ORIGINAL RESEARCH

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Sedentary Behavior Is Associated With Low Leisure-Time Physical Activity and High Body Fatness in Older Brazilian Adults

Abstract: *Sedentary behavior (SB) has emerged as a new health risk factor, including risk of premature death. This study examined the association between SB and measures of physical activity and body fatness in older Brazilian adults. Self-report measures of SB (ie, sitting time [ST]), leisure-time physical activity (LTPA), and body fatness (body mass index [BMI]) were collected from 355 older adults aged 60 years and older by trained interviewers. Statistical procedures were conducted using SPSS software with significance set at* P < .05. *Overall, the median ST was 3 hours per day. Mean values of LTPA and BMI for the entire sample were 90.0 (197.4) min/week and 26.5 (4.9) kg/m^2, respectively. Partial correlations controlling for age revealed that ST was negatively associated with LTPA (*pr = *−.15 [−.25; −.04];* P = *.006) and positively associated with BMI (*pr = *.25 [.14; .35];* P < *.001). Age, BMI, and LTPA emerged as independent predictors of ST, explaining a small but significant variance in ST (*R^2 = *.12;* P = *.02). Furthermore, t test revealed a significant difference in LTPA and BMI between groups of different amounts of sitting. The findings suggest that prolonged ST may have a negative impact on LTPA and BMI in older Brazilian adults.*

Keywords: body fat; chronic diseases; elderly; developing country; sitting time

> High amounts of SB [sedentary behavior] in the older adult population have been linked to numerous adverse health outcomes, such as decreased functional fitness . . .

Over the past few years, sedentary behavior (SB) has emerged as a new health risk factor, including risk of premature death.[1,2] For instance, a study conducted with approximately 5000 adults, with average age of 57 years, observed that those reporting 10 hours per day in SB had nearly 30% greater risk of death compared with those who were less sedentary.[2] Different from inactivity, which relates to lack of moderate-to-vigorous physical activity, SB is defined as "any waking behavior characterized by an energy expenditure ≤1.5 METS [metabolic equivalents] while in a sitting or reclining posture."[3]

High amounts of SB in the older adult population have been linked to numerous adverse health outcomes, such as decreased functional fitness,[4] increased risk of breast cancer and diabetes,[5,6] increased metabolic risk, and increased mortality rates.[7,8] Few studies to date have examined the association

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between SB and measures of physical activity (eg, leisure-time physical activity [LTPA]) and body fatness in the older adult population. This is important as older adults have been found to be a group with one of the lowest rates of regular physical activity participation.[9,10] This is of further importance as there is evidence that overweight and obesity is one of the major causes of the onset and severity of chronic diseases.[11,12] For instance, in the older adult population, overweight and obesity have been linked to early-onset of chronic morbidities and functional impairment, which leads to premature mortality.[12] Researchers have examined the joint association of television viewing time and moderate-to-vigorous physical activity with overweight/obesity among older Japanese adults between the ages of 65 and 74 years.[13] According to the authors, spending less time watching television was independently associated with lower risk of being overweight/obese.[13] Despite providing important information, the previous focused specifically on television viewing, which may be a predominant SB among older adults, but does not cover all other settings where this behavior can take place. For instance, SB can further occur in other recreational screen time (ie, computer/tablet/phone use) in household environments; jobs that largely require prolonged sitting in occupational environments; and prolonged sitting time in transportation, particularly using autosmobiles.[14] Like almost all nations in the globe, Brazil's older adult population is growing rapidly. Currently, nearly 14% of Brazil's population is considered older adults (ie, 60 years and over), with projections indicating that this number will increase to approximately 30% by the year 2050.[15] Population aging comes with challenges specially in the health sector as older adults are more vulnerable to develop chronic diseases and other conditions.[16] One study showed that about 82% of older adults in Brazil report at least one chronic disease, high blood pressure and diabetes being the most prevalent.[17] Furthermore, recent results from the Brazilian surveillance system (ie, VIGITEL) demonstrated that less than 40% of the older adults population engage in LTPA at the recommended amount.[18] To this end, increasing the understanding of the potential impact of SB and factors such as physical activity and body mass index (BMI; ie, a measure of body fatness) in older adults may provide valuable information for devising policies and developing strategies and interventions aiming to improving health and well-being among older adults. This is important because human environments and technology have been reengineered and designed to limit physical activity and promote SB. Mitigating the amount of time older adults spend in this detrimental health behavior is timely as the sedentary epidemic is a phenomenon occurring worldwide.[19]

Building on previous work on SB, this study adds to the currently literature by investigating the association between SB assessed as sitting time, and not only screen time, and measures of physical activity (ie, LTPA) and body fatness (ie, BMI) in older adults living in Brazil. As an emergent and important issue, there is a paucity of studies focusing on this population. We hypothesized that higher amounts of sitting time would be inversely associated with LTPA such that those reporting high levels of sitting time would report lower LTPA, and positively associated with BMI such that those reporting high amounts of sitting time would present with high BMI values.

