Nutritional status and handgrip strength in elderly living at low human development index community

Estado nutricional e força de preensão manual em idosos residentes em comunidade com baixo índice de desenvolvimento humano

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ABSTRACT

Design of the study: Epidemiological cross-sectional population-based household study. **Objective:** To investigate the relationship between anthropometric indicators of nutritional status and muscular strength in community-dwelling elderly with low human development index. **Methodology:** Elderly (N = 316) residents of a city in Brazil's Northeast Region were submitted to an interview and a physical evaluation. The dependent variable assessed was handgrip strength. The independent variables were body mass index and arm muscle area. The control variables were age, smoking, physical activity, hospitalization and hyperglycemia. Simple and multiple linear regression models were used for statistical analyses. **Results:** Following control by adjustment variables, there was significant positive correlation of handgrip strength with body mass index ($\beta_{adjusted}$ = 0.439; p = 0.010; $r^2_{adjusted}$ = 0.062) and arm muscle area ($\beta_{adjusted}$ = 0.046; p = 0.003; $r^2_{adjusted}$ = 0.087) for male individuals, but not for female individuals. **Conclusions:** Anthropometric indicators of nutritional status have been positively related to handgrip strength in elderly men, but not in women.

Keywords: Anthropometry. Nutritional Status. Hand Strength. Body Mass Index. Health of the Elderly.

Introduction

Aging causes structural and functional changes to our many organic systems. Changes to the musculoskeletal system are commonly associated with the progressive decline in muscle strength and mass.[1]

Handgrip strength is one of the most used methods in population-based studies to assess muscle

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Artigo recebido em 10/06/2013
Aprovado para publicação em 05/12/2013

strength as it is a reliable and easily measured.[2,3] It is also considered a marker of global strength in individuals, and is pointed out as an indicator of nutritional status, morbidity and mortality in older people.[3,4]

The relationship between anthropometric indicators of nutritional status and handgrip strength in older people has been investigated in recent years.[5,6,7] This relationship may be influenced by the individual's social context.[8] Sociodemographic factors, behavior and health conditions, which influence nutritional status,[9] may be linked to the muscle strength of the elderly.

Only one home-based epidemiological study was found in Brazil investigating the relationship between anthropometric indicators of nutritional status and handgrip strength in the elderly.[6] This research was conducted in the most developed region in the country, and there are no other studies exploring this association.

Considering that socio-cultural, economic and political differences in different Brazilian regions can provide different results to the object of investigation, this study aimed to assess the relationship between anthropometric indicators of nutritional status and handgrip strength in community-dwelling Brazilian elderly with low human development index (HDI).

Material and methods

Setting and Study Population

This is a cross-sectional study that analyzed data from a home-based epidemiological survey called "Nutritional status, risk behaviors and health conditions of elderly in Lafaiete Coutinho-BA". The city studied, located in northeastern of Brazil, had 4,162 inhabitants during the period of data collection. All inhabitants were registered with the Family Health Program (FHP). Two FHP teams (one doctor, one nurse, auxiliary nurses and community health) covered the entire town. This program aims to increase the population's access to primary care.[10] The city has low indicators of health and quality of life, ranking 4,530 in the country's Municipal HDI (MHDI = 0.607).[11] The population is mostly comprised of agricultural workers and service providers.

A full census was conducted in the city in January 2011 to identify the elderly participating in the investigation. All urban residents aged ≥ 60 (n = 355) were selected for interviews and examinations. The houses were located using FHP information. Of the 355 elderly comprising the study population, 316 (89.0%) took part in the research; 17 (4.8%) people refused to participate, and 22 (6.2%) individuals were not located after three household calls in alternate days, and were thus considered losses.

A special form was used, based on the questionnaire used in survey on Health, Well-being, and Aging (SABE) in seven countries in Latin America and the Caribbean[12], except for the physical activity questionnaire[13] which was more comprehensive in this study.

The data was collected in two phases. The first phase consisted of a household interview conducted by one interviewer only and involving many aspects such as personal information, cognitive assessment, health status, functional status, drugs in use, use and access to health services, employment history and sources of income, dwelling characteristics, mobility and flexibility tests, food frequency and physical activity. The second phase was carried out at two Family Health Units in the city and included blood pressure tests, blood tests, anthropometry and handgrip strength test. This phase was scheduled to take place within one to three days of the household interview.

