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Sedentary behavior as a predictor of functional disability in older adults

Comportamento sedentário como preditor de incapacidade funcional em adultos idosos

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ABSTRACT

The aim of this study was to identify the amount of time spent in sedentary behavior that may be critically related to functional disability in older adults. A cross-sectional study was conducted with a random sample of 624 older adults (65.1% women) aged 60 to 96 years. Perceived limitations in instrumental activities of daily living were used as indication of functional disability. Time spent in sedentary behavior was assessed using the International Physical Activity Questionnaire (IPAQ). The prevalence of functional disability was 29.4%. The mean total time spent in sedentary behavior was 576.51 ± 5.14 min/day. *Receiver Operating Characteristic* (ROC) curves were used to identify cut-points for time spent in sedentary behavior that could discriminate functional disability in older adults. The results suggested that spending > 600.00 min/day and > 614.00 min/day in sedentary behavior, for men and women, respectively, was a discriminator for functional disability in the current study. These cut-points can be used to identify older adults who are most vulnerable to functional disability in future studies.

Keywords: Behavior; Aged; Disabled persons.

RESUMO

O objetivo deste estudo foi identificar pontos de corte para o tempo gasto em comportamento sedentário que podem potencialmente discriminar a presença de incapacidade funcional em idosos. Um estudo transversal foi realizado com uma amostra aleatória de 624 idosos (65,1% mulheres) com idade entre 60 e 96 anos. As limitações percebidas nas atividades instrumentais da vida diária foram utilizadas como indicação de incapacidade funcional. O tempo gasto no comportamento sedentário foi avaliado usando o Questionário Internacional de Atividade Física (IPAQ). A prevalência de incapacidade funcional foi de 29,4%. A média do tempo total despendido em comportamento sedentário foi de 576,51 ± 5,14 minutos/dia. As curvas de característica operativa do receptor (ROC) foram usadas para identificar pontos de corte para o tempo gasto em comportamento sedentário que discriminassem a incapacidade funcional em idosos. Os resultados sugeriram que despender > 600,00 min/dia e > 614,00 min/dia em comportamento sedentário, para homens e mulheres, respectivamente, foram discriminadores de incapacidade funcional no presente estudo. Esses pontos de corte podem ser usados para identificar os idosos que estão em maior vulnerabilidade à incapacidade funcional em estudos futuros.

Palavras-chave: *Comportamento; Idoso; Pessoas com deficiência.*

Introduction

Population aging is a worldwide phenomenon. In 2025, the number of people aged 60 or older will reach 1,200 million[1]. Aging is often associated with greater likelihood for functional disability, which occurs as a result of many factors, including low levels of physical activity[2] and inadequate health behaviors. Functional disability is a major public health concern and generates high costs to national health systems[3]. An effective way to avert or delay functional disability is regular en-

gagement in adequate levels of physical activity. Older adults who are physically active usually demonstrate improved strength and muscular endurance, increased aerobic capacity, better balance and coordination, and better physiological well being compared to inactive peers[4]. Physical activity is typically associated with lower likelihood of obesity, as well as beneficial effects on chronic diseases[5] and quality of life[6]. These associations are well established in the literature.

More recently, researchers have dedicated substantial attention to the study of sedentary behavior (SB), as its associations with health have been shown to be independent of those from physical activity[7]. SB has been defined as any waking activity performed in a lying or sitting position that does not increase energy expenditure above 1.5 METs[7]. SB has been considered a risk factor for several adverse health outcomes[8], including disability in basic and instrumental activities of daily living[9]. Owing to the risks of SB to population's health, monitoring and reducing these behaviors in older adults is essential. Similarly, assessment of functional status in older adults is necessary, as many of these individuals have several co-occurring diseases that usually impact their daily life[10]. Theoretical models of functional disability indicate that functional limitations precede disability[11], denoting that acting upon its possible causes can be effective in preventing such end-point.

In spite of the deleterious effects of SB to health, there has been limited knowledge related to the daily amount of time spent in SB that may be related to greater likelihood of functional disability. Examination of this subject is important for allowing identification of individuals who may be at greater risks for functional disability, and also to support public health professionals in making decisions pertaining to interventions aiming at improving and/or maintaining functional status in older adults. There fore, the aim of this study was to identify cut-points for time spent in SB that can potentially discriminate the presence of functional disability in older adults.

