Physical activity as a predictor of absence of frailty in the elderly

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Summary

Objective: To analyze physical activity in different domains (work, transportation, housework and leisure) as a predictor of the absence of frailty. **Methods:** An epidemiological cross-sectional study with a random sample of 622 individuals aged ≥ 60 years was carried out in Uberaba, MG, Brazil. Receiver operating characteristic (ROC) curves were generated and compared with physical activity in different domains and the absence of frailty. Cutoffs points of physical activity (minutes/week) were established to predict the absence of frailty. A confidence interval of 95% was established in order to find the largest areas under the ROC curves for work, transportation, household and leisure. The total physical activity and its domains were assessed by the international physical activity questionnaire. The index of frailty (unintentional weight loss, functional limitation to chair rise, handgrip strength, physical activity and exhaustion) was based on the study by Fried; the participants were dichotomously classified as not frail and frail. **Results:** The prevalence of frailty was 19.7% (men) and 20% (women). Physical activity of moderate or vigorous intensity accumulated in different domains for 145 minutes/week for women and 140 minutes/week for men or 85 minutes/week for women and 112.5 minutes/week for men for activities in the leisure domain showed the best cutoff to predict the absence of frailty. **Conclusion:** The practice of physical activity, especially in leisure time or accumulated in different domains, contributes to the prevention of frailty in the elderly.

Keywords: Motor activity; frail elderly; aging.

Study conducted at Universidade de Brasília (UnB), Postgraduate Program in Health Sciences, Brasília, DF, Brazil

Submitted on: 10/11/2011
Approved on: 02/10/2012

Financial Support:
Fundação de Amparo à Pesquisa do Estado de Minas Gerais FAPEMIG Process #: APQ-03000-10, Brazil

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Conflict of interest: None.

Introduction

Population aging is a worldwide phenomenon with consequences on several aspects of society. Among the concerns created by the increase in life expectancy, quality of life appears as one of the most important, since there is a considerable increase in continuous use of drugs in old age due to the high prevalence of chronic degenerative diseases.

The pathological processes themselves generate damage and inconvenience to the elderly; however, the greatest loss occurs in functional limitations and in the inability to perform the social tasks of daily life. This set of aspects that involves a sequence of aging processes is called "biological frailty syndrome", herein called frailty.

In spite of the lack of a concise definition of what characterizes the state of frailty, there are common features that indicate that this concept is broad and dynamic, involving both physiological and psychosocial aspects[1-4]. Frailty in the elderly individual is related to a greater predisposition to morbidities, falls, hospitalizations, institutionalizations and mortality[5-8], as there is a decreased resistance to stressors and lower energy reserves, in which a cycle of exacerbation of mutual decline in multiple systems results in energy deficit, sarcopenia, decreased muscle strength and strain tolerance[1,7].

Regular physical activity has been shown to be protective against several components of frailty in older men and women[9], including sarcopenia, functional impairment, cognitive performance and depression[10]. Even though the level of physical activity is commonly indicated as part of the components of frailty, it is essential to establish cutoff points for different domains of physical activity in minutes per week to enhance the prediction of frailty in the elderly.

Physical activity is a human behavior characterized by any body movement of skeletal muscles resulting in energy expenditure[11], which can be assessed in the following domains: occupational, transportation, housework and leisure.

The human aging process leads to a decrease in physical activity practices and studies have reported that women present the biggest decline, when compared with men[12,13]. Moreover, the housework domain seems to have an important role in the distribution of time devoted to the practice of physical activity by women[12,14]. Regardless of the domain, increasing the level of physical activity is important for the health of the individual[14]; however, in the leisure domain the benefits seem to be higher due to the ludic characteristic, the higher potential for community involvement and the maintenance of an active lifestyle.

Thus, the objective of this study was to analyze the predictive power and identify the cutoffs of physical activity in their different domains for the absence of frailty in elderly individuals of both genders.

Methods

Subjects

This study is part of the Population Study of Physical Activity and Aging (Estudo Populacional de Atividade Física e Envelhecimento – EPAFE), with a cross-sectional design which evaluated a population of 10,683 individuals aged 60 years or more, of both genders, living in the city of Uberaba, Minas Gerais, located in the Southeast Region of Brazil, in the period from May to August 2010.

The characterization of the elderly was age 60 years or more, proposed by the United Nations[15] for developing countries. Thus, the sample consisted of individuals aged 60 to 96 years of age, selected randomly using the Epi Info 7 software; the selection was home-based and representative of the urban area proportional to the district, the family health team and gender.

