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The association between physical activity, sedentary behavior and the occurrence of falls in asymptomatic adults over 40 years old

Associação entre atividade física, comportamento sedentário e a ocorrência de quedas em adultos assintomáticos acima dos 40 anos de idade

La asociación entre la actividad física, el comportamiento sedentario y la ocurrencia de caídas en adultos asintomáticos mayores de 40 años

Ana Esther Pereira de Oliveira[a], Thatiane Lopes Valentim Di Paschoale Ostolin[a], Wesley de Oliveira Vieira[a], Rodolfo Leite Arantes[b], Antônio Ricardo de Toledo Gagliardi[b], Evandro Fornias Sperandio[a], Victor Zuniga Dourado[a]*

[a] Universidade Federal de São Paulo (UNIFESP), Santos, SP, Brazil
[b] Instituto de Medicina Cargiovascular Angiocorpore (ANGIOCORPORE), Santos, SP, Brazil

Abstract

Introduction: Sedentary behavior (SB) has been described as an independent risk factor for health, regardless of the recommended amount of moderate-to-vigorous physical activity (MVPA). However, SB and MVPA as predictors of falls have been poorly investigated. **Objective:** To compare the associations between SB and MVPA and the occurrence of falls in middle-aged and older adults. **Method:** The participants wore a triaxial accelerometer over

* AEPO: BS, e-mail: aana.esther@gmail.com
TLVPO: MS, e-mail: thati.ostolin@gmail.com
WOV: Doctoral student, e-mail: wes_zn@hotmail.com
RLA: PhD, e-mail: arantes.r@uol.com.br
ARTG: PhD, e-mail: antoniogagliardi@ig.com.br
EFS: PhD, e-mail: evandrosperandio@yahoo.com
VZD: PhD, e-mail: vzdourado@yahoo.com.br

the dominant hip for seven days to measure SB and MVPA. The occurrence of falls and cardiovascular risk factors were assessed by self-report. Isokinetic peak torque (PT) of knee extension, peak oxygen uptake (V'O2) in a ramp treadmill protocol, and lean (LBM) body mass and body fat (BFM) (bioelectrical impedance) were also assessed. The critical roles of SB and MVPA on the occurrence of falls were compared by multiple logistic regression adjusted for age, sex, cardiovascular risk factors, LBM, peak V'O2, and PT of knee extension. **Results:** 379 participants were evaluated, aged 40-80 years. Forty-eight participants reported at least one fall in the previous 12 months (14.5%). Fallers presented lower SB and higher MVPA. They were predominantly women and older adults with lower physical fitness. After multivariate analysis, MVPA, but not SB, was selected as an independent predictor of falls, increasing the odds ratio of having a fall (1.184, 95% confidence interval, 1.016 – 1.378). **Conclusion:** Episodes of falls in predominantly middle-aged and women subjects were associated with a higher amount of MVPA, not the opposite, indicating an adverse effect of MVPA in these subjects.

Keywords: Physical Fitness. Fitness Trackers. Fall. Sedentary Lifestyle. Middle Aged.

Resumo

Introdução: *O Comportamento sedentário (CS) tem sido descrito como fator de risco independente para saúde, a despeito da recomendação de atividade física moderada a intensa (AFMI). Contudo, pouco foi investigado se CS e AFMI são preditores da ocorrência de quedas.* ***Objetivo:*** *Comparar as associações entre CS e AFMI e a ocorrência de quedas em adultos de meia-idade e idosos.* ***Método:*** *Os participantes usaram acelerômetro triaxial no quadril dominante por sete dias para obtenção de CS e AFMI. A ocorrência de quedas e o risco cardiovascular foram avaliados através de autorrelato. Avaliamos o pico de torque (PT) isocinético da extensão de joelho, o pico de consumo de oxigênio (V'O2) em protocolo de rampa na esteira, e massa magra (MMC) e gordura (GC) corporais (bioimpedância elétrica). Comparamos o papel de CS e AFMI na ocorrência de quedas através de regressões lineares múltiplas ajustadas por idade, sexo, fatores de risco para doença cardiovascular, MMC, V'O2 pico, e PT da extensão de joelho.* ***Resultados:*** *Avaliamos 379 participantes de 40 – 80 anos. Quarenta e oito participantes reportaram, pelo menos, uma queda nos 12 meses anteriores ao estudo (14.5%). Os caidores apresentaram menor CS e maior AFMI. Eles eram predominantemente mulheres e idosos com menor aptidão física. Após as análises multivariadas, AFMI foi selecionada como preditor independente da ocorrência de quedas, aumentando o odds ratio de cair (1.184, 95% intervalo de confiança, 1.016 – 1.378).* ***Conclusão:*** *Os episódios de quedas, sobretudo em mulheres de meia-idade, foram associados com maior AFMI, indicando efeito adverso da AFMI nestes sujeitos.*

