeconomic stratum presented less sitting time (-68.4; 95%IC: -127.6; 9.3), but only for models 1 to 5 (i.e. adjusted for socio-demographic variables). There was-

not significantly association between socioeconomic stratum and sitting time after adjustments for PE, Sport Participation and Fitness perception (model 6; Table 3). Boys presented less sitting time than girls on weekdays but not on weekend in all adjustment models. City of residence had no association with ST on both week and weekend (Tables 2 and 3 respectively).

Table 2 – Estimates from socio demographic variables, physical activity participation and fitness perception predicting sedentary behavior (sitting weekday minutes) in different Brazilian cities, n = 1089.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	B (95%)	B (95%)	B (95%)	B (95%)	B (95%)	B (95%)
Gender (ref = girls)						
Boys	-53.01 (-80.3; -25.8)**	-53.24 (-80.4; -26.0)**	-41.03 (-69.6; -12.5)**	-44.29 (-72.4; -16.2)**	-42.9 (-70.8; -15.0)**	-33.22 (62.6; -3.87)*
Age (ref = 14-15 years)						
17-18y	27.26 (-7.4; 61.9)	24.07 (-10.7; 58.8)	22.11 (-12.8; 57.1)	23.12 (-11.6; 57.8)	20.26 (-14.5; 55.0)	19.96 (-15.0; 54.92)
16y	5.05 (-28.2; 38.3)	1.98 (-31.4; 35.3)	1.33 (-32.2; 34.8)	2.23 (-31.0; 35.5)	1.38 (-31.8; 34.6)	1.80 (-31.6; 35.24)
Social economic Stratum (ref = C2,D,E)						
A	-55.75 (-115.1; 3.6)	-55.07 (-114.5; 4.3)	-48.71 (-108.4; 11.0)	-55.26 (-114.5; 4.0)	-55.87 (-115.1; 3.3)	-50.40 (-110.1; 9.26)
B1	-7.34 (-58.8; 44.1)	-5.34 (-56.9; 46.3)	-1.91 (-54.0; 50.2)	-1.51 (-53.1; 50.1)	-5.05 (-56.6; 46.5)	-0.74 (-53.0; 51.49)
B2	-26.58 (-70.0; 16.9)	-25.8 (-69.3; 17.7)	-21.02 (-64.9; 22.9)	-24.98 (-68.4; 18.4)	-28.46 (-71.8; 14.8)	-23.33 (-67.2; 20.50)
C1	-5.18 (-49.5; 39.1)	-4.96 (-49.3; 39.3)	-3.09 (-47.7; 41.5)	-7.96 (-52.2; 36.3)	-10.24 (-54.5; 34.0)	-8.53 (-53.3; 36.20)
Householder education (ref = Incomplete junior high school)						
Higher Education Degree	51.65 (7.3; 96.0)*	51.49 (7.2; 95.8)*	49.83 (5.4; 94.2)*	55.23 (11.0; 99.5)*	52.16 (8.1; 96.2)*	51.67 (7.2; 96.10)*
High school diploma / Incomplete higher education	63.27 (24.7; 101.8)**	62.37 (23.9; 100.8)**	55.85 (17.1; 94.6)**	63.84 (25.5; 102.2)**	63.7 (25.4; 102.0)**	57.90 (19.1; 96.67)**
Junior high school diploma / Incomplete high school 2	56.88 (16.0; 97.7)**	55.93 (15.1; 96.7)**	49.03 (8.0; 90.1)*	56.51 (15.8; 97.2)**	56.51 (15.8; 97.2)**	49.91 (8.9; 90.94)*
Municipalities (ref = Botucatu)						
São Paulo		88.97 (-23.6; 201.6)	95.13 (-25.0; 215.3)	90.91 (-23.2; 205.0)	97.05 (-23.2; 217.3)	104.01 (-25.6; 233.62)
Cáceres		72.92 (-34.6; 180.5)	77.22 (-37.2; 191.6)	78.3 (-30.7; 187.3)	81.77 (-33.0; 196.5)	90.23 (-33.2; 213.64)
Participation in PE (ref = No)						
Yes			-47.69 (-83.4; -12.0)**			-33.13 (-70.0; 3.72)
Sport participation (ref = No)						
Yes				-33.82 (-62.1; -5.5)*		-17.14 (-47.5; 13.18)
General fitness (ref = Poor fitness)						
Very good					-88.46 (-140.3; -36.6)**	-65.29 (-120.8; -9.83)*
Good					-63.2 (-107.3; -19.1)**	-48.45 (-94.9; -1.98)*
Average					-45.14 (-89.5; -0.8)*	-37.89 (-83.2; 7.41)