When determining the sample size, the procedures proposed by Luiz and Magnanini[16] for finite populations were used. In this calculation a significance level of 5% (corresponding to a confidence interval of 95%, z [a]/2 = 1.96) and tolerable sampling error of 3% were adopted, resulting in a required sample of 490 subjects to estimate the prevalence of frailty in 14%. This first estimate of sample size was increased by 20% in order to explore the adjusted associations between frailty and the domains of physical activity, in addition to a 10% increase to compensate for any loss, resulting in a minimum total sample of 647 elderly individuals.

Among the selected elderly, nine no longer lived at the provided address, four refused to participate in the study, two had died, two died during the course of the research and eight questionnaires had incomplete information and were excluded from the study. Thus, the final study sample consisted of 622 elderly (218 men and 406 women) aged > 60 years.

Collected data

For the evaluation a multidimensional interview, applied individually, which consisted of sociodemographic, physical and mental health, physical activity level and the index of frailty aspects, was created. The sociodemographic data were age, education (years of schooling), marital status (single, married/living with partner, widowed, divorced/separated), current occupation (retired/pensioner, homemaker, paid work), living arrangements (lives alone, lives alone with spouse, lives with spouse/children, lives with spouse/children/grandchildren) and family income (expressed in number of minimum wages).

The physical and mental health aspect refers to the presence of self-reported diseases and cognitive impairment assessed by the mini-mental state examination, originally developed by Folstein et al.[17] and validated for the Brazilian population by Almeida[18].

Physical activity

The level of usual physical activity was obtained using the long version of the International Physical Activity Questionnaire (IPAQ)[19], adapted for the elderly[20], which provides examples of activities that are common for the elderly and fill-in fields of information to record the time, considering the hours and minutes usually used for every day in the week, instead of only indicating the weekly frequency and total time spent to perform these physical activities.

The IPAQ has questions related to physical activities in a typical week of moderate and intense activity, lasting for at least 10 continuous minutes, divided into four domains of physical activity: work, transportation, housework and leisure/recreation, as well as sitting time, which was not used in this study.

Frailty

Frailty was measured according to the modified version of Fried et al.[1], being identified by the presence of three or more of the five assessed components: decreased handgrip strength in the dominant hand, measured by a dynamometer, adjusted for gender and body mass index (BMI); unintentional weight loss > 5% of body weight in the previous year; reports of "exhaustion" evaluated by the question "Do you feel full of energy?" of the geriatric depression scale (GDS-15) by Sheik and Yesavage[21], validated for the Brazilian population by Almeida and Almeida[22]; functional limitation at the chair rise, evaluated by the elderly individual's incapacity to rise five consecutive times from the chair without using the arms; and low level of physical activity (< 150 min/week of physical activity).

Data analysis

The characterization of the variables was shown as means, standard deviations, minimum and maximum values and frequencies. To compare the distribution of variables according to gender, Student's *t*-test for independent samples (continuous data) and the chi-square test (categorical data) were used.

The predictive power and the cutoffs of different patterns and domains of physical activity for the absence of frailty were identified by receiver operating characteristic (ROC) curves, frequently used to determine cutoffs for diagnostic or triage tests[23].

Initially, the total area under the ROC curve was identified among the physical activity patterns in their different domains (work, transportation, housework, leisure) and total physical activity (the four domains analyzed together) for the absence of frailty. The larger the area under the ROC curve, the greater the discriminatory power of physical activity for the absence of frailty. A confidence interval (CI) of 95% was adopted to determine whether the predictive capacity of physical activity patterns in their different domains was not due to chance, and its lower limit should not be < 0.50[24].

Subsequently, the sensitivity and specificity were calculated and cutoff points for the physical activity patterns in their different domains (work, transportation, housework and leisure) and total physical activity for the absence of frailty. The values identified through ROC curves consist in the cutoff points that should promote a more appropriate balance between sensitivity and specificity for physical activity as the discriminator for the absence of frailty. Data were analyzed using the statistical program MedCal, release 11.4.4.

This study followed the ethical principles of the Declaration of Helsinki and Resolution #196/96 of the National Health Council. Research protocols were evaluated and approved by the local Research Ethics Committee (Protocol #. 1521/2009). Study participants signed an informed consent.

Results

Six hundred twenty-two individuals (65% females and 35% males), aged 60-96 years with a mean age of 71.08 years (SD = 7.77) were studied. The majority of the elderly individuals were married or lived with a partner (57.4%); lived in multigenerational households (54.9%), specifically bigenerational (30.7%, grandparents and grandchildren); had low educational level, since 40.3% had a maximum of two years of schooling and 19.1% were illiterate; 72.7% were retired or pensioners and had low monthly income, of which 51.6% received up to two minimum wages (R$ 1,020.00) (Table 1).