Methods

This study involved a secondary analysis performed on a data set from a previous population-based study conducted to examine the prevalence of and factors associated with physical inactivity in a midsized city located in the State of Sao Paulo, Brazil.[20,21] Briefly, a stratified random sampling procedure was used to select a representative sample of adults (ie, 20 years and older) living in Rio Claro, Sao Paulo, Brazil, using the census tracts defined by the Brazilian Census Bureau. The procedure yielded 800 households selected for interview. All residents in each household aged 20 years and older who were able to walk independently and capable of maintaining a normal conversation were eligible for inclusion in the study. A total of 1572 adults were interviewed. However, for the purpose of this study, only individuals aged 60 years and older were selected for the analysis. This yielded a sample of 359 individuals aged 60 years and older. Four out of the 359 included individuals presented with missing data on the sedentary time variable and were excluded from the analysis. Thus, the final analytical sample was composed of 355 individuals. This number represents nearly 1.5% of the total number of older adults living in the city of Rio Claro (ie, 25 000).

Measures

Sedentary Behavior. SB was assessed as sitting time and it was self-reported using the following item on sitting, available in the International Physical Activity Questionnaire (IPAQ): During the last 7 days, how much time did you usually spend sitting on a weekday? This question asked respondents to think about the time spent at work, at home, while doing housework, and during leisure time. Moreover, it included time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch TV or using the computer. Part of the analysis conducted in this study used sitting time as a continuous variable. We further used the median value of sitting time per day (ie, 180 minutes per day; 3 hours) reported by the participants to allocate participants into 2 different groups. Similar procedures have been used elsewhere.[13] Of the total number of persons analyzed in this study, 186 (52.4%) reported ≤180 minutes per day of sitting time and where allocated into the low sitting time group, and 169 (47.6%) reported >180 minutes per day of sitting time and were allocated into the high sitting time group.

Leisure-Time Physical Activity. LTPA was assessed using Section 4 of the IPAQ questionnaire, expressed as minutes per week. The questions used were related

to total LTPA performed in moderate to vigorous intensity during the last 7 days prior to the interview with a minimum duration of 10 minutes per session. The IPAQ defines moderate activity as activities performed for at least 10 minutes that produce an increase in respiration and heart rate, and cause sweating. Vigorous activity is defined as those activities that produce greater increases in respiration, heart rate, and sweating. The IPAQ is a valid and widely used instrument to measure physical activity that has been validated in the Brazilian population.[22,23]

Body Fatness. Body fatness was obtained through BMI, which uses a combination of individual's height and weight. Because of the epidemiological approach of the study, height and weight were self-reported. There is evidence of high correlation between self-reported and measured height (r = .96), weight (r = .99), and BMI (r = .99).[24] BMI was calculated as weight in kilograms divided by height in meters squared.[25] Although BMI does not measure body fat directly, studies have demonstrated that BMI is moderately correlated with more direct measures of body fat obtained from other valid measures such as skinfold thickness measurements, bioelectrical impedance, densitometry, and dual energy X-ray absorptiometry.[26,27]

Demographics and Health Variables. A collection of sociodemographic variables was gathered, including gender (male/female), age, years of education (<8 and ≥8 years), and socioeconomic status (SES), which was defined according to the procedure adopted by the Brazilian Economic Criteria Classification where participants are classified as belonging to high, medium, or low SES.[28] Perceived health was self-reported by the following question: Overall, how would you consider the general state of your health? Participants' answers were categorized into 5 possible options ranging from excellent to very poor and later combined into excellent and very good, good, and poor and very poor. Chronic diseases were ascertained from an affirmative answer to the question, "Has any physician or other health professional ever told you that you have (disease name)?" The chronic diseases examined in this study include hypertension, diabetes, and arthritis. We further summed and employed the number of diagnosed chronic diseases and categorized participants as reporting 0, 1, and 2 or more chronic diseases.