Methods

The study protocol and procedures were in accordance with the Declaration of Helsinki and the 196/96 resolution of the National Health Council from the Brazil Ministry of Health. The study was previously approved by the Human Research Ethics Committee of the Federal University of Triangulo Minero (ruling number 1521/2009) and all participants provided written informed consent before taking part in the study.

This study is a secondary analysis of data collected from a cross-sectional study entitled "Study on Population Aging and Physical Activity". Information on study protocol and procedures has been published elsewhere[12]. For the present study, a random sample of 624 people aged 60 years or older was selected from a study population of 10,683 people. Participants were local residents of Uberaba, MG (Brazil) and were registered in the "Health and Family Strategy" program from the Brazilian Government. Participants were selected using a stratified family-based random sampling technique (district, health team and gender). Participants were included if they presented with no severe visual and auditory difficulties, did not use wheelchairs, had no serious sequelae resulting from cerebral vascular accident, and had no disease at terminal stage.

A questionnaire was used to assess sociodemographic information, including gender, age, years of education, marital status (married/living with a partner or not married/not living with a partner), family arrangement (alone, with partner, senior homes or others), employment status (work, retired or pensioners) and socioeconomic status, according to the Brazilian Association of Research Companies[13].

Physical activity and SB were measured with the International Physical Activity Questionnaire (IPAQ), adapted for the Brazilian older population by Benedetti et al.[14] This questionnaire estimates the weekly amount of time spent in physical activity (moderate and vigorous) lasting for a minimum of 10 minutes per bout in four domains: work, transportation, domestic activities and leisure. For estimating SB, participants reported the time spent sitting (min/day*)* on weekdays and weekend days. Time spent in SB in min/day was calculated as the weighted mean using the following equation: "Time spent in SB (min/day) = ((sitting time during weekdays*5) + (sitting time during weekend days*2))/7".

Functional disability in instrumental activities of daily living (IADL) was assessed using the Lawton-Brody Index translated and validated for the Brazilian population by Santos and Virtuoso-Junior[15]. The Lawton Instrumental Activities of Daily Living Scale contains one question for each of the following activities: ability to use the telephone, mode of transportation, shopping, food preparation, housekeeping, responsibility for own medications, and ability to handle finances. One point is awarded if the person reports that he/she does not perform or is unable to perform

the activity; 2 points are awarded if participant is able to perform the activity with partial help; and 3 points are awarded if the participant is able to perform the activity without assistance[15]. Total score is computed by summing the points from all questions. Total dependence in IADL is denoted by a score of ≤ 5 points, partial dependence in IADL is denoted by a score of > 5 and < 21 points, and independence in IADL is denoted by a score of 21 points[15]. This classification does not account for educational level. In this study, the cut off score of 13 points was used for determining presence of functional disability.

Mean and standard deviation were used to represent descriptive information on the different study variables. Kolmogorov-Smirnov tests were used to verify normal distribution of data before deriving association and comparison analyses. Independent T-tests were used to compare sociodemographic, physical activity and SB data according to gender (male-female). Pearson production-moment correlation coefficients were used to examine associations between estimates of SB from weekdays and weekend days. *Receiver Operating Characteristic* (ROC) curves were applied to identify the SB cut-points with highest discriminatory power for presence of functional disability. This technique is frequently used to verify the diagnostic performance of clinical exams and tests. It consists in the identification of the total area under the ROC curve overlapping independent and dependent variables. The higher the area under the ROC curve, the better the discriminatory power of the independent variable for the dependent variable. To determine if individuals with time spent in SB higher than the cut-point value had higher likelihood of functional disability, a Poisson regression analysis was used with the SB cut-point value set as the independent variable and functional disability (presence or absence) set as the dependent variable. The prevalence ratio for functional disability based on SB was adjusted for age, sex, and years of education. All data analyses were conducted in the MedCal statistical program, v 11.4.4. Statistical significance for all tests was set at $p < 0.050$.

Results

Participants' mean age was 71.08 ± 7.77 years, ranging from 60 to 96 years, 65.1% women. Participants were predominantly married or lived with a partner (52.7%) or were residents of senior homes (54.8%). In relation to socioeconomic and employment statuses, 81.5% of the participants were retired or pensioners, and 51.4% and 33.2% belonged to the lowest socioeconomic strata C and D, respectively. The prevalence of functional disability in the study sample was 29.4%. The mean total time spent sitting was 576.51 ± 5.14 min/day. Distribution of age, years of education and variables related to physical activity and SB are shown in Table 1. When examining differences in the mean and frequency of the study variables between men and women, the only significant differences were found for variables related to physical activity level. Women presented lower time spent (min/day) in physical activity at work, transportation and leisure activities. On the other hand, women spent significantly more time in physical activity pertaining to the domestic domain (Table 1).