Mild to moderate cognitive impairment was detected in 16.7% (n = 104) of the elderly, present in 14.7% of the men and 17.8% of the women interviewed; although the rate of cognitive decline was higher for women, the difference was not significant. As for frailty, it was found that 19.9% of the individuals were frail and 80.1% were not frail, with a similar frequency between genders (Table 1).

When considering the level of physical activity, an average of 295.5 min/week (SD = 281.8) was spent performing moderate to vigorous physical activity, with no significant differences between genders (p = 0.97). When the areas of physical activity were analyzed separately, significant differences were found in means (p < 0.001), with women spending less time in work activities (23.2 min/week, SD = 123.5 versus 64.4 min/week, SD = 221.6), transportation (60.5 min/week, SD = 70.6 versus 77.9 min/week, SD = 95.4), and leisure (54.4 min/week, SD = 94.6 versus 73.8 min/week, SD = 121.1); however, regarding housework, women spend more time in such activities, when

Table 1 – Characteristics of the elderly – Uberaba, MG, Brazil

Variable	General		Men		Women		
	%	n	%	n	%	n	p*
Age range							
60-69 years	47.9	298	45.4	99	49.3	199	0.636
70-79 years	36.3	226	37.6	82	35.6	144	
≥ 80 years	15.8	98	17.0	37	15.1	61	
Marital status							
Single/separated/divorced	15.0	93	11.0	24	17.1	69	< 0.001
Married/living with partner	57.4	357	75.2	164	47.8	193	
Widowed	27.7	172	13.8	30	35.1	142	
Individuals living in the same household							
Lives alone	11.9	74	10.1	22	12.9	52	0.011
Only the spouse	33.3	207	38.5	84	30.4	123	
+ children	30.7	191	33.9	74	29.0	117	
+ grandchildren	24.1	150	17.4	38	27.7	112	
Years of study							
Illiterate	19.1	119	17.9	39	19.8	80	0.592
1 to 2 years	21.2	132	19.7	43	22.0	89	
≥ 3 years	59.6	371	62.4	136	58.2	235	
Family income							
≤ 1 MW	17.4	107	11.2	24	20.8	83	0.003
1.1 to 2 MW	34.2	210	38.6	83	31.8	127	
2.1 to 4 MW	33.9	208	31.6	68	35.1	140	
≥ 4.1 MW	14.5	89	18.6	40	12.3	49	
Occupation							
Retired and works	8.8	55	15.7	34	5.2	21	< 0.001
Retired or pensioner	72.7	452	76.1	166	70.8	286	
Homemaker	12.7	79	0.5	1	19.3	78	
Paid job	5.8	36	7.8	17	4.7	19	
Cognitive deficit							
Absence	83.3	518	85.3	186	82.2	332	0.316
Presence	16.7	104	14.7	32	17.8	72	
Diseases							
No	4.7	29	7.8	17	3.0	12	0.006
Yes	95.3	593	92.2	201	97.0	392	
Frailty							
Frail (0 to 2 criteria)	80.1	498	80.3	175	80.0	323	0.923
Not frail (≥ 3 criteria)	19.9	124	19.7	43	20.0	81	

* Chi-square test; MW, minimum wages.

compared with men (172.7 min/week, SD = 166.8 versus 54.3 min/week, SD = 90.4). Table 2 shows the areas under the ROC curves with their respective confidence intervals for physical activity in the different domains as predictors of the absence of frailty. ROC curves were constructed for males and females.

The largest areas were observed in the field of housework, transportation and leisure, respectively, and some differences were observed between the genders. For males, the areas of leisure/recreation and transportation show the greatest area under the curve, whereas for females the largest area is in the field of housework.

Table 2 – Area under the ROC curve and 95% confidence interval between the domains of physical activity as predictors of absence of frailty in elderly individuals – Uberaba, MG, Brazil

Domains	Total	Men	Women
PA leisure	0.68 (0.65-0.72)	0.72 (0.65-0.76)	0.67 (0.62-0.71)
PA work	0.55 (0.51-0.59)	0.59 (0.52-0.66)	0.53 (0.48-0.58)
PA transportation	0.75 (0.72-0.79)	0.72 (0.66-0.78)	0.78 (0.73-0.82)
PA housework	0.78 (0.75-0.81)	0.71 (0.64-0.77)	0.84 (0.80-0.88)
Total PA	0.89 (0.86-0.91)	0.90 (0.86-0.94)	0.86 (0.85-0.92)

PA, physical activity; ROC, receiver operating characteristic.

