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Association between low level of physical activity and mobility limitation in older adults: evidence from the SABE study

Associação entre baixo nível de atividade física e limitação de mobilidade em idoso: evidência do estudo SABE

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Abstract *Several studies are limited by verifying the level of physical activity with questionnaires and not through objective measurement in older adults. This article aims to analyze the association between a low level of physical activity with accelerometry) and mobility limitation in older adults. A population-based cross-sectional study conducted with 543 older adults. Multiple regression analysis was performed using hierarchical analysis, grouping the variables into two blocks ordered according to the precedence with which they acted on the outcomes. Among the evaluated older adults, 13.7% presented mobility limitations and among these 60.39% were in the low level of physical activity group. Older adults with a low level of physical activity (OR = 3.49 [2.0 - 6.13]), aged 75 and over (OR = 1.97 [1.03 - 3.72]), living without a partner (OR = 2.01 [1.09 - 3.68]), having difficulty performing basic (OR = 2.49 [1.45 - 4.28]) and instrumental (OR = 2.28) [1.18 - 4.36]) activities of daily life, and multimorbidity (OR = 2.06 [1.04 - 4.08]) were independently associated with mobility limitation. A low level of physical activity increases the chance of mobility limitation in older adults, regardless of sociodemographic and clinical variables.*

Key words *Ageing, Epidemiology, Motor activity, Mobility limitation*

Resumo *Vários estudos são limitados por meio da verificação do nível de atividade física com questionários, mas não possuem medidas objetivas em adultos mais velhos. O objetivo deste artigo é analisar a associação entre um baixo nível de atividade física e limitação de mobilidade em idosos. Um estudo transversal de base populacional realizado com 543 idosos. A análise múltipla da regressão foi realizada usando a análise hierárquica, agrupando as variáveis em dois blocos ordenados de acordo com a precedência com que atuaram sobre os resultados. Entre os idosos avaliados, 13,7% apresentaram limitações de mobilidade e entre estes 60,39% estavam no baixo nível de atividade física. Idosos com um baixo nível de atividade física (OR = 3,49 [2,0 - 6,13]), com idade igual ou superior a 75 anos (OR = 1,97 [1,03 - 3,72]), vivendo sem parceiro (OR = 2,01 [1,09 - 3,68]), dificuldade de viver sem um parceiro (OR = 2,01 [1,09 - 3,68]), dificuldades com atividades básicas (OR = 2,49 [1,45 - 4,28]) e as atividades instrumentais (OR = 2.28) [1.18 - 4.36]) atividades da vida do dia a dia e multimobilidade (OR = 2,06 [1,04 - 4,08]) foram associadas independentemente à mobilidade. Um baixo nível de atividade física aumenta a possibilidade de limitação da mobilidade em adultos idosos, independentemente das variáveis sociodemográficas e clínicas.*

Palavras-chave *Envelhecimento, Epidemiologia, Atividade motora, Limitação da mobilidade*

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Introduction

With the aging process, the chance of mobility limitation increases in older adults due to postural instability and alterations in gait, consequently increasing the risk of falls[1]. Alterations in mobility may occur due to motor dysfunction, sense of perception, balance, or cognitive impairment[2]. The locomotor apparatus undergoes changes, causing a reduction in range of motion, modifying walking to shorter and slower steps, and a tendency to drag the feet, generating higher caloric expenditure. The base of support expands and the center of body gravity tends to move forward, seeking greater balance[3]. For this reason, seems important verifying factors associated with mobility limitation.

A robust body evidence has shown that a low level of physical activity is associated with mobility limitation[4,5]. Yet, studies showed that the practice of physical activity can improve and/or maintain functional capacity during the aging process[6-8]. Thus, a meta-analysis[9] with studies on frail individuals showed that the group with a low level of physical activity presented a significantly slower usual walking speed than the group with an intermediate/high level of physical activity, as well as demonstrating the worst results in the lower limb strength (sitting and standing) and balance tests[9].

Mobility it is more than a person's physical ability to walk or move within an environment and their ability to adapt to it. Mobility is assessed by the capacity of its basic activities of the day independently[10]. However, mobility limitation is most common in elderly, and are mainly caused by decreased muscle strength[1], changes in body composition (fat accumulation and decreased muscle and bone mass)[11,12], cognitive decline[13], decreased functional capacity[14]. Thus, it is understood that increase time physical activity older people demonstrate better mobility and functional capacity, as well as a lower risk of chronic diseases during the aging process[15-17].

