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Relationships between physical activity, physical fitness and mortality among the elderly: Fibra Study

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Abstract

Being physically active and maintaining great physical fitness protect older adults against early death. However, is not clear through which mechanisms such relationships occur or whether physical fitness is required to prevent mortality in this population. The objective was to investigate relationships between physical activity, physical fitness and occurrence of death among the elderly residing in a community and explore the mediating effects. A cross-sectional study from FIBRA Study database, collected in Campinas city, in Sao Paulo state, Brazil between 2008 and 2009 was performed. The occurrence of death was verified in August 2017 in the Mortality Information System (MIS). Physical activity was measured through self-reporting while physical fitness was measured through physical performance tests with 800 participants aged 65 years or older. A model was drawn to test relationships and mediating effects between global, leisurely, domestic physical activities, physical fitness, and mortality, controlled by sex and age. The results demonstrated three main findings: 1) the direct effect of global physical activity on death and its indirect effect mediated by slowness; 2) the direct effect of domestic activity on death and its mediated effect through weakness; and 3) the direct effect of slowness on death. Physically inactive, weak and slow elderly have a greater probability of death. Moreover, the benefits of physical activity are probably beyond physical fitness.

Keywords: Aging, Morbidity. Physical Performance. Wellness, Health Promotion.

INTRODUCTION

Physical activity (PA) has been highlighted as one of the most important health behaviors for healthy aging and quality of life achievement[1-4]. Being physically active is recognized for postponing disability, morbidity and mortality in later life[5-8]. In addition, physical fitness, such as muscle strength and walking ability, is required for an independently life and for performing outdoor activities, allowing greater social participation[9-11].

PA has been defined as any body movement produced from muscle contractions resulting in caloric expenditure[12]. It can be performed in different contexts or domains and its practice may be characterized in leisure, at work, for displacement and in domestic activities. Evidences have shown that regular physical activity practice minimizes the physiological effects of the aging process and increases longevity by limiting the development and

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progression of chronic diseases and preserving functional capacity[7]. In addition, psychological and cognitive functions are also improved by physical activity and contribute to maintaining social participation which, consequently, increases well-being[3-5].

Physical fitness is defined as the physical or physiological ability to perform activities, such as walking, running, jumping, grabbing and carrying[11]. Handgrip strength and walking speed have been used to evaluate physical fitness among older people, in order to identify changes in muscle mass and strength required to perform daily activities[14-18]. Losses in muscle strength and mass characterize weakness and slowness which are determinants of multimorbidity, disability and mortality[15, 17, 18]. Low physical activity and impaired physical fitness have shown strong a association with mortality. However, the domain of physical activity that influences mortality is still controversial. Furthermore, it is unknown whether physical fitness is required to prevent mortality despite practicing physical activity[9-11]. The aim of this study was to investigate relationships between physical activity, physical fitness and occurrence of death among the elderly and to explore mediating effects, in order to clarify whether physical fitness can explain the influence of physical activity on mortality.

METHODS

Study design and sampling

The FIBRA Study was a cross-sectional study performed in Campinas city, Sao Paulo, Brazil with a representative sample of older population, between 2008 and 2009. The main purpose was to investigate frailty and its relationships with sociodemographic, biological and psychosocial variables in urban community-dwelling older adults aged 65 years or older.

The sample was randomly obtained from geographically delimited areas and its size was calculated by estimating the degree of frailty, according to the local elderly population, taking into account the distribution of gender and age groups. In this study, the sample was formed by 800 participants, without cognitive impairment suggestive of dementia, guaranteeing the quality of self-reported data[19].

Data collection comprised two phases. First, households were visited to identify seniors 65 and older who could understand instructions and agreed to participate. Reasons for exclusions were: severe cognitive impairment suggestive of dementia, low mobility (need of a wheelchair or being bedridden), sequelae of stroke with localized loss of strength and/or aphasia, Parkinson's disease in severe or unstable stage, severe deficits in hearing or vision, greatly hindered communication, or being terminally ill. The second phase included participants who were interviewed by trained graduate and undergraduate students in sessions lasting from 90 to 120 minutes conducted in public and accessible places with the time and day scheduled. Participants signed an informed consent form approved by the Research Ethics Committee of the Faculty of Medical Sciences of State University of Campinas under the protocol number 208/2007, CAAE 39547014.0.10001.5404.