The cutoff points, with their respective sensitivities and specificities of total physical activity (work, transportation, housework and leisure activities) and of the leisure/recreation domain as predictors of the absence of frailty for elderly males and females can be seen in Figure 1.

For elderly women, the cutoff point determined for total physical activity was 145 min/week (sensitivity of 0.844 and specificity of 0.814), and for the leisure activity domain it was 85 min/week (sensitivity of 0.951 and specificity of 0.316).

As for elderly men, the cutoff points of moderate to vigorous intensity physical activities for the leisure domain was 112.5 min/week (sensitivity of 0.977 and specificity of 0.320) and for total physical activities, the equivalent of 140 min/week (sensitivity of 0.977 and specificity of 0.731).

Discussion

Although frailty represents a construct that is hard to understand, it is a key marker for the diagnosis of human health, especially for the elderly, regardless of the considered features. The diagnosis of frailty allows the medical practitioner to anticipate the decline in social function that is related to the processes of functional incapacity and isolation of the elderly at home. Also, the evaluation of the physical activity level provides additional information on health problems, regarding both functional limitations and functional incapacity[14,25,26].

There is a consensus in the literature regarding the role of physical activity in preventing and even treating frailty[9,27,28] but few studies have attempted to identify the predictive power of physical activities in their several domains as a discriminator of the absence of the frailty.

In the present study, the physical activity domains (work, transportation, housework and leisure) showed to be potential predictors for frailty. The increase in time spent on physical activities in any domain results in a greater protection of the body from the onset of incapacitating processes and, consequently, frailty. However, more emphasis was given to leisure activities, due to the fact that this domain is commonly highlighted in the literature[9,29-31]. Leisure activities are in general related to pleasurable activities, higher intensities and greater potential for professional interference.

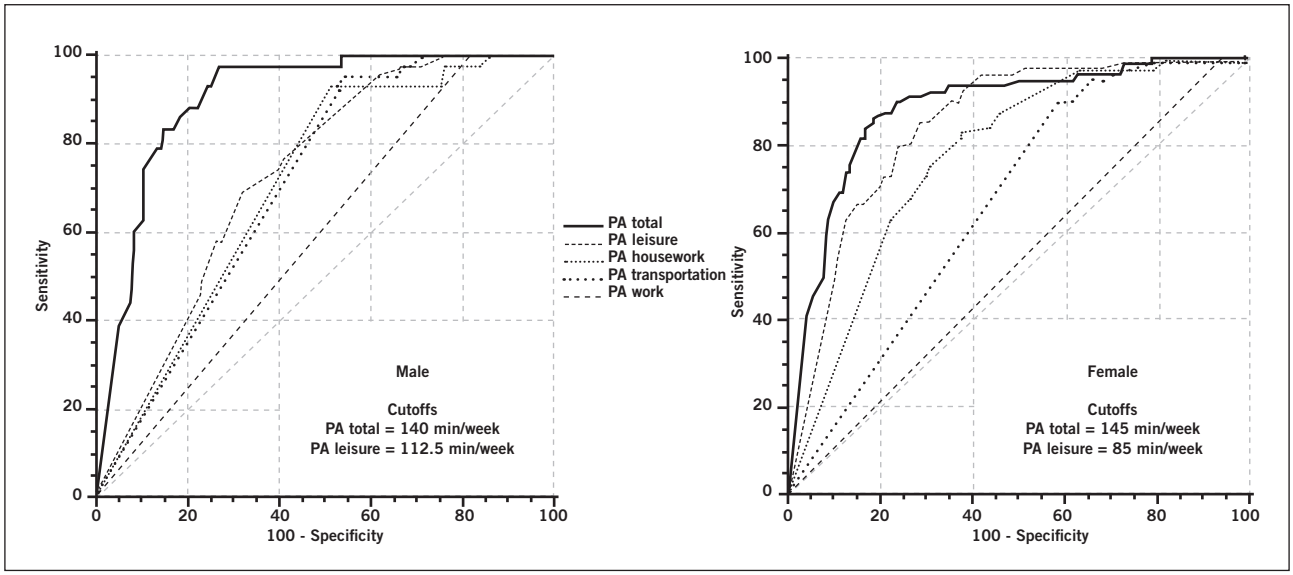

Figure 1 – Cutoffs with respective sensitivities and specificities of total physical activity and the domain of leisure physical activity as predictors of frailty in male and female elderly individuals – Uberaba, MG, Brazil. PA, physical activity.