SES = Social economic Stratum; PE = physical education; Ref = Reference; * p< 0.05 ; **p<0,01.

Table 3 – Estimates from socio demographic variables, physical activity participation and fitness perception predicting sedentary behavior (sitting weekend minutes) in different Brazilian cities, n = 1089.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	B (95%)	B (95%)	B (95%)	B (95%)	B (95%)	B (95%)
Gender (ref = girls)						
Boys	0.3 (-31.5, 32.0)	-0.45 (-32.2, 31.3)	11.51 (-22.2, 45.2)	12.52 (-20.3, 45.4)	9.67 (-22.8, 42.1)	20.62 (-13.8, 55.05)
Age (ref = 14-15 years)						
17-18y	-4.68 (-44.6, 35.3)	-9.97 (-50.3, 30.4)	-13.31 (-54.2, 27.6)	-10.95 (-51.1, 29.2)	-14.42 (-54.9, 26.1)	-15.08 (-56.1, 25.90)
16y	4.83 (-33.5, 43.2)	0.21 (-38.5, 38.9)	-2.74 (-42.0, 36.6)	0.45 (-38.1, 39.0)	0.59 (-38.1, 39.3)	-0.40 (-39.7, 38.89)
SES (ref = C2,D,E)						
A	-64.79 (-133.1, 3.5)	-53.28 (-122.4, 15.8)	-44.69 (-114.5, 25.1)	-51.4 (-120.2, 17.4)	-54.26 (-123.1, 14.5)	-45.61 (-115.2, 23.98)
B1	-80.44 (-138.8, -22.1)**	-68.46 (-127.8, -9.1)*	-61.68 (-121.9, -1.5)*	-62.92 (-122.1, -3.7)*	-68.45 (-127.6, -9.3)*	-60.05 (-120.2, 0.07)
B2	-48.64 (-98.2, 0.9)	-40.91 (-91.0, 9.1)	-35.12 (-85.9, 15.6)	-39.09 (-88.9, 10.8)	-43.66 (-93.5, 6.1)	-36.84 (-87.4, 13.72)
C1	-39.18 (-90.8, 12.5)*	-33.58 (-85.6, 18.4)	-29.64 (-82.2, 23.0)	-37.1 (-88.9, 14.7)	-39.25 (-91.1, 12.6)	-36.28 (-88.9, 16.30)
Householder education (ref = Incomplete Junior High School)						
Higher education degree	35.46 (-16.5, 87.5)	35.29 (-16.6, 87.2)	36.28 (-16.1, 88.7)	40.66 (-11.2, 92.5)	37.17 (-14.5, 88.9)	40.27 (-12.0, 92.58)
High school diploma / Incomplete higher education	41.71 (-3.3, 86.7)	41.54 (-3.4, 86.5)	37.5 (-8.1, 83.1)	42.94 (-1.8, 87.7)	42.14 (-2.7, 87.0)	39.09 (-6.4, 84.58)
Junior high school diploma / Incomplete high school 2	27.61 (-19.7, 74.9)	29.34 (-18.0, 76.7)	26.28 (-21.6, 74.2)	29.53 (-17.6, 76.7)	30.38 (-16.9, 77.6)	26.96 (-20.8, 74.75)
Municipalities (ref = Botucatu)						
São Paulo		32.42 (-44.8, 109.6)	32.89 (-56.5, 122.3)	31.69 (-47.0, 110.4)	37.95 (-52.5, 128.4)	36.87 (-64.5, 138.20)
Cáceres		56.9 (-13.4, 127.2)	57.2 (-21.7, 136.1)	60.65 (-10.2, 131.5)	63.55 (18.3, 145.4)	66.94 (-22.1, 156.01)
Participation in PE (ref = No)						
Yes			-46.09 (-87.0, -5.2)*			-27.22 (-69.7, 15.21)
Sport participation (ref = No)						
Yes				-48.27 (-81.3, -15.2)**		-29.95 (-65.9, 5.99)
General fitness (ref = Poor Fitness)						
Very Good					-99.92 (-162.3, -37.5)**	-70.10 (-137.1, -3.10)*
Good					-94.11 (-147.1, -41.1)**	-75.74 (-131.8, -19.69)*
Average					-62.48 (-116.0, -9.0)*	-52.98 (-107.8, 1.87)