Palavras-chave: *Aptidão Física. Monitores de Aptidão Física. Quedas. Comportamento Sedentário. Meia Idade.*

Resumen

Introducción: *El comportamiento sedentario (CS) se ha descrito como un factor de riesgo independiente para la salud, independientemente de la cantidad recomendada de actividad física moderada a vigorosa (AFMV). El CS y el AFMV como predictores de caídas fueron poco investigados.* ***Objetivo:*** *Comparar las asociaciones entre CS y AFMV, y la ocurrencia de caídas en adultos de mediana edad y mayores.* ***Método:*** *Los participantes usaron un acelerómetro triaxial durante siete días para medir CS y AFMV. La ocurrencia de caídas y factores de riesgo cardiovascular se evaluaron mediante autoinforme. Se evaluó el torque máximo isocinético (TM) de la extensión de la rodilla, el consumo máximo de oxígeno (V'O2) en un protocolo de rampa en la estera, y masas corporales magra (MMC) y grasa (GC) (impedancia bioeléctrica). Comparamos los papeles de CS y AFMV en la ocurrencia de caídas mediante la regresión logística múltiple ajustada por edad, sexo, factores de riesgo cardiovascular, MMC, pico de V'O2 y TM de la extensión de la rodilla.* ***Resultados:*** *Se evaluaron 379 participantes de 40 – 80 años. Cuarenta y ocho participantes informaron al menos una caída en los 12 meses previos (14,5%). Caedores presentaron menor CS y mayor AFMV. Eran predominantemente mujeres y mayores con menor aptitud física. Después de los análisis multivariados, AFMV, pero no CS, fue seleccionada como predictor independiente de caídas, lo que aumentó la odds ratio de tener una caída (1.184, intervalo de confianza del 95%, 1,016 – 1,378).* ***Conclusión:*** *los episodios de caídas en mujeres de mediana edad se asociaron con mayor AFMV, lo que indica un efecto adverso de AFMV en estos sujetos.*

Palabras-clave: *Aptitud Física. Monitores de Ejercicio. Caídas. Estilo de Vida Sedentario. Mediana Edad.*

Introduction

Falls can be determined by functional disorder or environmental hazard [1, 2]. Depending on who falls and how it occurs, the fall can lead to activity restriction, fear of falling, fractures, hospitalization, and hence decreased quality of life, loss of independence and even death [3, 4]. Older adults are the most affected and their hospitalizations can be quite onerous [5].

Despite the highest prevalence of falls being in the elderly population, a recent study demonstrated similar proportion of fallers among middle-aged (45-64 age group) and older adults (over 65 years) [6]. Besides that, the rate of falls and fall-related injuries increases from 25-34 years and above [6]. Therefore, it is necessary to identify the main predictors of the occurrence of falls also in middle-aged adults.

Previous studies suggest that lifestyle is also related to the occurrence of falls. The daily level of physical activity positively correlates to the occurrence of falls in older adults [7]. Being physically inactive or presenting a low level of physical activity in daily life is associated with a higher occurrence of falls and less time until the next episode of falling [7, 8]. Physical activity (PA) decreases the rates of morbidity and mortality and helps to maintain functionality and mobility [9].

Sedentary behavior (SB) tends to increase and PA tends to decrease with aging [10-12]. As for SB, it is characterized by any physical activity with low energy expenditure (less than 1,5 MET), such as sitting, lying down, driving, watching TV [10]. A high SB may occur regardless the amount of the moderate-to-vigorous physical activity (MVPA) [13]. In addition, SB is an independent risk factor with a direct influence on metabolism, bones, vascular health, the onset of chronic diseases, and it also increases the risk of all-cause mortality in older adults [10-12]. Also, since falling can be determined by the interaction between chronic predisposing diseases, impairments and use of medications [14], there is a need to consider these other variables to clarify the association between the SB, MVPA, and occurrence of falls in middle-aged and older adults.