Nevertheless, in epidemiological studies, the level of physical activity (PA) is typically identified using subjective methods (questionnaires and recall questions), due to their low cost and ease of application in large populations in a short period of time[18,19]. However, these methods present some disadvantages which limit their accuracy, especially in older adults[20], such as cognitive deficits, which might increase the risk of recall bias and use of subjective methods to assess PA might suffer from the social desirability bias[21]. In this context, the use of portable monitors such as accelerometers, can contribute by identifying PA levels with greater precision in elderly subjects, as the monitors provide objective PA data such as frequency, intensity, and duration[22,23].

To date in some countries, there are no population cohort studies that represent the older population in a large metropolis, using an objective method (accelerometry) to identify the association of a low level of physical activity with mobility limitation. However, it is not clear whether these tools provide identifying factors associated of PA in elderly people. Thus, the aim of this study was to analyze the association between a low level of physical activity with accelerometry and mobility limitation in older adults**.**

Methods

Study population

This is a cross-sectional study with a probabilistic sample of elderly people living in São Paulo, Brazil in 2010, part of the SABE Study - Health, Welfare, and Aging (Saúde, Bem-Estar e Envelhecimento, in portuguese).

The SABE Study is a longitudinal study of multiple cohorts which started in 2000 with a random sample of 2,143 individuals aged 60 years or more in the city of SP (cohort A). In 2006, 1,115 individuals from the first cohort were located and re-interviewed. The difference in numbers was due to deaths (649), refusals (177), changes in location (51), institutionalization (11), and not being located (140). At that time a new random sample of 298 individuals aged 60 to 64 (cohort B) was introduced, who were added as this age group was no longer represented in the original sample. In 2010, 990 individuals were located and interviewed and, as in 2006, a new cohort of elderly patients (n = 355) 60-64 years (cohort C) introduced. The losses corresponded to deaths (280), refusals (109), changes in location (49), institutionalization (10), and not being located (63).

For the present study, in 2010, all located and re-interviewed elderly individuals (cohorts A and B, n = 990) were asked to use an accelerometer for three consecutive days; of these, 599 agreed to participate (65 and older). Participants who presented less than two days valid use of the device (31) or presented incomplete data (25) were excluded. Finally, 543 elderly individuals, aged 65 years or older (mean 76.2 + 8.05 years), living in the city of São Paulo, took part in this study.

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Measures

Dependent variable: mobility limitation

In the current study, the *Short Physical Performance Battery (SPPB)*[24] was used to analyze the mobility limitation of the older adults. This test battery identifies static balance, lower limb strength, and usual walking speed.

The balance test contains three stages, performed in sequence (10 seconds each). In the first stage, the elderly person stands with feet together, in the second stage, with the heel of one foot against the side of the hallux of the opposite foot, and in the third stage, with one foot in front of the other. The score of the three positions was summed and the final score was obtained from the sum.

In the usual walking speed test, the older adults were required to walk three meters at the same speed they used for their daily activities and the time of the course was recorded by the interviewers.

To identify the strength of the lower limbs, the sitting and rising chair test was performed, where the elderly person kept their arms crossed over their chest and, at a sign from the researcher, got up and sat in the chair as quickly as possible, five times within a maximum of 60 seconds.

The scores for each of the three tests range from zero (cannot do) to four (best performing) points. For the current study all points were summed and the elderly were classified as: 0 - no mobility limitation when, from the 12 possible points, they obtained seven or more points, and 1 - with mobility limitation, those with six or less points.

Independent variable

For the analysis of PA level, a motion sensor type accelerometer, brand Actigraph, model GT3X (Actigraph LLC, Pensacola, FL) was used, delivered by a trained technician to the elderly volunteers who agreed to use the equipment. The participants were instructed to wear the accelerometer on their waist on the right side of the body, held in place with the aid of an elastic waistband, for 24 hours for three consecutive days, removing it only for swimming or water activities[14].

The monitor was prepared the day before use (Monday) with the name and number of the questionnaire and monitor. Each elastic waistband was made individually, according to waist circumference, and the device programmed to start the count from nine o'clock on Tuesday morning and stop the count at nine o'clock on Friday morning.

On completion of the trial period, the monitors were collected for *downloading* the recorded data. This process was carried out using Actlife software, version 5.0. Only full days of monitoring were included in the database. Consecutive time periods with zero counts were considered as a period in which the patient was not using the accelerometer and days with less than ten hours of use of the device were excluded as they could have increased the variability[14].