As for time spent in SB, it was observed that men presented higher values (min/day) for both weekdays and weekend days compared to women. Figure 1 indicates associations between times spent in SB on weekdays and weekend days. (Women, $r = 0.72$; Men, $r = 0.59$).

Figure 2 displays areas under the ROC curves and confidence intervals for time spent in SB as a predic-

Table 1 – Sociodemographic characteristic, physical activity and sedentary behavior, Uberaba, Minas Gerais, 2010, Brazil (n = 624).

Variable	**Women** (n = 406)			**Men** (n = 218)			
	Mean	SD	95% CI	Mean	SD	95% CI	*p-value
Age (year)	70.78	7.96	(70.00 - 71.56)	71.60	7.40	(70.61-72.58)	0.430
Years of education	3.24	2.95	(2.95- 3.52)	3.71	3.34	(3.26-4.16)	0.070
Physical activity (min/week)							
Work	23.35	123.51	(11.27 - 35.43)	64.40	221.60	(34.82-93.98)	< 0.001
Transport	60.45	70.58	(53.54 - 67.35)	77.94	95.38	(65.20-90.67)	< 0.001
Domestic activities	127.67	166.82	(156.03 - 188.99)	54.29	90.43	(42.22-66.36)	< 0.001
Leisure/ recreation	54.42	94.57	(45.17 - 63.67)	73.76	121.11	(57.59-89.93)	< 0.001
Total	309.06	272.24	(282.43 - 335.69)	270.39	297.63	(230.66-310.12)	< 0.001
Sitting time - weekday (min/day)	544..49	140.09	(530.79 - 558.19)	588.53	136.06	(570.37-606.70)	0.001
Sitting time – weekend (min/day)	605.12	128.45	(529.55 - 617.68)	638.51	127.83	(621.44-655.57)	0.002

* p-value for comparison t-test on the equality means (unpaired); SD = standard deviation.

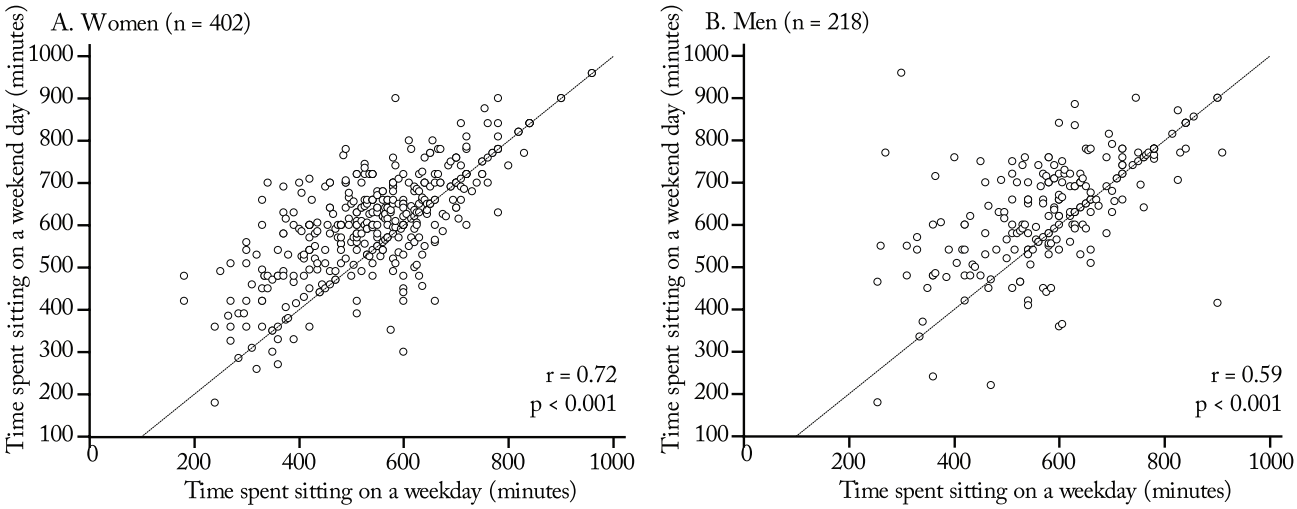

Figure 1 – Correlation between times spent sitting on weekdays and weekend days in both sexes, Uberaba, Minas Gerais, 2010, Brazil (n = 624).