Most studies on sedentary behavior have investigated its effects on cardiovascular outcomes and physical function; however, literature is scarce regarding the impact of SB on the occurrence of falls, which is mainly measured by using triaxial accelerometers. Thus, we hypothesized that SB is an independent predictor of falls in middle-aged and older adults, regardless of the amount of MVPA. Hence, this study aimed to evaluate the association between SB and MVPA and the occurrence of falls in asymptomatic middle-aged and older adults. Secondarily, the profile of fallers and non-fallers in the sample studied was compared.

Method

Study design and ethics

This is a cross-sectional study, which evaluated the data of the first participants enrolled in the EPIMOV study (Epidemiology and Human Movement Study). In brief, the EPIMOV study is an ongoing prospective cohort study whose primary objective is to determine the association between SB and low levels of physical activity and fitness and the incidence of chronic hypokinetic diseases. The assessments of the EPIMOV study have been detailed elsewhere [15]. The study was approved by the Human Research Ethics Committee of the local University (Protocol no. 186.796).

Participants

We analyzed the data of 379 asymptomatic participants (117 men and 262 women). The EPIMOV sample was composed of asymptomatic adults aged 18 years or older. The sample was selected by convenience and participants were recruited via advertisements in social media, local universities, magazines, and local newspaper. All volunteers were informed about the risks and discomforts related to the research protocol and provided written informed consent.

For this study, only those ≥ 40 years were selected. The EPIMOV inclusion criteria were not having severe cardiovascular or pulmonary conditions (e.g., stable or unstable angina, myocardial infarction, cardiac surgery, chronic obstructive pulmonary disease or recent history of respiratory infections). Subjects who used walking aids or those with orthopedic or musculoskeletal disorders that could lead to falls or disruption in the performance of the tests were not included, as well as those who did not complete all assessments.

All participants completed a protocol consisting of two days of evaluations. First, they were submitted to a clinical assessment, self-reported history of falls, anthropometric measurements, and cardiopulmonary exercise test. At the end of the first day of assessment, they received a triaxial accelerometer and were instructed on its use. In the second visit, seven days apart, participants returned the accelerometer, performed a body composition (bioelectrical impedance) and muscle function assessments (isokinetic dynamometry).

Clinical assessment

Initial clinical assessment included a questionnaire to register education level, medication history, and current diseases. Then, all participants answered the Physical Activity Readiness Questionnaire to detect any possible contraindications to performing PA [16]. The following self-reported cardiovascular risk factors were considered: age (male ≥ 45-yr; female ≥ 55-yr), family history of cardiovascular disease (myocardial infarction or sudden death in first-degree relatives), arterial hypertension, diabetes, dyslipidemia, obesity and current smoking [17].

Self-reported falls

Participants were inquired about episodes of falls in the previous 12 months prior this study. The participants answered two questions: "Did you fall in the last 12 months?". If the answer was yes, we also inquired "How many times did you fall within this period?". A fall was defined as any event that led to an unplanned, unexpected contact of the body with a surface. According to what was previously described, these aforementioned questions are specific and sensible for detecting the history of falls. They were stratified as fallers (one or more falls within 12 months prior to the study) and non-fallers (no falls within the period).

We recorded the occurrence of falls in participants over the age of 40 years due to the increasing prevalence of falls among middle-aged individuals, as well as the increased rates of chronic diseases and continuous use of medications in this age group [6, 18, 19].

Cardiopulmonary exercise testing

Cardiopulmonary exercise was tested on a treadmill (ATL, Inbrasport, Porto Alegre, Brazil) using an individualized ramp protocol with increases in velocity and inclination until exhaustion. Oxygen uptake, carbon dioxide production, R ($V'CO_2/V'O_2$), minute ventilation, and heart rate were monitored throughout the test using a gas analyzer (Quark PFT, Cosmed, Pavona di Albano, Italy). The mean peak oxygen uptake values (ml/min/kg) during the last 15s of the cardiopulmonary exercise testing were used to assess cardiorespiratory fitness [20].

Anthropometric and body composition evaluation

Height (m) and body mass (kg) were measured with a digital balance with a stadiometer (Toledo®, São Paulo, Brazil). Then, the body mass index was calculated.

Body composition was evaluated by bioelectrical impedance (310e BIODYNAMICS, Detroit, USA) at room temperature. Impedance and reactance values were collected with the subject in supine position with arms and legs in 30º and 45º of abduction, as described by Kyle et al. [21, 22]. After cleaning the skin, two electrodes were positioned on hand and foot on the same side of the body. Using the equation developed for healthy subjects, lean body mass and fat body mass were calculated [23]. We instructed volunteers not to ingest any liquid or food for 4 hours prior to the test and not to exercise for 12 hours before the sessions.