Occurrence of death was obtained in August 2017 through the Mortality Information System (MIS), a national website developed by Brazilian Ministry of Health.

Variables and instruments

Physical activity was assessed by self-reporting through the modified version of Minnesota Leisure Activity Questionnaire (MLAQ)[20], and the International Questionnaire for Assessment of Physical Activity Level

(QIAF), validated for the Brazilian population[21]. Participants were asked about weekly frequency and daily time of the physical activity performed in four domains: leisure; domestic activity; paid or voluntary work and walking as a form of displacement. Then, they were grouped in three categories: global physical activities – composed of leisure, domestic, work and displacement activities; leisurely activities; and domestic activities. Participants were classified according to American College of Sports and Medicine (ACSM) and American Health Association (AHA) as physically inactive when they did not engage in moderate or vigorous physical activity; insufficient physically activity when they did some physical activity with a moderate intensity but less than 150 minutes per week or with a vigorous intensity but less than 75 minutes per week; and physically active when they performed physical activities with a moderate intensity equal to or greater than 150 minutes per week or with a vigorous intensity equal or superior to 75 minutes per week, or maintained an equivalent combination of moderate and vigorous activity[22]. Physical activity intensity was classified according to Estimation of Metabolic Equivalent (MET) as low (<3 METs), moderate (3-6 METs) and vigorous (>6METs)[23].

Physical fitness assessment comprised handgrip strength and walking speed. Handgrip strength was measured with the dominant hand by a Jamar dynamometer. Walking speed was indicated by time taken to cover a distance of 4.6m. Both measurements were performed three times each, and then the means were calculated. Grip strength values were adjusted for body mass index and sex, while walking speed was adjusted for height and sex. Because there are no standardized cut-off points for older population regarding weakness or slowness, they were determined by quartiles. Therefore, the lower 20% of the mean distribution values of the three measurements were considered as weak and slow[13].

Information about deaths was collected from the Mortality Information System (MIS). Three researchers, independently, verified whether the name of participants of FIBRA Study was in the MIS database. After that, information provided by those investigators was compared. In addition to the name, it had to match at least one more piece of personal data in order to confirm if the person had died. This careful procedure was taken to avoid confusion with homonyms. Then, the death variable was classified as yes (dead) or no (alive).

Sociodemographic characteristics, such as sex (male/female) and age (65-69, 70-74, 75-79, 80 and more) were obtained by self-reporting.

Statistical analyses

To describe the sample's characteristics, descriptive analyses of categorical variables were performed with absolute (n) and percentage (%) frequencies. Distribution and associations between independent variables and death were analyzed by Pearson's chi-squared test. Poisson regression analyses was also performed to estimate adjusted prevalence ratios.

The theoretical model was drawn to test relationships between variables of interest through path analysis, model of structural equations and estimation by maximum likelihood for 672 participants who had completed all information. Path analysis was employed to test the hypothesis that physical fitness mediates the effect of physical activity on mortality (Figure 1). The following parameters were used to evaluate total model fit: Chi-squared test> 0.05; Chi-squared ratio <2.0; GFI (Goodness of Fit Index)> 0.85; AGFI (GFI Adjusted for Degrees of Freedom)> 0.80; SRMR (Standardized Root Mean Square Residual) <0.10; RMSEA (Root Mean Square Error of Approximation) <0.08; CFI (Bentler's Comparative Fit Index)> 0.90; NNFI (Bentler & Bonett's Non-standard Index)> 0.90. In order to analyze the quality of the data fit for proposed paths, tests of significance were performed for path coefficients: absolute values of t> 1.96. The Wald test was used to suggest exclusion of some paths and the Lagrange multipliers test defined the need to create paths not considered in the initial model. Trajectories that were not statistically significant were progressively eliminated and the structural model was recalculated until acceptable values were obtained for all adjustment adequacy criteria. Acceptable values for all adjustment adequacy criteria were obtained with a significant reduction in the chi-squared statistic ($p = 0.025$) (Figure 1).