For the present study the elderly participants were divided into two levels of PA, from the percentile distribution of counts per minute (CPM). The study sample was divided into tertiles and categorized into two groups, using the 33rd percentile as the criterion for classification. The older adults in the lowest tertile were classified as having a low level of physical activity and the elderly in the other two tertiles were classified as having an intermediate/high level of physical activity.

Covariates

Socio-demographic characteristics

Socio-demographic characteristics include sex, age, years of schooling, marital status, and work activity. Age was grouped into two 10-year categories, with individuals aged 75 years or older combined into a single group. Educational level was analyzed from the number of years of schooling and categorized as $\leq$ 4 years or $\geq$ 5 years. Marital status was classified as married (married or in a stable relationship) or not married (single, widowed, divorced, or separated). Work activity was defined by the question: "Do you currently work".

Chronic pain

Chronic pain was classified from two questions. *Do you feel pain or discomfort when you make some physical efforts or movements such as standing up or walking* and *Have you experienced any pain for more than three months, which hurts continuously or comes and goes at least once a month?* If the participant answered 'yes' to either of the two questions they were classified as having chronic pain.

For falls, the older adults were classified as faller or non-faller according to the question *Have you had a fall in the 12 months prior to the interview??*

Multimorbidity

Multimorbidity was classified and analyzed from the presence of two or more chronic diseases[16]. Number of chronic diseases reported was obtained from the question *Have you ever been told by a doctor or nurse that you have or have had* ...? including the following diseases: hypertension, diabetes, joint disease, heart disease, chronic lung disease, osteoporosis, stroke and cancer.

Sarcopenia

Sarcopenia was identified according to the criteria established by the *European Working Group on Sarcopenia in Older People* (EWGSOP). Participants with lower mass (20th percentile) and muscle strength (30 kg for men and 20 kg for women) or walking velocity (<0.8 m/s in normal walking) were considered sarcopenic[25]. First, for measurement of muscle strength, was utilized (Jamar dynamometer), wherein the participants sat, elbow next to the hip, with neutral position of the wrist. The manual pressure force data were shown as right or left, regardless of hand domain[26]. Second, for the walking velocity, a 4 m speed test was measured, with speed measured manually with a stopwatch or other electronic device to measure gait time[27,28]. Finally, muscle mass was estimated by apendicular skeletal muscle mass (ASM). This equation has been validated in the Brazilian population with a high correlation between methods (r=0.86 for men and r=0.90 for women, respectively, $p<0.05$)[29].

Difficulty in performing basic activities of daily living (BADLs) was identified if the participant answered yes to one or more questions: Do you have difficulty 1) dressing your upper body (above your waist)?; 2) dressing your lower body (below the waist)?; 3) taking a shower ?; 4) performing your personal hygiene? (wash and dry hands, wash and dry face, comb hair, shave, or apply make up); 5) eating?; 6) walking across the room?; 7) lying down or getting up from the bed or sitting and getting up from a chair?; and 8) going to the bathroom alone?

Difficulty in performing instrumental activities of daily living (IADLs) was identified from the presence of difficulty in performing eight activities (using the telephone, shopping, preparing meals, performing light or heavy household chores, taking medication, managing money, and using transportation). The older adults who reported difficulty or inability to perform one or more of the activities was classified as having difficulty in performing IADLs.

Cognitive decline

Cognitive decline was identified using a modified version of the Mini-Mental State Examination (MMSE)[18]. This instrument contains 13 items (maximum score of 19 points), not dependent on level of education, and the cut-off point used for positive screening for cognitive decline is 12 or less[19].

Nutritional status

Nutritional status was verified from the body mass index (BMI); the older adults were classified as normal weight (< 28 kg/m²) or overweight (≥ 28 kg/m²)[13]. Body weight was measured using a digital scale, Filizola, with an accuracy of 0.1 kg and maximum capacity of 150 kg and height was measured using a fixed metal stadiometer, accurate to 0.1 cm, with a maximum length of two meters.

Statistical analyses

The differences between groups were estimated using Wald's generalized test of equality between means and the Rao-Scott test, which take into consideration sample weights for estimates with population weightings[30].

The chi-square test analyzed the association between the variables and also compared proportions. A binary logistic regression was represented by the *Odds Ratio* (OR) and confidence interval (CI95%) values. The variables that presented an association of $p \leq 0.20$ in the univariate model were selected for the multiple regression analysis.