Muscle function assessment

Knee muscle function was measured using an isokinetic dynamometer (Biodex System 3 PRO, Lumex Inc., Ronkonkoma, NY, USA). In the seated position, the upper body and the lower limb under evaluation were fully stabilized by straps. The mechanical rotation axis of the device was aligned to the rotational axis of the assessed joint. The angles and positions of the chair and the dynamometer were adjusted as recommended by the manufacturer. Device software allowed gravity correction and correct limb weight readings during all tests. To warm up and get familiar with the exercises, the participants completed three to five submaximal repetitions. The peak torque, in Nm, and the total work, in kJ, of knee extension and flexion were obtained by two tests, the first one with five movements at 60º/s and the second with 30 repetitions at 300º/s. We selected the greater value for further analysis in all the tests mentioned above. We applied these tests to quadriceps muscle under strong verbal encouragement [24].

Physical activity daily level assessment

To evaluate SB and PA, a previously validated triaxial accelerometer was used (GT3X+, Actigraph, Inc., Pensacola, FL) [25, 26]. The equipment consists of a small, lightweight box (4.6 cm × 3.3 cm × 1.5 cm) to be attached to the waist above the dominant hip by a band (total weight = 19 g), which allows the measurement of human movement in the vertical, sagittal and mediolateral axes.

We instructed the participants to maintain their normal activities for seven consecutive days of the evaluation period. The accelerometer was used during waking hours, except in activities involving water or during night sleep. We considered valid the data of the participants who used the device for at least 4 days (4-7 days) and at least 12 consecutive hours per day, as well as no excessive counts (> 20,000).

The SB and sedentary activities were obtained as previously described [11]. Briefly, we considered SB as less than 100 counts per minute (cpm) or ≤ 1.5 METs and non-wearing time was defined as, at least, 60 consecutive minutes of 0 cpm, i. e., between 0 and 99 cpm, allowing up to a 2-minute interval of non-zero cpm. The measurements were calculated as min/d as well as in percentage of the total time.

The amount and intensity of weekly PA levels was evaluated as follows: light (≤ 3.00 METs or 100 – 1,951 cpm), moderate (3.00 to 5.99 METs or 1,952 – 5,724 cpm), vigorous (6.00 to 8.99 METs or 5,725 – 9,298 cpm), very vigorous (≥ 9.00 METs or > 9,499 cpm) and MVPA (> 3.00 METs or > 1,951 cpm). Physical inactivity was considered as less than 150 min/week of MVPA, according to previously recommended values [27, 28].

Statistical analysis

Statistical analysis was performed using SPSS, version 23 (SPSS Inc., Chicago, IL, USA) at a $p < 0.05$ level of statistical significance. Initially, data were analyzed descriptively. The continuous variables are shown as means ± standard deviation and the categorical variables as frequency and percentage. The variables with non-normal distribution were shown as median (interquartile range). Then, the sample was stratified into two groups according to self-reported history of falls. A comparison of SB and PA variables was performed between the groups by using the t-test or Mann-Whitney test, depending on data distribution.

Lastly, a backward stepwise multiple logistic regression analysis with the occurrence of falls was fit as the outcome and SB and MVPA as the main predictors. Univariate analysis verified the influence of other potential predictors such as age (yr), sex, cardiovascular risk factors (arterial hypertension, diabetes, dyslipidemia and physical inactivity), lean body mass (kg), peak oxygen uptake, peak torque of knee extension (Nm), educational level, and use of medication. We included in the multivariate model those showing p values < 0.20. All the predictors included were tested for multicollinearity. The residual pattern was also investigated by evaluating its distribution and number of outliers so that the validity of our model could be attested. To confirm that our sample size was enough to answer our research question, the free software statstodo (www.statstodo.com) was used, considering a small effect size of 0.25, an alpha error at 0.05, beta at 0.20 and up to 10 predictors included in the model. It was found that 251 participants would be enough to fit the proposed multiple logistic regression.

Results

Forty-eight (12.6%) participants reported having fallen at least once within the 12 months prior to our study. These participants were mostly middle-aged and older women with significantly higher cardiovascular risk and lower physical fitness. They also presented worse values of BMI and body composition (Table 1). It was found in the non-adjusted comparison that fallers presented less SB, a higher very light PA and a higher MVPA when compared with non-fallers (Table 2). After the logistic multiple regression analysis, we observed that high MVPA was positively associated with the occurrence of falls. Additionally, a higher amount of MVPA increased the chance of falling by 18%. On the other hand, SB was not selected as an independent predictor of the occurrence of falls. The advancing age and a higher cardiovascular risk were also associated with an increased fall risk. In contrast, greater muscle strength decreased the chance of falling (Table 3).