Procedures

The questionnaire was administered face-to-face by 17 trained interviewers. The interviewers received 40 hours of training for administering and coding the questionnaire and were not aware of the study objectives. Furthermore, 2 additional assistants with experience in EPI INFO software (EPI INFO, Atlanta, GA), a public domain statistical software for epidemiology developed by the Centers for Disease Control and Prevention, performed the data entry. When there was more than one person eligible for the study at home at the time of data collection, interviewers were instructed to conduct interviews with one individual at a time and in a private place to prevent any bias in responses. Proxy responses were not employed in this study; therefore, 100% of the findings represent participants' responses. The set of questions were administered individually with an average time of 30 minutes each. Quality control was carried out by revisiting 10% of households. Refusals were computed when the resident refused to answer the questionnaire or after 5 visits (3 by the interviewers and 2 by the researchers).

Data Analysis

Statistical analyses were performed using SPSS version 22 (SPSS Inc; IBM Corp, Armonk, NY) and significance set at $P < .05$. Descriptive values of all measures were reported as mean (SD), unless otherwise noted. Chi-square test and t test were used to examine potential differences between groups of different amounts of sitting time (ie, low levels of sitting time vs high levels of sitting time) in demographics and health variables. Partial correlation (pr) analysis controlling for age was used to check the associations between sitting time and measures of physical activity and body fatness (ie, BMI). The magnitude of the correlations of 0.1, 0.3, and 0.5 was described as representative of small, moderate, and large, respectively, based on existing guidelines.[29] We then performed additional linear regression to determine whether the physical activity and body fatness correlates observed in the previous analysis predict time spent sitting. We finally performed t test for independent sample to compare physical activity and body fatness between groups of different amounts of sitting time (ie, low levels of sitting time vs high levels of sitting time). Because age was significantly different between groups, we further conducted analysis of covariance (ANCOVA) using age as covariate. Effect sizes using Cohen d based on a difference in mean scores between sitting time groups of pertinent variables were further calculated and interpreted as small (d = .2), moderate (d = .5), and large (d = .8 or higher).[29]

Ethical Statement

The study was approved by the Ethics Committee on Research in Humans of the Sao Paulo State University (IRB # 0848), and signed informed consent was obtained from participants before data collection.

Results

The median (25th, 75th percentiles) sitting time for the sample was 180 (120, 360) minutes per day. Demographic and health variables are displayed in Table 1 separated by groups of different sitting time status. Briefly, the majority of the sample was composed of females with an average age of 70 years. More than 70% of the sample reported having less than 8 years of formal education, and a similar amount was classified as low SES. In terms of chronic diseases, almost half of the sample presented with at least one chronic disease.

In the partial correlation analysis, age was used as a control variable because of its well-known impact on LTPA and

Table 1.

General Demographics and Health Characteristics of the Sample[a].

Variables	Overall	Groups of Sitting Time		P[c]
		Low Levels of Sitting Time[b] (n = 186)	High Levels of Sitting Time[b] (n = 169)	
Age, mean (SD)	70.2 (7.5)	68.5 (6.3)	72.1 (8.3)	.006[d]
Sex, % female	62.3	60.8	63.9	
Education, years, n (%)				.294
<8	254 (71.5)	133 (71.5)	121 (71.6)	
≥8	101 (28.5)	53 (28.5)	48 (28.4)	
Socioeconomic status, n (%)				.138
High	68 (19.2)	34 (18.3)	34 (20.1)	
Medium	33 (9.3)	19 (10.2)	14 (8.3)	
Low	254 (71.5)	71.5 133 (71.5)	121 (71.6)	
Perceived health, n (%)[e]				.065
Excellent/very good	53 (14.9)	30 (17.5)	23 (15.2)	
Good	232 (65.4)	128 (74.9)	104 (68.9)	
Poor/very poor	37 (10.4)	13 (7.6)	24 (15.9)	
Chronic diseases, n (%)				.554
0	113 (31.8)	57 (30.6)	56 (33.1)	
1	168 (47.3)	93 (50.0)	75 (44.4)	
≥2	74 (20.8)	36 (19.4)	38 (22.5)	

[a]Group allocation was done based on the median value of sitting time observed in the sample (ie, 180 minutes per day [3 hours per day]).
[b]Low levels of sitting time: ≤3 hours per day; High levels of sitting time: >3 hours per day.
[c]All *P* values represent χ^2 test, unless otherwise noted.
[d]*t* test.
[e]N = 322 (33 missing values).