The following information was used in this study: (1) sociodemographic characteristics (age, gender); (2) lifestyle (smoking and physical activity); (3) health status (glycemia and hospitalization); (4) anthropometrics (body mass, height, arm circumference and triceps skin fold - TSF); (5) handgrip strength.

The study protocol was approved by the local Ethics Committee. Participation was voluntary and all subjects signed an informed consent.

Measures

Handgrip strength (dependent variable)

Data was collected by health students in graduation and post-graduation courses (*strictosensu*), who received special training for testing, refinement and calibration of interviewers.

Individuals who refused to take the test or who did not understand the instructions due to cognitive problems were excluded from the analyses. Elderly submitted to arm or hand surgery in the three months prior to data collection did not take the test.

Before the test the interviewer explained and demonstrated the task and made sure that it could be carried out without any risks for the individual.

Handgrip strength was assessed with a hydraulic dynamometer (Saehan Corporation SH5001, Korea). The test was performed on the arm considered

by the individual to be the strongest. During the test the individual remained seated with their elbow on a table, forearm pointing forwards and palms facing up. Each individual made two attempts with a one-minute interval and the higher value (kg) was considered for this study. Participants were stimulated to apply maximum force.

Anthropometric indicators of nutritional status (independent variables)

The anthropometric data was obtained by three Physical Education students who were given theoretical and practical training in order to standardize the anthropometric techniques used in this study. The precision and accuracy of the anthropometrists were confirmed on 20 volunteers prior to data collection by assessing interobserver and intraobserver technical errors. All students presented variations compatible with those accepted for experienced observers.[14]

Body mass was measured with portable digital scales (Zhongshan Camry Electronic, G-Tech Glass 6, China); individuals were weighed barefoot and wearing a minimum amount of clothing. Height was measured according to the technique developed by Frisancho,[15] using a portable compact stadiometer (Wiso, China) set up at an adequate location according to the manufacturer's instructions. The arm circumference was measured with an inelastic anthropometric tape measure (ABN^{TM}, Brazil) according to Callaway et al.[16] TSF was measured with an adipometer (WCS, Brazil) according to Harrison et al.[17] All anthropometric measures, except for body mass, were taken three times, and the mean values were used in the analyses. The body mass index [BMI = body mass (kg) / height^2 (m)] and arm muscle area {AMA = [(AC - π x TSF)^2/ 4 x π] - 10, for men; AMA = [(AC - π x TSF)^2 / 4 x π] – 6.5, for women} were calculated.[18]

Adjustment variables

Sociodemographic: age (as a continuous variable).

Lifestyle: smoking (smoker, ex-smoker or non-smoker) and physical activity (insufficiently active / active). The instrument used to assess the usual physical activity level was the International Physical Activity Questionnaire (IPAQ), long version[13]. Individuals considered insufficiently active were those who spent less than 150 minutes on moderate or vigorous physical activity per week.

Health conditions: hospitalization in the last 12 months (none / one or more) and high fasting glucose (yes / no). Accutrend@ Plus (Roche Diagnostics, Germany) was used to measure plasma glucose after 12 hours fasting. Capillary blood samples were collected via a transcutaneous puncture to the medial side of the middle finger tip using a disposable hypodermic lancet. Alcohol 70% was applied for local antisepsis prior to the puncture. Individual measurements were taken by previously trained undergraduate and graduate health students, following the manufacturers' instructions. High fasting glucose (≥ 126 mg/dl and/or use of oral medication to control glycemia and/or use of insulin) was defined according to current guidelines for diagnosing diabetes in Brazil.[19]

All adjustment variables were included in this study in accordance with the recommendations of other studies that showed that these variables are related both with handgrip strength and nutritional status,[5,9,20,21] and can be potential factors of confusion in the relationship between the dependent variable and the independent variables.

Data Analysis

Simple and multiple linear regression models stratified by gender were estimated. Handgrip strength was defined as the dependent variable and nutritional indicators (BMI and AMA) as variables of interest. For multiple models, the adjustment variables considered were age (years), smoking (categorical), physical activity (categorical), hospitalization (categorical), and hyperglycemia (categorical). The variables included in the multiple model were not substantially collinear (variance inflation factor <2). Confidence values of 5% ($p<0.05$) were fixed and considered statistically significant. The statistical procedures were done in SPSS® v. 17.0 (SPSS Inc., Chicago, IL).

Results

Descriptive analyses

The age of the individuals varied from 60 to 105 years of age, 74.2 (mean) ± 9.7 years old (standard deviation). For women (n = 173), the mean age was 74.9 ± 10.0 years old (60 to 103 years old) and for men (n = 143) it was 73.4 ± 9.4 years old (60 to 105 years old). Table I presents the sample description in relation to the categorical adjustment variables: smoking, physical activity, hospitalization and hyperglycemia.