Multiple regression analysis was performed using hierarchical analysis, grouping the variables into two blocks ordered according to the precedence with which they acted on the outcomes. First, the block of sociodemographic variables was included, and then the block composed of clinical variables. The variables selected in the first block were kept in the model even if the statistical significance was not preserved with the inclusion of the subsequent block, remaining as control variables for the proximal block, according to the theoretical model proposed in Figure 1.

For the regression models, a "partial model" was considered adjusted only by sociodemographic variables and, "final model", adjusted by both blocks of variables (see Table 1). For the interpretation of the results in the final models, we considered the identification of a statistically significant association ($p<0.05$) between a given variable under study and the outcome in ques-

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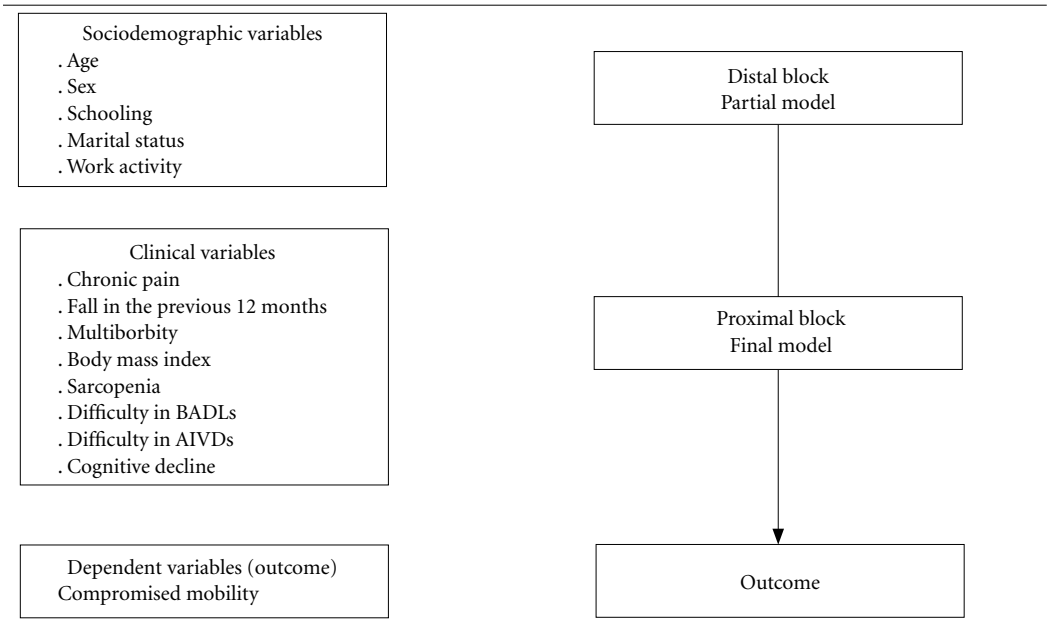

Figure 1. Hierarchical analysis theoretical model for investigation of variables associated with mobility limitation, structured in two blocks of variables.

Source: Authors.

tion, after adjusting for the potential variables of the same block and the upper hierarchical blocks, which would indicate the existence of an independent association pertaining to that variable.

All analyzes were performed using STATA software, version 11.0, and statistical significance was set at 5%.

All study participants were informed about the study procedures and only those who signed the informed consent were included in the sample. All protocols were reviewed and approved by the Ethics Committee (Protocol no. 2044/2010).

Results

The elderly in the present study spent an average of 12 minutes and 6 seconds per day in moderate/vigorous intensity activities, with significant differences between men (17 minutes and 54 seconds) and women (8 minutes and 46 seconds). The general characteristics of the study population are showed in Table 2. Most of them are women, who no longer perform work, have chronic pain and multimorbidity. Among the elderly analyzed, 74 had mobility limitation (13.62%).

Sociodemographic variables, according to the level of physical activity observed by the CPM, are presented in Table 3. A higher prevalence of a low level of physical activity was found in the elderly aged 75 years and over, living without a partner, and not currently working. Older adults with five or more years of schooling were mostly in the intermediate/high level of physical activity.

Clinical variables, according to the level of physical activity observed by the CPM, are presented in Table 1. The variables chronic pain, difficulty in performing activities of daily living (BADLs and IADLs), and cognitive decline were associated with the level of physical activity.