BMI. Sitting time revealed to be significantly positively correlated with BMI (*pr* = .25 [.14; .35]; *P* < .001) and negatively significantly correlated with LTPA (*pr* = −.15 [−.25; −.04]; *P* = .006). Despite its statistical significance, both correlations are considered small to moderate in magnitude.

The partial correlation analysis was followed by linear regression analysis with stepwise entry to determine whether BMI and LTPA predicted sitting time in this sample based on the statistically significant associations observed in the partial correlation analysis. Age (*B* = 5.41, *SE B* = 1.13, β = .24), BMI (*B* = 7.98, *SE B* = 1.74, β = .23), and LTPA (*B* = −.097, *SE B* = .04, β = −.117) entered into the equation and explained a small but significant variance (R^2 =.12; *P* = .02) in sitting time. This indicates that age, BMI, and LTPA emerged as independent predictors of sitting time in this sample.

Mean LTPA and BMI values overall and separated by groups of different amounts of sitting time are given in Table 2. Briefly, individuals reporting low levels of sitting time (ie, ≤3 hours per day) were found to have significant higher levels of LTPA compared with individuals reporting high levels of sitting time (ie, >3 hours per day). In terms of BMI, those reporting low levels of sitting time were found to have significant lower BMI compared with those reporting high levels of sitting time. The difference between the groups for both parameters was found to be small to moderate in

Table 2.

Mean and Standard Deviation of Time Spent in Leisure-Time Physical Activity and Values of Body Mass Index Separated by Groups of Different Amounts of Daily Sitting Time[a].

Parameter	Overall	Groups of Sitting Time		P^c	d^d
		Low Levels of Sitting Time[b] (n = 186)	High Levels of Sitting Time[b] (n = 169)		
LTPA, min/week	90.0 (197.4)	120.6 (236.6)	56.3 (135.1)	.001	0.33
BMI, kg/m^2	26.5 (4.9)	25.6 (4.6)	27.4 (5.1)	.002	–0.37

Abbreviations: LTPA, leisure-time physical activity; BMI, body mass index.
[a]Group allocation based on the median value of sitting time observed for the sample (ie, 180 minutes [3 hours per day]).
[b]Low levels of sitting time: ≤3 hours per day; High levels of sitting time: >3 hours per day.
[c]*t* test for independent samples.
[d]Cohen's *d* effect sizes.

magnitude based on the observed effect sizes.

Because age was significantly different between groups, we performed ANCOVA using age as covariate. Even after controlling for age, differences in LTPA remained statistically significant, favorable to those reporting low levels of sitting time compared with those reporting high levels of sitting time (118.8 [*SE* 14.5] vs 58.3 [*SE* 15.2]; $F[2, 352] = 8.018$; $P = 0.005$; $d = 0.30$). BMI also remained statistically significant, favorable to those reporting low levels of sitting time compared with those reporting high levels of sitting time (25.5 [*SE* 0.36] vs 27.6 [*SE* 0.38]; $F[2, 352] = 15.487$; $P < .001$; $d = -0.42$).

Discussion

This study examined the association between sitting time and measures of physical activity (ie, LTPA) and body fatness (ie, BMI) in a representative sample of community-dwelling older adults. The findings demonstrated a small but significant negative association between sitting time and LTPA, such that those reporting less sitting time had higher values of LTPA. A small-to-moderate positive significant association between sitting time and BMI was further observed, such that those reporting high amounts of sitting time had higher BMI. The results further demonstrated that age, BMI, and LTPA were significant independent predictors of sitting time, and collectively these variables explained 12% of the variance in sitting time observed for the sample. Further analysis demonstrated that those sitting for more than 3 hours per day reported reduced LTPA and higher BMI values. Collectively, our findings suggest that sitting time negatively affects LTPA and BMI in older adults. This is important as lack of moderate-to-vigorous physical activity and excess body fatness have been independently associated with several adverse health outcomes including cardiovascular disease.[12,30]

