Factors associated with muscle strength in older men from a rural Brazilian community

Fatores associados à força muscular de homens idosos de uma comunidade rural brasileira

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ABSTRACT

Objective: To investigate the association between socio-demographic indicators, lifestyle variables, health conditions, and muscle strength of older men from a rural community of southern Brazil. **Methods:** A cross-sectional, population-based household survey was carried out in a city in southern Brazil. A total of 207 older men (≥ 60 years) participated in the study. Handgrip strength (HGS) was measured with a dynamometer and the timed chair stand test evaluated lower limb muscle strength/endurance (LLMS). Sociodemographic information, lifestyle and health conditions were obtained from subjects. The prevalence ratio was used as measure of association, by Poisson regression analysis (crude and adjusted). **Results:** The proportion of men who displayed poor HGS was 19.0% (IC95%:13.3-24.8) and poor LLMS was 25.3% (IC95%:18.9-31.7). Advancing age, illiteracy and more than three morbidities were associated with poor HGS and LLMS. Poor performance in the LLMS test was associated with lifelong agricultural work, unemployment and altered cognitive status. **Conclusion:** Factors associated with muscle strength are specific to the test.

Keywords: Aging; Muscle Strength Dynamometer; Time and Motion Studies.

RESUMO

Objetivo: Investigar a associação entre indicadores sociodemográficos, variáveis do estilo de vida, condições de saúde e força muscular de homens idosos de uma comunidade rural. **Métodos**: Estudo transversal, de base domiciliar e populacional realizado em uma cidade do sul do Brasil. Participaram do estudo 207 homens idosos (≥ 60 anos). A força de preensão manual (FPM) foi mensurada com um dinamômetro e o teste de levantar e sentar verificou a força muscular de membros inferiores (FMMI). Informações sociodemográficas, estilo de vida e condições de saúde foram investigadas. A razão de prevalência foi empregada como medida de associação, por meio da análise de regressão de Poisson (bruta e ajustada). **Resultados**: A proporção de homens com FPM inadequada foi de 19,0% (IC95%:

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13,3-24,8) e a FMMI inadequada foi de 25,3% (IC95%: 18,9-31,7). O avanço da idade, não saber ler e escrever e relatar três ou mais morbidades foram associadas com FPM e FMMI inadequadas. A FMMI inadequada também foi associada à trabalhar na agricultura ao longo da vida, à não trabalhar, à nunca fumar e ao estado cognitivo alterado. **Conclusão:** Os fatores associados à força muscular são específicos ao teste.

Palavras-chave: Envelhecimento; Dinamômetro de Força Muscular; Estudos de Tempo e Movimento.

Introduction

Brazil's population is aging rapidly as evidenced by epidemiological profile changes, such as a higher prevalence of chronic and incapacitating illnesses, as well as by a higher demand for health services resulting in rising health sector expenditures.[1] Noncommunicable diseases and injuries can influence an older people's physical function, inhibiting or hindering their autonomy and their independence when carrying out daily tasks.[2] Issues regarding noncommunicable diseases and injuries can be a greater source of worry in small towns and rural regions. Older adult residents of rural areas encounter more problems with health services because of such reasons as difficulty of access, low income, little education and shortages of services.[3,4]

Older people living in small towns and rural areas often have social and cultural values, principles and conduct that differ from their cohorts in urban areas.[5, 6] Activities of the countryside are numerous. They begin in infancy or adolescence and demand much physical effort. Work usually requires flexing the torso, crouching and lifting loads, thereby increasing the risk of musculoskeletal lesions,[7] reducing muscle strength and causing functional decline.

Muscle strength is a physiological variable indispensable to carrying out daily activities, to functional independence and to autonomy as age advances. Handgrip and "chair stand" tests have been used as indicators of health among older adults,[8,9] being good predictors of incapacity and indicators of necessary health care for older adults.[10,11]

Investigations of physical performance of older men in rural regions are still scarce in Brazil. Considering the relevance of muscle strength as an essential component of older adult health surveillance and as a factor in disability risk and progression, the objective of this study was to investigate the association of sociodemographic indicators, lifestyle and health conditions with muscle strength in older men living in a rural community in southern Brazil.