In the analysis of the association of low level of physical activity with mobility limitation, it was observed that 13.7% of the older adults presented mobility limitation and among individuals with mobility limitation, 60.39% presented a low level of physical activity. Among individuals without mobility limitation, only 20.26% presented a low level of physical activity ($p<0.0001$).

In the analysis involving mobility limitation (Table 4), regardless of the variables of the first block (sociodemographic variables) and the second block (clinical variables), a low level of physical activity remained associated with mobil-

Table 1. Distribution (%) of the older adults according to physical activity level and clinical variables.

Variables	Low level of physical activity	Intermediate/ high level of physical activity	P
Chronic pain			
No	21.13	78.87	0.0090
Yes	31.21	68.79	
Fall in previous 12 months			
Did not fall	24.86	75.14	0.0778
Fell	31.80	68.20	
Multimorbidity			
No	22.87	77.13	0.0994
Yes	29.74	70.26	
Sarcopenia			
No	27.91	72.09	0.2912
Yes	26.70	73.30	
Difficulty in BADLs			
No	21.46	78.54	<0.0001
Yes	42.43	57.57	
Difficulty in IADLs			
No	14.78	85.22	<0.0001
Yes	43.22	56.78	
Cognitive decline			
No	22.01	77.99	<0.0001
Yes	61.63	38.37	
BMI			
< 28 kg/m^2	26.19	73.81	0.7661
≥ 28 kg/m^2	25.01	74.99	

Source: Authors.

Table 2. General Distribution (%) sociodemographic and clinical variables of the older adults.

Variables	Proportions (%)
Sex Feminine	62.99%
Age range (≥ 75 years)	37.74%
Years of schooling (≥ 5 years)	44.45%
Marital status (Live without partner)	47.63%
Work activity (Not currently working)	78.12%
Chronic pain (Yes)	59.00%
Fall in previous 12 months (Yes)	31.15%
Multimorbidity (Yes)	61.81%
Sarcopenia (Yes)	15.13%
Difficulty in BADLs (Yes)	27.00%
Difficulty in IADLs (Yes)	43.37%
Cognitive decline (Yes)	12.90%
BMI (≥ 28 kg/m^2)	31.30%
Mobility Limitation (Yes)	13.62%

Source: Authors.

ity limitation. In addition, older adults 75 years old and over, who lived without a partner, with difficulty in activities of daily living, and multimorbidity, were more likely to present mobility limitation.

Discussion

To the best of our knowledge, the present study showed that older adults with a low level of physical activity are more likely to present mobility limitation. Of the elderly with mobility limitations, 60.39% were identified as having a low level of physical activity, while this number was only 20.26% in the older adults without mobility limitations. Also, regardless of sociodemographic and clinical variables, a low level of physical activity remained associated with mobility limitation.

The present study found that a high prevalence of a low level of physical activity measured with accelerometers in sample population. Other studies also find association with a population study conducted with more than 10,000 elderly men and women from the United Kingdom, however, unlike the present study, mobility limitation was analyzed by a questionnaire[31]. Interestingly, a study using data from the 2003 - 2006 NHANES[32] showed that adults with self-reported mobility limitations spent more time on sedentary behavior and less time on mild and moderate activities. On the other hand, similar results were found in a clinical trial conducted with 47 older adults, with a mean age of 77.2 years, and a usual low walking speed (<0.8m/s); the neuromotor exercises increased the usual walking speed and improved performance of other activities of daily living for the older adults with mobility limitation[33].

Decreasing usual habitual physical activity is the starting point in the process of installation of mobility limitation[34]. This is linked to maintenance of independence to perform activities of daily living as, even in elderly people without other limitations, walking difficulties are associated with the accelerated decline in physical function

and a high risk of institutionalization[35]. Therefore, improvement in physical abilities (strength, endurance, and speed) is associated with the usual practice of physical activity. Despite these findings, it is still unclear whether the positive effects of exercise can be sustained for a long enough period of time and maintained to avoid limitation in mobility throughout life (Landi *et al.*, 2010).

Strategies to promote spent more time in practice of physical activity should be encouraged for reduction mobility limitation. Moreover, it is already well documented in the literature that thigh levels of physical activity could be advocated as an effective therapy to reduce inflammation biomarkers and, consequently, risk factors for adverse health conditions, such as mobility limitation and risk of death. Nonetheless, this gives hope to the idea that recommendation in guideline by ACSM, which includes light to moderate intensity exercise for 150 minutes or more per week, can improved health and reduce mobility limitation[36]. Other suggestion are physical activities that promote higher pleasure, may be adding music, and group training might be important strategies to increase affective feelings while exercising and consequently improve physical function.