SES = Social economic Stratum, PE = physical education * p < 0.05 , **p < 0,01.

After adjusting for all socio-demographic variables (models 3 and 4), PE and sport participation was inversely associated with sitting time on both week and weekend (Tables 2 and 3 respectively) though the associations were not significant anymore after adjustment for further covariates (model 6). The most consistent independent variable related to sitting time was

self-perception of fitness. Across all models, those adolescents with best perceptions of general fitness level had less sitting time on both week and weekends. After adjustment for all variables, adolescents with very good perception of fitness had -65.29 minutes of sitting time on weekday and -70.1 minutes of sitting time on weekend (model 6; Tables 2 and 3 respectively).

Discussion

In the present study, city of residence was not related to ST in adolescents. However, other factors such as gender, SES and educational status, participation in sports and PE and perceptions of fitness were related to students ST. The inverse association between PE and Sports participation with sitting time were influenced by self-perception of fitness. Being girl and having householder in the highest education degree had an independent and direct association with more sitting time on weekdays in youth. On the other hand, having a self-perception of good fitness had a protective effect on sitting time independent of all other factors.

Our findings counter to a prior study with Brazilian adolescents that showed protective effect of living in Mato Grosso's inland compared to capitals on ST. The author's hypothesized that adolescents in relatively larger cities had more access to electronic devices while those living in small cities had more opportunities to participate in activities that involve greater energy expenditure like playing outdoors²⁰. It's also hypothesized that small towns are easier/more accessible for walking and cycling, have more favorable safety and traffic conditions and less access to technological facilities¹³.

Conversely, in our study, Caceres (the smallest city) had the highest weekend sitting time among the three cities. On the other hand, Botucatu (medium city) had the lowest levels of sitting time on both, weekday and weekend. These results indicate that factors other than city of residence may exert a great influence on ST in youth. It is also important to note the data from the Institute for Applied Economic Research (IPEA) demonstrate lower crime rates in Botucatu when compared to Caceres and São Paulo. Even though we have not evaluated crime indicators in our study, higher rates of crime have been related to increase sedentary behavior among adolescents and should be considered in future research in Brazil²¹.

In the present study, those adolescents in the highest SES stratum presented less sitting time only on weekend. Regarding the educational level, our study shows that sitting time on weekdays occurs in a larger degree between adolescents with the highest household educational level. The negative association between SES and sitting time differs from that reported in a Brazilian cohort with adolescents²². The explanation for these discrepancies is not clear due to the limited number of studies on this issue in Brazil¹³. It is also worth mentioning that in other studies addressing sedentary behavior

in Brazil^{20,23} did not split it into week and weekend making it difficult to compare. Considering that youth sedentary time patterns vary between days of the week and between countries²⁴ there is a need for research examining this aspect among Brazilian adolescents.