Methods

Setting and Study Population

This is a cross-sectional study based on data from a population-based household epidemiological survey,[12] "Effectiveness of health actions, physical activity and nutrition among older adults of the municipality of Antônio Carlos, Santa Catarina". Information regarding place, study population and sampling procedures was published in an earlier study[12] and will be presented briefly. The study population (n = 917) comprised all older adults enrolled as of 2009 in a primary health care program that covers 100% of the municipality, consisting of three coverage areas. We interviewed all 134 residents in the community that were aged 80 and above; 56 of these were men. We also used random sampling of residents (both sex) between 60 and 79 years of age (n = 782) to select of 471 for interviews (with an error margin of 5 percentage points, prevalence with an unknown outcome of 50%, test power of 80% and sample loss of 15%). Considering simple sampling, this group was stratified by the three health care program areas. By the end of the sampling, 343 people aged between 60 and 79 were evaluated, of whom 151 were men; the error margin increased to 5.4 percentage points. The stratified sample was not proportional and sampling weights were used in the data analysis. In this study, the sample involved a total of 207 older men (≥ 60 years).

The criteria for sample loss were lack of an adequate informant (in cases where there was a need); the candidate not found after three visits on alternate days; and the impossibility of reaching an individual's home due to adverse road conditions.

In this study, older men who met any of the following exclusion criteria were not enrolled: people who were unable to understand the test instructions due to cognitive problems; those who couldn't walk or needed help to remain standing up; those who had paralysis of a limb or used a prosthesis (leg), or who could not keep their balance were not included

in the timed "chair stand" test and those who had undergone arm or hand surgery in the three months prior to data collection did not take a handgrip strength test.

Dependent variables

Handgrip strength (HGS) was evaluated by dynamometer (Takei, Japan), using the arm chosen by the subject as having the greater strength. During the test´s execution, the man remained sitting, with an elbow resting on a table, forearm extended in front, and palm of the hand turned upward, and was requested to apply maximum possible pressure on the dynamometer.[13] Two trials, with a brief pause (1 minute) were allowed and the highest pressure (kg) was recorded. The values in kilograms of the performance in the HGS test were defined according to body mass index (BMI). BMI was categorized according to the criterion adopted by the Brazilian System of Surveillance for Food and Nutrition:[14] <22 kg/m², underweight; ≥ 22 kg/m^2 and ≤ 27 kg/m², adequate; and >27 kg/m², overweight.

Poor HGS was fixed in the first fifth of the values of HGS, based on the proposal of Fried et al.[15] Poor HGS thus was classified as follows: 14 kg to 26 kg, normal weight; 12 kg to 23 kg, underweight; and 12kg to 27 kg, overweight.

The timed "chair stand" test[16] assessed lower limb muscle strength/endurance (LLMS). In this test the man, with his arms crossed over his chest, was requested to stand up and sit down on a chair five times as quickly as possible in less than a minute. The classification to evaluate the performance in the test of the strength of the lower limbs was as follows: >16 seconds = poor performance; ≤ 16 seconds = adequate performance.[13]

The LLMS test and HGS test always highlight indirect measures of lower limb strength.

Independent variables

Sociodemographic data: age (continuous variable), literacy (literate; illiterate), living arrangement (lives alone; lives accompanied), occupation throughout life (agriculture; other professions), currently working (yes; no).

Lifestyle variables: smoking (smoker and former smoker; never smoked) and self-reported daily sitting time. The sitting time (sedentary behavior) was recorded in minutes, and the final result was obtained from: time spent sitting (min/week) = minutes in a sitting position/week day multiplied by 5 workdays + minutes sitting/weekend day multiplied by 2. The value obtained was divided by seven, and the values (time in hours/day) were divided into tertiles (<4hours/day; ≥ 4hours and <6hours/day; ≥ 6h/day). The sitting time was verified by observing the time in minutes that an individual spent sitting during one weekday and one weekend day. This item corresponds to domain 5 of the International Physical Activity Questionnaire.[17]

Health conditions variables: number of morbidities (0 to 2; 3 or more), history of a fall in the previous year *(*no; yes) and cognitive function (normal; altered). The number of self-reported morbidities was verified in relation the diseases previously diagnosed (hypertension, diabetes, cancer, chronic lung disease, coronary heart disease, cerebrovascular disease, arthritis or osteoarthritis, osteoporosis and depression.). The *history of a fall* in the previous *year* was verified by the question "Have you fallen in the past 12 months?". The Mini-Mental State Examination (modified and validated) verified the cognitive function,[18] The cut-off for cognition function were: ≥ 12 points, altered; and < 12 normalpoints[19].