The establishment of cutoff points (minutes per week) for physical activity through the ROC curves allow for the indication of values for which there is higher optimization of sensitivity as a function of specificity to discriminate the absence of frailty in the elderly. For physical activities of leisure, a period of 85 min/week was the cutoff point to predict frailty in women, which is lower than that found for men in the same domain (112.5 min/week). The cultural aspects of gender in the country can be a possible explanation for the differences.

In general, when men retire from their work activities, they appear to suffer more severe functional impairment due to the rapid decline in physical activities regardless of the analyzed domain; thus, there is a greater dependence on physical activities during leisure[12]. On the other hand, for elderly women the change in their routine with advancing age is less striking due to the intense volume of the physical activities in the household, which cause less dependence for leisure activities, within the range of recommended physical activity[12,14].

The areas of the curves for the different physical activity domains showed a more elevated area in the housework domain for women when compared to men and the mean time spent on such activities by women is more than three times that spent by men.

The greater exposure of women to domestic activities is positive due to increased energy expenditure; on the other hand, these women still belong to a generation with transportation restrictions in areas related to leisure and work, as they are still bound to the household responsibilities[32], in addition to losses in communication and social function due to the tendency of isolation from family with the possible departure of children to live with their spouses and the death of friends of the same age range[25,33]. The prevalence of frailty was similar between the genders, despite the greater longevity of women together with greater exposure to functional risk behavior.

When analyzing the total time of physical activity, elderly women, differently from what was seen in leisure activities, require more time of physical activity (145 min/week) than men (140 min/week) to avoid frailty. These data reinforce the previous comments, which mentioned the higher dependence of men on leisure activities and therefore, the involvement of other domains would be reduced.

Some limitations should be highlighted in the study, such as its cross-sectional nature, which prevents verifying the cause and effect association between the variables; the measurements of self-perception may have been influenced by the low educational level of participants and by their motivational aspects. However, the statistical procedure used in the study allowed the estimation of the cutoff values of physical activity and the results are close to the scores recommended by the literature. Moreover, the evaluators of the study were trained in order to minimize motivational interference and even to adjust explanations during the interview to the possible doubts of the respondents in the face of variations in levels of schooling.

The amount of physical activity required to preserve the health of individuals is a subject that has been discussed for a few decades in epidemiology, especially by certain studies[34-37]. These studies have shown that the higher the level of physical activity, the lower the chances of developing chronic degenerative diseases, with relatively modest levels of physical activity for approximately 150 minutes per week being sufficient to provide significant protective effects to several diseases[34,35,38].

The benefits of physical activity for health and longevity are a consensus among experts in gerontology, constantly demonstrated by several scientific societies and institutions through documents that highlight the importance of encouraging the practice of physical activities in public health actions. Similarly, discussions on the subject have been frequent in recent decades, such as the World Assembly on Ageing, the numerous forums held by the World Health Organization (WHO), the United Nations (UN) and societies of gerontology and geriatrics from different countries.

The sociodemographic characteristics of the elderly in this study are similar to those reported in surveys in Latin America, a fact that emphasizes the potential generalization of the present results to other populations[39]. Although the total time spent in physical activity practices was lower than the score defined for physical activity as one of the indicator criteria for frailty, the values were relatively close to the recommended 150 min/week. However, the major contribution of this study is the possibility of simplifying the estimation of physical activity, given the limitations to estimate the total time spent in physical activities practiced by the elderly; the sole assessment of activities in the leisure domain are sufficient to predict frailty.

Another aspect to be highlighted is the possibility for professional experts in the area to deliver a clearer message to the elderly and these, in turn, would have an easier and more agreeable target to be achieved, as the required time spent on leisure activities is less than that required for the sum of the domains of physical activity. The cutoff points for physical activity described in this study represent only a reference estimate to be used in population diagnoses, as well as in interventionist measures aiming to preserve the functional independence of the elderly; however, cohort studies, which can identify more precisely the intensity and volume of physical activity required to minimize the impacts of the aging process, are necessary.

Conclusion

The results of this study indicated that physical activity performed during leisure time and total physical activity (work, transportation, housework and leisure) can predict the absence of frailty in the elderly. Regarding the amount necessary to prevent frailty, it is suggested that men should have 140 min/week and women 145 min/week of physical activity of moderate to vigorous intensity, accumulated in the four domains. Similarly for the domain of leisure physical activity, 85 min/week for women and 112.5 min/week for men would be sufficient to predict frailty among the elderly.

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