Another important observation is that sports and PE participation in our study showed a negative association with adolescents' sitting time regardless of their city of residence or socio-demographic factors. However, the associations lost the significance when the 3 variables related to PA (Sports and PE participation and youth's fitness self-perception) were analyzed together (model 6), suggesting a close relationship between them. Physical self-perception is an aspect of self-concept that is likely to be affected by physical activity participation²⁵ and increased fitness parameters (e.g cardiovascular fitness)²⁶. It is plausible that the relationship are bidirectional. For example, if adolescents have high perceptions of conditioning it might encourage them to engage in various types of physical activities (including more PE and sports classes), thus increasing their conditioning and self-perception of it. On the other hand, low perceptions of fitness can lead youth to avoid physical activities, thus engaging in sedentary choices decreasing their opportunities to be active and develop better self-perceptions of fitness. Adolescents with lower levels of PA tend to adopt other negative health habits such as cigarette smoking, lower fruit and vegetable intake and greater television watching²⁷.

Considering the intricate relationship between the abovementioned variables, physical self-components could be enhanced through involving youth in sports programs and PE classes. Specially, for adolescents from public schools, the opportunities to practice sports and PE must be assured by public policies. In the last years, national initiatives like the "More Education Program" and "Second Time" have focused on promoting better infrastructure, teacher professional development training and more opportunities for sport^{24,28}. The Second Time Program from the Ministry of Sports aims to democratize the access to the sport practice in order to promote the integral development of children, adolescents and young people, especially in areas of social vulnerability. However, not all municipalities are a part of these programs and less than 3% of the students enrolled in public schools are reached by them, leading to disparities in Sport opportunities between Brazilian cities²⁹. Furthermore, a more recent program, changed the original format of "More Education Program" to

the “New More Education Program” emphasizing full-time school and more Mathematics and Portuguese classes leaving the sport into a second place (as a low priority). Thus, the expansion and continuity of the sports-related programs is essential to democratize the access to physical activities in adolescence

Regarding PE, according to the National Adolescent School-based Health Survey (PeNSE)³⁰ only half of Brazilian public high schools attend at least two PE class per week and only 49.3% of girls attend PE at least two times per week. This is despite the fact that PE is mandatory for high school students. Our results show that almost a quarter of our students do not attend at least one PE class/week, among girls it increases to 36% that highlight the need for emphasizing PE attendance for girls.

Despite the original results from our study, some gaps needs to be addressed. First, the cross-sectional study design does not allow us to establish precedence between ST and some independent variables, thus causality cannot be inferred. For example, in our study is difficult to know the temporal sequence between sitting time and fitness perception and reverse causation can occur. Second, even though we have used a validated questionnaire to measure sitting time, there may have been errors associated to adolescent’s difficulty to remember their activities during the last week and under or over reporting can occur. Furthermore, different domains of sedentary behavior (i.e. time spent on cell phones and tablets, sitting down in transit or in the school environment) could not be evaluated by IPAQ. Few studies in Brazil have measured sedentary behavior with objective methods and beyond different domains of sedentary behavior and more studies are necessary to verify different correlates of sedentary behavior according to specific domains²⁸.

Based on the data identified in this review, we can conclude that the city of residence was not associated to sitting time among adolescents from public schools. Other factors like PE and sports participation and self-perception of fitness may be best correlates of sitting time among adolescents. There is a need for more studies to better understand these correlates of ST in the Brazilian context.

Sedentary Behavior can be attributed to a variety of individual, environmental and policy-level factors. In particular for youth from low-mid income families, school and sports participation seems to be a critical determinant of low levels of sitting time on both week and weekends, which shows the need for national pub-

lic and local school policies in Brazil. Adding physical education classes to the daily school routine and adding extracurricular sports activities in the school environment appears to be promising strategies for reduce sedentary behavior in Brazilian adolescents. Considering the current great violence in Brazil streets, the school environment could be used as a reference point for students and their community to practice sports and cultural activities on weekends. For this purpose, the current national policies must be evaluated, reviewed and better implemented.

Conflict of interest

The authors declare no conflict of interest.

Authors’ contribution

Pizano RE made substantial contributions to manuscript’s conception and design, acquisition, analysis, interpretation of data and writing. Ravagnani CFC made substantial contributions to conception, participated in drafting the article and revising it critically for intellectual content. Weaver RG made substantial contributions to conception, design, analysis and interpretation of data and revising it critically for intellectual content. Vitalle MSS made contributions to conception and revising the manuscript critically for intellectual content

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