Table 1
Sample description (number and percentage) according to categorical adjustment variables and gender. Lafaiete Coutinho, Brazil, 2011.

Variables	*n (% response)*	*Men*	*Women*	*All*
Smoking	315 (99.7%)			
Smoker		28 (19.9%)	7 (4.0%)	35 (11.1%)
Ex-smoker		84 (59.6%)	63 (36.2%)	147 (46.7%)
Non-smoker		29 (20.6%)	104 (59.8%)	133 (42.2%)
Hospitalization in the last 12 years	314 (99.4%)			
None		108 (76.6%)	129 (74.6%)	237 (75.5%)
One or more		33 (23.4%)	44 (25.4%)	77 (24.5%)
Physical activity	310 (98.1%)			
Insufficiently active		68 (48.5%)	80 (47.1%)	148 (47.7%)
Active		72 (51.5%)	90 (52.9%)	162 (52.3%)
Hyperglycemia	309 (97.8%)			
Yes		12 (8.6%)	24 (14.1%)	36 (11.7%)
No		127 (91.4%)	146 (85.9%)	273 (88.3%)

It was verified that 57.8% of the sampled individuals were smokers or ex-smokers, smoking being more common among men than women. There was a proportional distribution between men and women regarding recent hospitalization. Most of the elderly were classified as being physically active. The frequency of individuals with hyperglycemia was higher among women.

Table II presents the description of the sampled individuals' BMI, AMA and handgrip strength values (mean, standard deviation, minimum and maximum). BMI mean was higher for women, but male individuals exhibited higher AMA and handgrip strength means.

Anthropometric indicators of nutritional status and muscle strength

The relationship between anthropometric indicators of nutritional status and handgrip strength is shown on Table III. The results of the simple regression analysis showed that both BMI and AMA were significantly related to handgrip strength in both genders. However, the multiple linear model indicated that when controlled by age, smoking, physical activity, hospitalization and hyperglycemia, the relationship between both indicators and handgrip strength lost significance for female individuals, remaining significantly associated only for male individuals.

Discussion

This is the first population-based study involving community-dwelling elderly subjects with low HDI to verify the relationship between anthropometric indicators of nutritional status and handgrip strength, considering the adjustment of intervening variables such as age, smoking habits, physical activity, hospitalization and hyperglycemia. Since MHDI is a measurement used to compare the degree of human development among various municipal areas[22], the results shown here allow clarifying whether anthropometric indicators of nutritional status can also be used as predictors of handgrip strength in populations exposed to social and economic factors determining lower quality of life. Besides, the findings may serve as parameters for analyses aimed at preventing functional limitation and promoting physical recovery in populations exhibiting characteristics similar to those in the present study.

Table 2
Mean, standard deviation, maximum and minimum values for body mass index (BMI), arm muscle area (AMA) and handgrip strength (HS) according to gender. Lafaiete Coutinho, Brazil, 2011.

Variables	*BMI (kg/m²)*	*AMA (cm²)*	*HS (kg)*
Men			
Mean	23.67	35.71	27.94
Standard deviation	4.14	9.58	8.03
Min - Max	13.60 - 37.50	9.90 - 56.30	6.00 - 47.00
Women			
Mean	25.27	30.48	18.16
Standard deviation	4.93	7.90	5.19
Min - Max	14.10 - 41.20	11.90 - 54.90	4.00 - 32.00
All			
Mean	24.54	32.87	22.55
Standard deviation	4.64	9.08	8.22
Min - Max	14.00 - 41.00	9.90 - 56.30	4.00 - 47.00
% answer	301 (95.3%)	307 (97.2%)	303 (95.9%)

Table 3
Coefficients of simple and multiple linear regression models between handgrip strength and anthropometric indicators of nutritional status according to gender. Lafaiete Coutinho, Brazil, 2011.

Independent variables	β_{crude}*(p-value)*	$\beta_{adjusted}^{*}$ *(p-value)*	$r^2_{adjusted}$
Men			
BMI	0.511 (0.002)	0.439 (0.010)	0.062
AMA	0.059 (<0.001)	0.046 (0.003)	0.087
Women			
BMI	0.219 (0.006)	0.109 (0.150)	0.041
AMA	0.149 (0.002)	0.087 (0.059)	0.050

* Adjusted for age, smoking, physical activity, hospitalization and hyperglycemia.