Variables were coded according to the following values: male 0 and female 1; age from 1 to 4 in ascending order of age; inactive for physical activity 1, insufficiently active 2 and active 3; low strength and slow gait were assigned the value of 1, while acceptable levels of physical fitness were assigned the value 0; and for survivors 0 and deaths 1. Statistical analyses were performed in SAS System for Windows (Statistical Analysis System), version 9.2. SAS Institute Inc, 2002-2008, Cary, NC, USA. Significance level adopted for the statistical tests was 5%, or p-value<0.05.

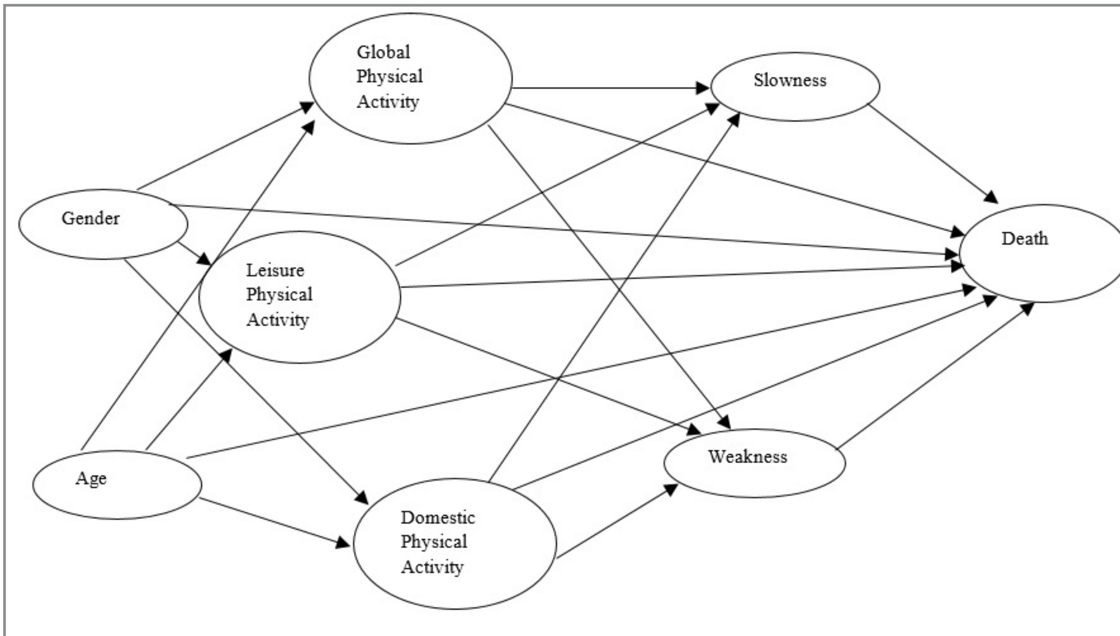

Figure 1. Initial model.

RESULTS

Descriptive analysis

Average age was 72.2 years (SD = 5.3), ranging from 65 to 90 years; 68.8% female. From 800 participants at the baseline, 129 (16.1%) had died in eight years. Table 1 demonstrates the distribution of frequency of death according to sex, age groups, physical fitness and physical activity, as well as the prevalence ratio. Occurrence of death was more frequent among men (23.7%) than women (12.7%); among older groups 75-79 years (24.3%) and 80+ (27.8%) compared to younger groups; among those classified as weak (27.8%) and slow (28.4%); and among those classified as physically inactive in global (26.4%) and domestic domains (21%), compared to their counterparts.