Our findings corroborate previous studies investigating associations between SB and adverse health outcomes (eg, lower functioning, lower fitness, increased risk of chronic diseases) in older adults.[4,6,7,13] Researchers have demonstrated that spending lower amounts of time watching television was associated with lower risk of being overweight or obesity, independent of meeting physical activity guidelines among older Japanese adults.[13] The results of that study corroborates the results of the present study where higher sitting time was positively associated with BMI. There is evidence of the association between television viewing, snacking behavior, and overweight or obesity in young adults. Researchers observed that in a sample of 613 individuals with ages ranging between 18 and 25 years, medium and high television viewers had higher odds of being overweight or obese.[31] To this end, it is possible that older adults have high levels of sitting time, snack more, or consume more energy-dense snacks. This could partially help explain the association observed in the present and previous studies. Our findings further demonstrated that sitting time was negatively associated with LTPA in that those with higher levels of sitting reported less LTPA. This should be a concern not only to individuals but also to authorities as both behaviors (ie, low physical activity and high SB) have been found to be health risk hazards, including increased risk of premature death.[32,33] A recent study conducted in over 600 individuals aged 60 years and older suggested that older adults who do not meet physical activity guidelines and spend high amounts of time in SB are more likely to present with depressive symptoms compared with those who meet the recommendations for physical activity and spend less time in SB.[34] Taken together, the aforementioned highlights the detrimental impact of SB in older adults and underscores the necessity of developing strategies and interventions aiming to mitigate SB and

improve physical activity in the older adult population. This is timely, as it is estimated that individuals spend the majority of their waking hours (ie, 70% or more) in SB, partially due to the fact that the built environment has been reengineered to limit opportunities for physical activity.

In the present study, older adults reported a median sitting time of 3 hours per day (ie, 180 minutes). In light of accumulated and recent evidence, it becomes clear that most of the population, including older adults, face a double-challenge: low physical activity and high SB levels. Regarding children, the American Academy of Pediatrics counsels parents to limit children's screen time (a proxy of SB) to no more than 2-3 hours per day.[35] The current evidence observed in the older adult population suggests that they also need similar advice from health professionals involved in their care. It is important that older adults—as possible and prudent—be encouraged to stand up from their chairs more frequently and move/walk. It is clear that more work is needed before establishing public health recommendations for reducing SB. However, preliminary evidence suggests that a potential message consistent with epidemiological evidence would be to reduce sitting time to no more than 2 hours per day, and to stand up and move after 30 minutes of uninterrupted sitting.[36,37] Potentially, this nonofficial recommendation could be used as a starting point by future intervention studies aiming to reduce SB in older adults. More important, advising older adults to reduce prolonged sitting should be done in combination with recommendations for physical activity/exercise and healthy eating.

This study has some limitations. All the information collected in this study is from a representative sample of older adults (ie, 60 years and older) living in a midsize city from a developing country in South America, Brazil. We do not know if older adults living in other nations/populations would report similar results. All information regarding SB, LTPA, and body fatness were self-reported. There is evidence that self-reported SB and LTPA tend to be underestimated and overestimated, respectively. Despite its validity as a measure of body fatness, BMI may present with challenges especially in the older adult population. Future studies should examine SB attempting to use an objective measure of SB (eg, accelerometer, ActivPAL) in combination with a self-report instrument in order to gather more accurate information. It is important that studies adopting sensors to objectively measure SB use it in combination of self-report measures to capture settings/domains of SB for qualitative purposes. Part of our statistical analysis may arguably be considered a limitation. We created 2 groups of different amounts of sitting time based on the median value and such a procedure may not create 2 real distinct groups.[38] This is because participants close to the median on both sides (ie, lower than the median and higher than the median) may be similar. Despite the limitations, we were able to provide novel evidence of the negative impact of sitting time on health (ie, BMI) and behavioral outcomes (ie, LTPA) in the older Brazilian adults.

Overall, sitting time was found to be associated with LTPA and levels of body fatness in older adults. The findings of this study underscore the need for strategies and interventions focused on reducing SB in this population. However, due to the additional public health challenge of low physical activity faced by older adults, it is important that initiatives focus on both. Reducing sitting time and increasing physical activity participation may have the potential to significantly reduce a myriad of health risk factors and ultimately improve health and well-being in this population.

Declaration of Conflicting Interests

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Ethical Approval

Ethical approval for this study was obtained from the Ethics Committee on Research in Humans of the Sao Paulo State University (IRB # 0848).

Informed Consent

Written informed consent was obtained from all participants before the study.

Trial Registration

Not applicable, because this article does not contain any clinical trials. AJLM

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