Table 1 – General characteristics of the studied sample stratified according to the history of falls (n = 379)

	Non-fallers (n = 331)	Fallers (n = 48)
Age (years)*	54 ± 9	58 ± 6
Sex		
Women, n (%)*	218 (65,9)	44 (91,7)
Men, n (%)	113 (34,1)	4 (8,3)
Weight (kg)	78 ± 17	79 ± 16
Height (m)*	1.62 ± 0.09	1.56 ± 0.07
Body Mass Index (kg/m²)*	29 ± 5	32 ± 6
Body fat mass (kg)*	27 ± 10	33 ± 12
Body fat mass (%)*	33 ± 7	39 ± 6
Lean body mass (kg)	51 ± 10	48 ± 9
Lean body mass (%)	72 ± 11	62 ± 15
Hypertension, n (%)*	80 (24,2)	21 (43,8)
Diabetes, n (%)*	45 (13,6)	18 (37,5)
Dyslipidemia, n (%)#	130 (39,3)	25 (52,1)
Obesity, n (%)*	150 (45,3)	31 (64,6)
Smoking, n (%)	45 (13,6)	6 (12,5)
Physical inactivity, n (%)§	63 (25,3)	6 (20,7)
Peak oxygen uptake (mL/min)*	1969 ± 679	1608 ± 350
Peak oxygen uptake (mL/min/kg)*	25 ± 8	20 ± 4
Peak oxygen uptake (%pred.)	99 ± 18	97 ± 16
Peak torque of knee extension at 60°/s (Nm)*	119 ± 48	79 ± 26
Total work of knee extension at 300°/s (kJ)*	1349 ± 534	966 ± 364

Note: *p < 0.05; #p = 0.09; §Assessment by triaxial accelerometers.

Table 2 – Daily life physical activity and sedentary behavior assessed by triaxial accelerometers according to the history of falls (n = 379)

	Non-fallers (n = 331)	Fallers (n = 48)
Energy expenditure (kcal)	2793 ± 1600	2912 ± 1466
Energy expenditure (kcal/d)	418 ± 219	453 ± 242
Sedentary behavior (%)	74 ± 8*	71 ± 8
Very light physical activity (%)	13 ± 4*	16 ± 4
Light physical activity (%)	6.3 ± 2.7	7.3 ± 3.0
Moderate physical activity (%)	4.4 ± 2.7	5.0 ± 3.7
Vigorous physical activity (%)	0.25 ± 0.74	0.13 ± 0.37
Moderate-to-vigorous physical activity (%)	4.0 ± 3.0*	5.2 ± 3.9
Mean number of steps/day	7850 ± 3184	8978 ± 4006

Note: *p < 0,05.

Table 3 – Results from the logistic multiple regression analysis with the occurrence of falls as outcome and with the sedentary behavior and the moderate-to-vigorous physical activity as main predictors in the studied sample over the age of 40 years (n = 379)

						95% interval confidence	
	B	**EP**	**Wald**	**p**	**Odds ratio**	**Lower limit**	**Upper limit**
Moderate-to-vigorous physical activity (% of total)	0.169	0.078	4.702	0.030	1.184	1.016	1.378
Age (years)	-1.322	0.42	4.243	0.039	0.267	0.076	0.938
Hypertension	1.835	0.550	11.138	0.001	6.268	2.133	18.418
Peak torque of knee extension at 60°/s (Nm)	-0.025	0.008	10.795	0.001	0.976	0.961	0.990
Constant	-1.130	0.867	1.699	0.192	0.323		

Discussion

We tested the hypothesis that SB could play a significant role as a predictor of falls in middle-aged and older adults, regardless of the amount of MVPA. However, our results demonstrated that a higher amount of MVPA, not a lower one, is associated with increased odds of falling.

Although MVPA is associated with the best quality of life, we found that high MVPA increased about 18% the odds of falling. Our results oppose those described in an extensive systematic review [29]. According to these authors, high level of PA is a protective factor against the occurrence of falls. In a previous study, the MVPA tends to reduce the risk of recurrent falls [30]. Another study suggests that MVPA also increases the time until the first fall occurs in addition to the decreased incident falls [31].