Statistical Procedures

For the descriptive analysis, we calculated the mean, standard deviation and prevalence. Poisson's regression [20] (crude and adjusted prevalence ratio) verified the associations between dependent variables (HGS and LLMS) and independent variables according to the hierarchical model order (Figure 1). Backward selection was conducted to select variables at each level in the adjusted model. The statistical significance of each variable in the model was evaluated either with Wald's heterogeneity or a linear trend test. All variables in the first level (i.e., sociodemographic) were adjusted among themselves regardless of the level of significance of the crude analysis. Only those with p≤ 0.20 in the adjusted analysis were maintained in the model.[21] Subsequently, second-level variables (lifestyle) were included, adjusted for first-level variables that remained in the model and for those of the second level with p≤ 0.20. Third-level variables (health conditions) were included in the analyses, then adjusted for the variables of the two previous levels that remained in the model and for those of the third level with p≤ 0.20. Variables with p<0.05 were considered factors associated with the dependent variables.

The analyses were conducted with statistical program SPSS®, version 16.0.

The protocol of the study was approved by the Universidade Federal de Santa Catarina's Committee of Ethics for Research with Human Subjects (nº 189/09). Participation was voluntary, and a signed informed consent form was obtained.

Results

The sample comprised 207 men with mean age of 73.3 ± 8.9 (60 to 95 years). From a total of 207 men analyzed, 8.0% (n=17) were unable to perform the timed chair stand test (exclusion criteria) and one man refused to try it. For the handgrip strength test, from a total of 207 men analyzed, 3.8% (n=8) refused to participate and one man (n=0.48) was unable to do so because he was bedridden.

Most of the men were literate, lived with others, had worked in agriculture throughout their lives, were not working at the time of the interview, were presently sitting for six hours or more a day, were either smokers or former smokers, reported at least two morbidities, had not suffered any falls in the previous year and showed normal cognitive function (Table 1).

Table 1. Distribution (%) of the men according to independent variables. Antônio Carlos, Santa Catarina state, Brazil, 2010/2011.

Variables	Response rate (%)	N	%
Literacy	100.0		
Literate		158	76.3
Illiterate		49	23.7
Occupation throughout life	97.7		
Other professions		141	69.5
Agriculture		62	30.5
Living arrangement	100.0		
Lives alone		13	6.3
Lives accompanied		194	93.7
Currently working	98.3		
Yes		110	54.2
No		93	45.8
Smoking	100.0		
Never smoked		80	38.6
Smoker; former smoker		127	61.4
Sitting time	94.3		
< 4h/day		44	22.4
≥ 4h and <6h/day		72	36.7
≥ 6h/day		80	40.8
Number of morbidities	100.0		
0 to 2		167	80.7
3 or more		40	19.3
Falls in the last year	100.0		
No		168	81.2
Yes		39	18.8
Cognitive status	97.0		
Normal		185	92.0
Altered		16	8.0

One hundred and ninety-seven men had their HGS checked. Of the total, 19.0% (IC95%: 13.3-24.8) had a poor HGS. Table 2 presents the results of associations between poor handgrip and independent variables in crude and adjusted analysis. The adjusted data show that in each year there was a probability that 4% of participants would have a poor handgrip. The adjusted analysis showed that a poor handgrip was significantly more frequent among illiterate men (PR: 2.91; IC95%: 1.96-4.33) and men with three or more morbidities (PR: 2.96; IC95%: 1.83-4.80).

We checked the LLMS of 182 men, 25.3% of whom (IC95%: 18.9-31.7) had poor LLMS. With advancing age, the probability of men having a poor LLMS was 2% after adjustment. The data in the adjusted analysis showed that poor LLMS was significantly more prevalent among illiterate subjects (PR: 1.52; IC95%: 1.09-2.10), who had worked in agriculture throughout their lives (PR: 1.54: IC95%: 1.04-2.28), had reported three or more morbidities (PR: 1.52; IC95%: 1.04-2.22) and had altered cognitive status (PR: 1.79; IC95%: 1.25-2.56). After adjustment, the data showed a negative association between a person's smoking history and poor LLMS (Table 3).