Table 1 – Distribution of percentages and prevalence ratios of mortality, according to sex, age, physical fitness and physical activity among older adults. FIBRA study – Campinas, 2008-2009. (n=800)

	Death*		PR** (95%CI)
	No (n=671)	Yes (n=129)	
Sex	p<0.001		
Male	215 (31.2)	51 (23.7)	1
Female	474 (68.8)	60 (12.7)	0.50 (0.36-0.70)
Age groups (years)	p<0.001		
65 – 69	253 (36.7)	32 (12.6)	1
70 – 74	228 (33.1)	26 (11.4)	0.84 (0.52-1.37)
75 – 79	136 (19.7)	33 (24.3)	1.98 (1.28-3.05)
80 +	72 (10.4)	20 (27.8)	2.17 (1.33-3.53)
Weakness	p<0.001		
No	569 (83.2)	79 (13.9)	1
Yes	115 (16.8)	32 (27.8)	1.69 (1.18-2.44)
Slowness	p<0.001		
No	578 (84.1)	80 (13.8)	1
Yes	109 (15.9)	31 (28.4)	1.79 (1.25-2.56)
Global physical activity	p=0.009		
Inactive	91 (13.2)	24 (26.4)	1
Insufficiently active	116 (16.9)	21 (18.1)	0.64 (0.38-1.06)
Active	481 (69.9)	66 (13.7)	0.50 (0.34-0.74)
Leisurely physical activity	p=0.186		
Inactive	204 (29.7)	41 (20.1)	1
Insufficiently active	153 (22.2)	22 (14.4)	0.69 (0.43-1.11)
Active	331 (48.1)	48 (14.5)	0.68 (0.47-0.98)
Domestic physical activity	p=0.003		
Inactive	305 (44.3)	64 (21.0)	1
Insufficiently active	139 (20.2)	22 (15.8)	0.83 (0.54-1.29)
Active	244 (35.5)	25 (10.2)	0.54 (0.36-0.82)

*Chi-squared test; **adjusted by sex and age.
CI: Confidence interval; PR: Prevalence Ratio

Path analysis and mediating effect

According to the estimation of coefficients, only statistically significant paths ($p<0.05$) were maintained in the final model which explained 6.87% of death variabilities (Figure 2). Sex and age were included in the analysis' adjustment. Relationships within the domain of physical activity and physical fitness were understood as interactions that were not the aim of this paper. Therefore, the results of interest focused on: 1) the direct effect of global physical activity on death and its indirect effect through slowness; 2) the direct effect of domestic activity on death and its indirect effect through weakness; and 3) the direct effect of slowness on death.

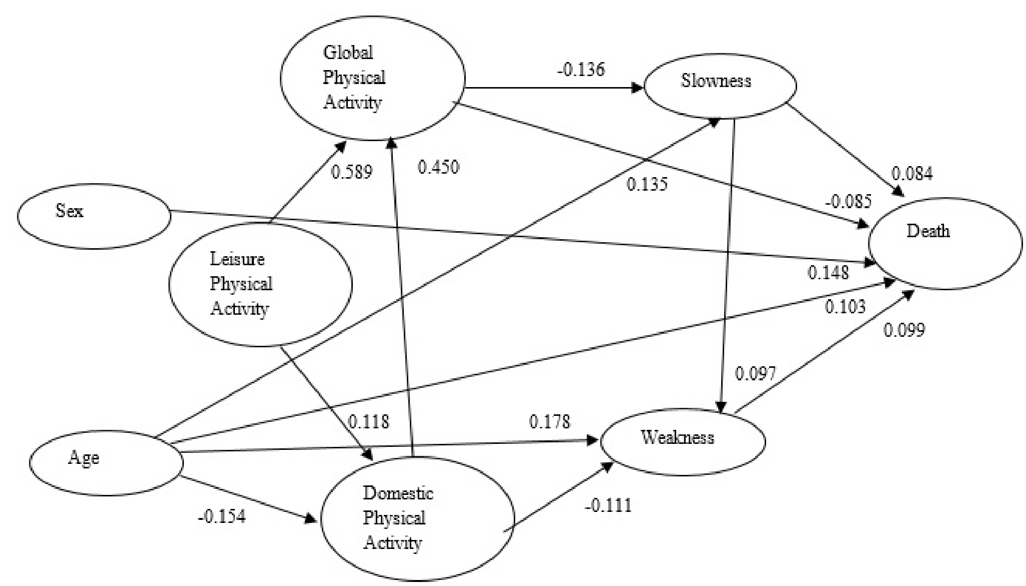

Figure 2. Final model (n=672).