This study has some limitations. First, the cross-sectional analysis prevents any causal relationships. Second, the use of the accelerometer for three days limited the prediction of physically active or inactive subjects during the weekend. For evaluation of the physical activity profile of adults and older adults, the use of the accelerometer is indicated for at least three consecutive days, but one of the days should be during the weekend. Although week and weekend days

Table 3. Distribution (%) of the older adults according to physical activity level and sociodemographic variables.

Variables	Low level of physical activity	Intermediate/ high level of physical activity	p
Sex			
Masculine	30.15	69.85	0.1700
Feminine	25.34	74.66	
Age range			
65 to 74 years	19.20	80.80	<0.0001
≥ 75 years	40.17	59.83	
Years of schooling			
≤ 4 years	32.19	67.81	0.0251
≥ 5 years	23.06	76.94	
Marital status			
Live with partner	22.76	77.24	0.0139
Live without partner	31.91	68.09	
Work activity			
Currently working	14.91	85.09	0.0033
Not currently working	30.54	69.46	

Source: Authors.

Table 4. Association between low level of physical activity and mobility limitation in the elderly, according to hierarchical logistic regression model.

Variables	Partial model ORa [CI 95%]	Final model ORa [CI 95%]
Low level of physical activity (Yes)	5.08** [2.90 – 8.90]	3.49** [2.00 – 6.13]
Sex (Feminine)	1.64 [0.82 – 3.26]	1.27 [0.59 – 2.75]
Age group (≥ 75 years)	2.27** [1.25 – 4.12]	1.97* [1.03 – 3.72]
Work activity (Not currently working)	1.62 [0.60 – 4.40]	1.04 [0.40 – 2.73]
Marital Status (Lives without a partner)	1.84* [1.07 – 3.16]	2.01* [1.09 – 3.68]
Schooling (< 4 years)	1.64 [0.99 – 2.71]	1.19 [0.68 – 2.08]
Cognitive decline (Yes)		1.92 [0.89 – 4.15]
Difficulty in IADLs (Yes)		2.28* [1.18 – 4.36]
Difficulty in BADLs (Yes)		2.49** [1.45 – 4.28]
Multimorbidity (Yes)		2.06* [1.04 – 4.08]

ORa= *odds ratio* adjusted (odds ratio); * p <0.05, ** p <0.01. IADLs= Instrumental activities of daily living; BADLs = Basic activities of daily living.

Source: Authors.

are alike in the elderly population, active older adults generally practice more sports activity during the weekdays[37]. Third, we used to measure nutritional status the body mass index and this can be considered another limitation of our study. Although BMI is a simple measurement of body mass index and is recognized for clinically diagnosing the risk of malnutrition. However, this study[38] also demonstrated that it is possible to estimate the level of physical activity in two days, from the moderate and high intensity of the physical activity measured in older adults using accelerometers. It is important to highlight that for evaluation of sedentary behavior, the number of days recommended is higher than that used in the present study, however, the days used enabled the use of accelerometers in a representative sample of a large city.

This study also has strengths. First, it was conducted with a representative sample of the elderly population in São Paulo. Second, to date, this is the first population study to analyze the association of a low level of physical activity with mobility limitation in Brazilian older adults using an objective measure (accelerometer). There is a high correlation (r = 0.83) between this type of measure and methods considered gold standard for energy expenditure analysis[39], which considerably increases the reliability of the results.

Conclusion

Older adults with a low level of physical activity, classified from the lowest tertile of CPM, were more likely to present mobility limitation, regardless of the sociodemographic and clinical variables studied in this work. Thus, not only a sedentary lifestyle (<30 min of moderate/vigorous activity), but also a low level of physical activity can be used as a method to identify older people with greater chances of mobility limitation. It is important to stress that actions should be taken to increase the usual practice of physical activity and the intensity of this practice, especially in older adults aged 75 years and over, living without a partner, with difficulty in performing daily activities, and with multimorbidity.

Collaborations

IC Gomes: Conceptualization, Investigation, Methodology, Project Administration, and Writing – Original Draft Preparation. LO Neto: Methodology, and Writing – Review & Editing. VDO Tavares: Methodology, and Writing – Review & Editing. YAO Duarte: Conceptualization, Investigation, Methodology, Project Administration, and Writing – Original Draft Preparation.

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