Table 2. Prevalence, analysis crude and adjusted to men, in relation to factors associated with poor handgrip strength. Antônio Carlos, Santa Catarina state,

			Crude Analysis		Adjusted Analysis*	
Levels[a]	**Variables**	**%**	**PR (CI 95%)**	**p**	**PR (CI 95%)**	**p**
1	**Aged**	-	1.05(1.03-1.08)	≤ 0.001 [b]	1.04(1.03-1.08)	0.001 b
	Literacy			≤ 0.001		≤ 0.001
	Literate	12.6	1		1	
	Illiterate	40.2	3.23(2.19-4.77)		2.91(1.96-4.33)	
	Occupation throughout life			0.50		-
	Other professions	17.1	1		-	
	Agriculture	19.8	1.71(0.74-1.86)		-	
	Living arrangement			0.93		-
	Lives alone	21.1	1		-	
	Lives accompanied	19.0	0.96(0.39-2.36)		-	
	Currently working			0.001		0.06
	Yes	13.3	1		1	
	No	27.3	2.08(1.37-3.16)		1.54(0.98-2.42)	
2	**Smoking**			0.74		-
	Never smoked	18.2	1		-	
	Smoker; former smoker	19.7	1.07(0.70-1.65)		-	
	Sitting time			0.56 [b]		-
	<4h/day	13.5	1		-	

PR: Prevalence ratio; 95% CI: confidence interval; *Adjusted for variables of the same level and the upper level with the value of the Wald Test p <0.20; [a]Levels: sociodemographic factors (1), lifestyle (2) and health conditions (3); [b]Test of Wald for linear trend.

Table 3. Prevalence, analysis crude and adjusted to men, in relation to factors associated with poor lower limb muscle strength. Antônio Carlos, Santa Catarina state, Brazil, 2010/2011 (n=182).

			Crude Analysis		Adjusted Analysis*	
Levels[a]	Variables	%	PR (CI 95%)	p	PR (CI 95%)	p
1	**Aged**	-	1.04(1.03-1.06)	≤ 0.001 [b]	1.02(1.00-1.04)	0.02 [b]
	Literacy			≤ 0.001		0.01
	Literate	20.7	1		1	
	Illiterate	40.4	1.95(1.40-2.71)		1.52(1.09-2.10)	
	Occupation throughout life			0.01		0.03
	Other professions	16.1	1		1	
	Agriculture	28.7	1.77(1.14-2.76)		1.54(1.04-2.28)	
	Living arrangement			0.71		-
	Lives alone	22.7	1		-	
	Lives accompanied	25.6	1.16(0.53-2.58)		-	
	Currently working			≤ 0.001		d”0.001
	Yes	12.0	1		1	
	No	42.8	3.69(2.47-5.52)		3.38(2.17-5.24)	
2	***Smoking***			0.15		0.01
	Never smoked	29.8	1		1	
	Smoker; former smoker	22.7	0.78(0.55-1.09)		0.67(0.49-0.92)	
	Sitting time			0.66[b]		-
	<4h/day	16.7	1		-	
	e”4h and <6h/day	23.0	1.29(0.71-2.32)		-	
	e”6h/day	20.8	1.19(0.67-2.12)			
3	***Number of morbidities***			0.001		0.03
	0 to 2	22.1	1		1	
	3 or more	39.4	1.78(1.26-2.53)		1.52(1.04-2.22)	
	Falls in the last year			0.03		0.37
	No	23.4	1		1	
	Yes	35.0	1.52(1.04-2.25)		1.22(0.78-1.92)	
	Cognitive status			≤ 0.001		0.001
	Normal	21.0	1		1	
	Altered	61.5	2.94(2.05-4.24)		1.79(1.25-2.56)	

PR: Prevalence ratio; 95% CI: confidence interval; *Adjusted for variables of the same level and the upper level with the value of the Wald Test p <0.20; [a]Levels: sociodemographic factors (1), lifestyle (2) and health conditions (3); [b]Test of Wald for linear trend.