DISCUSSION

The study covered some gaps with regards to the relationships between physical activity, physical fitness and death in older adults. Only global physical activity showed a direct effect on death independently of sex, age, weakness and slowness, which corroborate current evidence[8-10]. Probably, physical activity promotes benefits for elderly people beyond physical fitness or performance. Social and psychological aspects of physical activity can protect against mortality, however such mechanisms deserve more research. In addition, the indirect effect of slowness reinforces its role as a predictor of adverse health outcomes and mortality in this population[17,18]. Age-related conditions, such as decreasing levels of physical activity, recurrent falls, fear of falling and musculoskeletal pain, are usually associated with walking speed[24]. Therefore, slowness contributes to decreased levels of physical activity which increases the slowness, thus, characterizing a vicious circle that may lead to a progressive functional decline, social restriction and death.

The effect of domestic physical activities on death is mediated by weakness. The practice of physical activity in this domain responds to a significant proportion of the levels of physical activity recommended by the current guidelines among elderly[9,24]. Domestic activities are culturally shaped, and are more frequent among women specially in the context of social disadvantages. This contributes to overestimating physical activity levels since almost all of them perform home-keeping activities, such as washing dishes, doing the laundry and gardening[9,11]. Additionally, this domain of physical activity needs more investigation regarding the influence of gender roles and life course events, such retirement25. The importance of muscle strength may be explained by the fact that domestic activities require greater use of smaller upper body muscles which contributes to improved overall muscle strength and may overlap with the influence of domestic activities on mortality. Therefore, the contributions of domestic physical activities to reduce mortality in old age probably involve a more complex discussion which requires a more advanced analysis. In old age, a low level of physical activity and weakness increases the probability of becoming frail[13]. Pre-frailty and frail conditions affect more than 50% of the elderly population[19], and compromise the ability to perform activities outside of the home which results in the decline of social participation[26]. The elderly tend to be restricted to their home which is the place where they can move safely and independently, since it is a place that they know and is has a less demanding environment. In this context, the household contributes to the adaptive process in facing adverse health and social conditions, in order to maintain global functioning, independence and well-being.

Slowness increased the probability of death despite sex, age and physical activity. The role of walking speed for maintaining functional independence and preventing mortality in old age is well documented in literature[17,18]. In this study, this finding suggests that energy expenditure in life domains may be not enough to prevent mortality. This brings up the importance of physical exercise prescriptions professionally provided for muscle strength and resistance in elderly adults.

Although literature provides evidence concerning the influence of leisurely physical activities on mortality, such a relationship was not found in this study[6,7,11]. Generally, the distribution of prevalence of practicing leisurely physical activities is different between age groups and is greater among younger groups and lower among older groups. According to the literature, almost 50% of older adults aged 69 or under are physically active in leisure, as opposed to 10% of those aged 70 or more[8,9]. In the present study this distribution was more homogeneous among different age groups. Homogeneity of the groups may have overshadowed the results, since Path Analysis is strongly dependent on the variations of considered elements which probably characterize a limitation of the study.

Points that limited the power of extrapolation of results to the overall elderly population should be mentioned. These include the self-reporting of the level of physical activity which depends on cognitive abilities and motivation; the exclusion of participants with cognitive deficits suggestive of dementia; and the fact that data collection has been carried out in public places in previously scheduled sections which probably selected healthier older adults. Furthermore, the final model explained around 7% of mortality variability which can be considerable given the number of factors that influence mortality in old age and the complexity of the influence of physical activity on this outcome.

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CONCLUSION

In conclusion, physically inactive, weak and slow elderly adults have a greater probability of death. However, the benefits of physical activity are beyond physical fitness, probably because its influence on mortality is due to social and psychological aspects.

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