On the other hand, our results agree with those reported by Chan et al. [32] and more recently by Jefferis et al. [33]. These two cohort studies used a previously validated questionnaire and triaxial accelerometry, respectively, to evaluate physical activity in daily life. Similar to our findings, they showed that a higher amount of MVPA was positively associated with the occurrence of falls [34, 35]. Although it seems to be a paradoxical relation, Jefferis et al. [33] showed a new perspective, suggesting that this association presents a U-shaped relation when related to the mobility of the subjects. These authors reported that a higher amount of MVPA increased the risk of falling when considering subjects without mobility problems, however, did the opposite when considering subjects with mobility limitations [33].

It is also necessary to consider the level of exposure to the occurrence of falls to which the subjects are submitted [36], as well as the type of PA in which the individuals engaged. Therefore, the risk of falls should be expressed by the ratio of the number of falls over 1000 physically active days (e.g., with at least 30 minutes of MVPA) [36], since, at the onset of postural control problems, the subjects substantially reduce their physical activity level and, consequently, the level of exposure, to avoid the occurrence of falls [36, 37]. Previous studies also found that subjects who fell while engaging in usual activities exhibited lower PA and lower functional status than subjects who fell while engaging in risky or unusual activities [35]. Another study showed that subjects with fear of falling are less active and adjusted their behavior by reducing exposure [38]. Also, our sample was composed mainly of middle-aged adults, which may partially explain this result.

Although our hypothesis was not directly confirmed, the influence of SB may occur in association with less MVPA. Previous studies showed that physical inactivity combined with a high SB increases the occurrence of falls and also reduces the time until the next fall in physically inactive subjects [28, 31]. Moreover, SB is related to obesity, increased risk of diabetes and hypercholesterolemia, worse mental health, and worse vascular health and bone mineral density [10]. These factors are directly or indirectly related to the increased risk of falling [10].

The association between aging and the occurrence of falls is widely documented in literature. Subjects with 60 years and above have up to three times higher chance of falling when compared to middle-aged adults [39]. The larger proportion of female fallers observed in the present study was also previously described [40] and might be related to several factors, such as hormonal differences, lower muscle function, and differences in physical activity patterns among women [41].

Previous studies investigated the association between the occurrence of falls and the presence of chronic diseases, finding that chronically ill individuals are more likely to fall, and our results confirm the determinant association between arterial hypertension and risk of falling [42]. This is due to hypertension-related systemic effects as well as due to medicines commonly used to control blood pressure [42 ,43]. These medications along with the effects of the disease may decrease motor functions and result in muscle weakness, fatigue, vertigo or postural hypotension [43, 44].

Lower limb muscle function is important for the postural stability during daily living activities and has been identified as an independent predictor for the increased risk of falling, the occurrence of fractures and is also associated with an increased mortality rate [45]. In this study, knee muscle function was identified as an independent determinant of the occurrence of falls. Previous studies [33, 45, 46] observed the influence of higher quadriceps muscle strength on reduced occurrence of falls, especially regarding multiple episodes of falls [33, 47]. Lower limb muscle function also impacts on gait velocity and quality, which in turn is related to a higher risk of falling (e.g., loss of functionality and changes in gait pattern) [45].

Multi-component strength and balance training, followed by flexibility and aerobic resistance, is the most effective for fall prevention [48]. Elderly people with a higher risk of falling had worse agility, dynamic balance, aerobic endurance, and muscular endurance of the upper limbs when compared to an age-matched control group [49]. Accordingly, specific exercises to improve dynamic postural balance and muscle function are rational to reduce the risk of falling.

This study has some limitations that must be considered. The main limitations are the cross-sectional design and convenience sampling. The participants were mainly middle-aged and less fragile than participants in previous studies. This explains the lower proportion of fallers in our study. Despite this fact, our sample size was suitable for this analysis and the proportion of several general characteristics was similar to those described in Brazilian general population. On the other hand, the use of the triaxial accelerometry, instead of self-reported PA and SB, may be considered as one of the main strengths of this study. Also, the influence of PA and SB patterns on falls adjusted for direct measures of cardiorespiratory fitness and muscle function has been poorly investigated.

Future studies should investigate whether the effects of sedentary behavior on the occurrence of falls are mediated by the level of physical activity and fitness, as well as consider the pattern of physical activity and its risk of exposure to falls.

Conclusion

It was concluded that a higher quantity of MVPA, not the opposite, has an adverse influence on the occurrence of falls, regardless of SB. These results might be generalizable for mainly middle-aged hypertensive subjects, predominantly women and with lower muscular strength. Interventions to promote MVPA in this age group should be designed to improve quadriceps muscle strength and postural balance.

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