Discussion

Reduction in motor performance with advancing age was established in previous studies, both in relation to the HGS test[13,22,23] and to the LLMS test,[13,22,24] and can be explained by physiological mechanisms. With aging, there is a reduction in the number of fibers, cross-sectional areas,[25,26] muscle size and function, muscular blood irrigation (capillary density),[27] and in agonist muscle activation accompanied by increased antagonist muscle co-activation and changes to muscle arquitecture.[28]

The percentage in muscle strength reduction among the older subjects of the present study varied each year for both HGS (4%) and LMMS (2%). This disparity has been observed in other studies[23,29] and could be due to differential changes in patterns of movement as a result of aging, or to the use of direct measurement tests for upper limbs and indirect measurements for lower limbs.

Lower levels of schooling have been associated with lower motor performance and/or physical function.[30,31] However, the method of evaluating schooling in other studies was different from that used in the present study. In the 11-year long study of Gregory et al,[31] less (0-8 years) schooling was a predictive factor for incapacity in the mobility of older people in Baltimore. Schooling is an often used variable in epidemiological studies. Some authors argue that using this variable in studies involving older people may be inconvenient or less relevant because schooling may be determined in the early years of one's life and not change later on.[32]

Health status may explain the association between the higher number of morbidities (three or more) and poor performance in HGS and LMMS tests. Although having a chronic disease in itself does not convey its seriousness or stage of progress,[33] a higher number of diseases may place a greater burden on one's body. Chronic diseases may reduce bodily functions, indicating risk of incapacity.[34] Older people who have three or more diseases experience a poorer quality of life[35,36] and find it more difficult to carry out activities that instrumental to daily life.[35]

Rural work requires physical effort with frequent changes of postures, such as crouching and lifting loads, and requires caution. Such factors mean rural workers have higher predisposition to pain and musculoskeletal lesions of the lower limbs.[7,37] In short, the specific physical demands of an occupation can explain the association between lifelong work in agriculture and poor LLMS as verified in the present study. The positive association between lack of work and poor LMMS is supported by studies that established that employed individuals have greater physical mobility and/or physical capacity[38,39] than retired individuals. Data from the Brazil's National Household Sample Survey (known in Portuguese by the acronym PNAD) showed that working men had less difficulty carrying out daily activities and a smaller proportion of chronic diseases when compared to those who did not work.[38] Therefore, it is possible that men who do not work have worse health conditions and physical capacity than working men, which could explain poor LLMS. However, other factors may also be at play here.

The results showed that smokers or former smokers had a lower prevalence of poor LLMS. This finding seems to be a special characteristic of the population studied, because smoking has a pro-sarcopenic effect[40] and is commonly associated with a substantial decline in muscle strength.[41]

Altered cognitive status was associated with poor LLMS as established in earlier studies.[42,43] Impairment of the nervous system and elevated levels of markers of inflammation are related to the nature of this relationship.[44] Furthermore, any individual with altered cognition likely has reduced motivation, resulting in a decline in physical[43,45] and social activity.[45] These factors may lead to a reduction in physical capacity[43] and, consequently, in muscle strength.

The present study has three strong points: the survey of a representative sample of the male population between 60 and 79 years of age the survey and of the entire male population aged 80 years and above; and the involvement of men living in a rural area. It is also noteworthy that the HGS and LLMS evaluations, as well as the questionnaire, are widely used in literature as they are instruments and procedures used in epidemiological studies with household sampling and involve varied populations of older people.[13, 22, 44]

The study's limitations stem from the cross-sectional design. Although it is not possible to determine a causal relation, the associations analyzed are supported by literature; self-reported information, which may mean the interviewee interpreted information incorrectly. Another limitation is the possibility of unreliable responses when older respondents are helped by a caregiver or companion during the interview.

The measurement of HGS and LLMS are easy to apply and useful for identifying older adults at risk of functional decline. These tests could be incorporated into clinical geriatric practice and primary health care.[46]

Conclusions

Data show that with advancing age, illiteracy and three or more morbidities reported are positively associated with poor HGS and LLMS. A poor performance in the LLMS test is positively associated with lifelong agricultural work, unemployment and changes in cognitive status, and negatively associated with current or former smoking addiction.

The results highlight the importance of conducting longitudinal researches in order to determine the risk factors for reduced muscle strength.

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