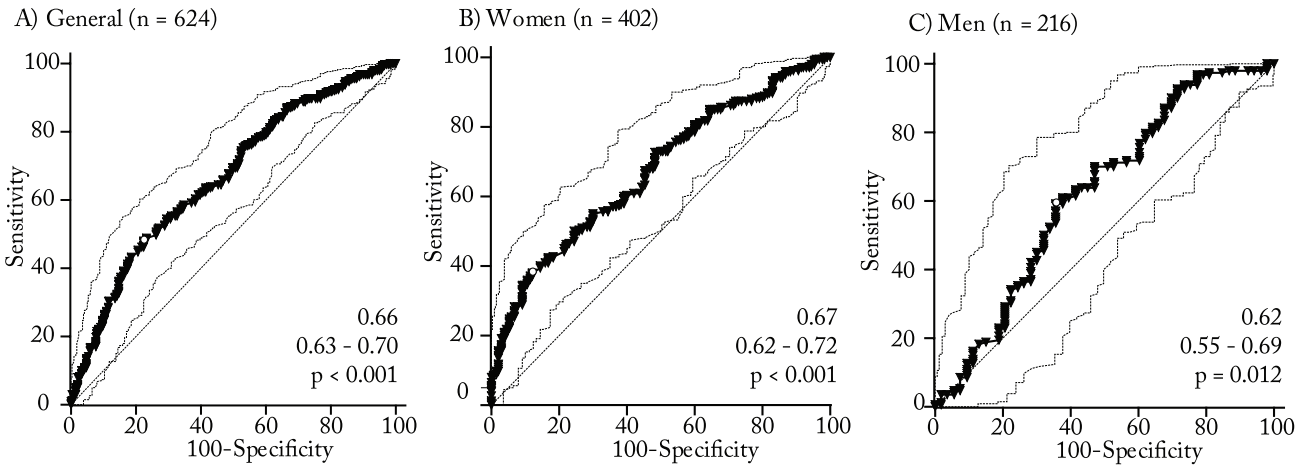

Figure 2 – ROC curves of sedentary behavior as a discriminator of functional disability in older adults, Uberaba, Minas Gerais, 2010, Brazil (n = 624).
ROC: receiver operating characteristic; CI95%: 95% confidence interval; p: significance level

tor of functional disability. The areas under the ROC curves were similar for both men and women when examining SB as a discriminator for functional disability (men: 0.62, CI95%: 0.522–0.685; women: 0.67, CI95%: 0.622–0.716).

The specific cut-points values for identifying functional disability based on SB as well as their sensitivity and specificity values are displayed in Table 2. The cut off points for SB that best discriminated functional disability were > 603.00 min/day for overall sample, > 614.00 min/day for women, and > 600.00 min/day for men. All the three cut-points presented higher specificity compared to sensitivity.

Those individuals sitting for more than 603.00 min/day were 1.22 (95%CI: 1.00–1.49) times more likely to present with functional disability than those sitting for less than 603.00 min/day (Table 3).

Table 2 – Cut-points of time spent sitting as a discriminator of functional disability, Uberaba, Minas Gerais, 2010, Brazil (n = 624).

	Cut-Points*	Sensitivity (%)	Specificity (%)
General	> 603.00	48.06	77.6
Women	> 614.00	38.18	87.69
Men	> 600.00	59.15	64.15

*Time spent sitting (min/day).

Table 3 – Prevalence ratio for functional disability in individuals spending excessive time in sedentary behavior (> 603 min/day), Uberaba, Minas Gerais, 2010, Brazil (n = 624).

SB	Prevalence (according SB)	PR	CI95%	Wald Chi-square	p-value
TSS ≤ 603.00 (n = 370; 59.3%)	61.6% (n = 228)	1			
TSS > 603.00 (n = 254; 40.7%)	83.1% (n = 211)	1.22	1.00 – 1.49	3.95	0.047

SB: Sedentary behavior; TSS: Time spent sitting min.day-1; PR: Prevalence ratio; CI95%: confidence interval; p: significance level. Prevalence ratio was controlled for age, sex, and years of education.

Discussion

The aim of this study was to identify cut-points for time spent in SB that could discriminate presence of functional disability in older adults. Our results indicate that spending more than 10 hours/day in SB is a significant indicator for functional disability. Studies on SB are relatively recent in epidemiology. However, the risks that SB poses to health are currently consensual. Several studies have been published emphasizing the importance of reducing SB for public health. Time spent in SB is of concern because evidence indicates that it directly relates to reductions in the capability of independently performing daily activities[16]. These reductions are in great part the result oflack of musculoskeletal stimuli[17], which cumulative may lead to functional disability.

Correlations between SB and functional decline have been consistently reported in the literature[18–20]. McDermott et al.[20] conducted a study in patients with peripheral arterial disease and observed significant associations between SB, walking speed and functional decline. Other studies reported that older adults who spend more time in SB present lower muscle strength[21],worst agility/dynamic balance and lower limb flexibility[22]. Consequently, they are at increased risks for dependence in daily activities. Studies conducted in Japan[23]and United States[24], identified that SB was associated with disability in activities of daily living. These results reinforce the need to reduce the amount of time that older adults spend in this type of behavior. In Brazil, there is a limited number of studies examining the associations of SB with health and function outcomes, and also of intervention aiming at reducing SB in older adults. Thus, the cut-points from the current study may serve as reference values for identifying older adults at higher risks for functional disability in future studies and interventions.

While the World Health Organization[25] recommend that older adults accumulate at least 150 minutes of physical activity per week for health benefits, recent evidence indicates that just meeting these recommendations might not be enough, as engagement in SB during prolonged periods can result in deleterious effects to health[7]. This is especially concerning for older adults, who usually spend more than 60% of their daily time in SB[26]. Of note, a substantial proportion of older adults do not perform any work-related activities, thus presenting with more leisure time and opportunities for engaging in SB[27].

In this context, it is important to target reductions in SB in older adults. A feasible manner for doing so is by incorporating small changes within the daily routine, promoting interruptions to SB on pre-defined or unplanned intervals. Studies have demonstrated that greater number of interruptions to SB are associated with better physical fitness[28] and less functional disability[29]. This indicates that older adults should be encouraged to break up sedentary time. Interrupting SB may lead to positive benefits in terms of functional autonomy as our results indicated that those older adults who sat for less than 603.00 min/day were 22.0% less likely to be functionally disabled than those who reported sitting for greater volumes.

The socio-demographic characteristics of the older adults from this study are similar to other research conducted in Latin America, which suggests the possibility of generalizing these data to other Latin American countries[30]. The cut-points for SB described here in may be used as a reference to identify older adults at greater risks for functional disability, as well as a target value for developing intervention programs aiming at preserving physical function in older adults. SB is a modifiable behavior and can be reduced with educational and physical activity promotion programs. These actions can contribute to reducing functional disability in older adults as suggested by our results.

It is important to highlight that, based on the sensitivity and specificity values, the cut-points from this study perform better at identifying true negative cases (i.e., sit less than 603.00 or 614.00 min/day and do not present functional disability) than true positives (i.e., sit longer than 603.00 or 614.00 min/day and present functional disability). Therefore, researchers should be aware of this when using our cut-points in their studies. Future research efforts should combine information on SB and other determinants, such as environmental and socioeconomic variables, to better identify functional disability in older adults.

This study has limitations. Measurement of SB was performed by a self-report instrument, which is subject to recall bias, especially in older adults. However, questionnaires are easy-to-use instruments that are cost-effective in public health research, allowing for quick assessment in large-scale studies. Another limitation of the study was the cross-sectional design, which limits our ability of determining cause and effect relationships. Further research should consider examining associations of SB with functional disability longitudinally, as this would allow for drawing inferences on causation.

The results of this study indicate that time spent in SB can predict functional disability in older adults. The cut-points for time spent in SB that most accurately predicted functional disability were > 603.00 min/day for the overall sample, > 600.00 min/day for men, and > 614.00 min/day for women. These cut-points may be used to identify those older adults who are at higher vulnerability to functional disability in future studies.

Conflict of interest

The authors declared no conflict of interest.

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Contribution of the authors

Virtuoso Junior JS, Tribess S, Rocha SV, Sasaki JE, Garcia CA, Meneguci J and Romo-Perez V made substantial contributions to the development of the project, data processing, and writing the paper. All authors read and approved the final manuscript.

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