The crude analyses showed that lower handgrip strength was observed among the elderly of both genders who exhibited lower BMI and AMA values, as was observed by Barbosa et al.[6] in the elderly of São Paulo, and by other authors in developing countries[7,8].

AMA exhibited higher coefficients of determination ($r^2_{adjusted}$) than BMI, as was verified in the study by Barbosa et al.[6] and by Pieterse et al.[7], with the elderly of Ruanda, living in refugee camps in Tanzania. This finding can be justified by a closer relationship between the AMA measure and muscle mass in the elderly[23].

Studies carried out in developed countries have shown conflicting results in relation to this issue. While

the research by Rolland et al.[24] showed that handgrip strength did not differ significantly due to weight status, Massy-Westropp et al.[25] established that a positive and weak relationship was found between BMI and handgrip strength values, both in young and older adults.

The results of the adjusted analysis by confusion factors enabled determining that BMI and AMA remained associated with muscle strength only in male individuals. However, reductions of 14.1% and 22.0% were observed in the regression coefficients ($\beta_{adjusted}$) of BMI and AMA, respectively.

These findings indicate that the confusion factors included in the multiple linear regression model may change the relationship between the anthropometric indicators of nutritional status and handgrip strength; this occurred mainly with female individuals. Studies verifying the relationship between nutritional status and handgrip strength considering the effects of variables related to age, lifestyle, hospitalization and diabetes have not been found in literature, which limit comparisons.

Although the characteristics of this study do not allow clarifying the reasons why the anthropometric indicators of nutritional status were predictors of handgrip strength only among the men, some evidences can be pointed out. First, BMI has a higher correlation with body fat mass in women, whereas it is highly correlated with fat-free mass in men.[26] The fact that muscle mass is the main component of fat-free mass suggests that BMI can be a better marker of strength in male individuals. Second, evidence suggests that infiltration of fat into muscle is higher among elderly women, even when they exhibit lower body mass.[27] Therefore, it is possible that AMA in elderly men has more contractile components per cm^2 when compared to women, and this may be related to the higher predictive capacity of AMA in elderly male individuals.

It is well known that adequate nutrition is essential for the good health, and changes in nutritional status have been associated with muscular mass loss and strength in the old age[5]. Literature has demonstrated that lower muscle strength is a predictor of functional limitations and physical incapacity in the elderly[28]. Therefore, a good nutritional status is fundamental to preserve muscle strength and functional capacity, and consequently, the quality of life of these individuals.

Among the limiting factors of this study the cross-sectional nature of the research design can be pointed out, which limit the verification of implicit causal relations among the study variables. Future studies sampling the elderly in regions with different HDI must be encouraged aiming to extend the knowledge about influences of the social context on the relationship between nutritional status and muscle strength. However, it is expected that the information presented can contribute to the development of policies aimed at the health of the elderly, guiding interventions for this population group, especially in regions with low HDI.

Conclusions

According to the results of this study, it is possible to conclude that BMI and AMA can be predictors of handgrip strength in community-dwelling elderly men with low HDI, but not in women. These findings suggest that anthropometric indicators can be used in populations with this characteristics as markers of muscle strength for male subjects only; alternatives for women should be further studied.

Acknowledgements

The research was partly funded by the UESB (UESB 117/2009 and 011/2010). The authors thank the Municipal Secretariat of Health of Lafaiete Coutinho-BA and the elderly who participated in the study.

RESUMO

Modelo do estudo: Estudo epidemiológico transversal, populacional de base domiciliar. **Objetivo:** Verificar a relação entre indicadores antropométricos de estado nutricional e força muscular em idosos residentes em comunidade com baixo índice de desenvolvimento humano. **Metodologia:** Idosos (N = 316) de uma cidade do Nordeste do Brasil foram submetidos a entrevista e avaliação física. A variável dependente analisada foi a força de preensão manual. As variáveis independentes foram o índice de massa corporal e a área muscular do braço. As variáveis de controle foram a idade, tabagismo, atividade física, hospitalização e hiperglicemia. Foram usados modelos de regressão linear simples e múltipla para as análises estatísticas. **Resultados:** Após controle pelas variáveis de ajuste, houve correlação

positiva significante da força de preensão manual com o índice de massa corporal ($\beta_{ajustado}$ = 0,439; p = 0,010; $r^2_{ajustado}$ = 0,062) e a área muscular do braço ($\beta_{ajustado}$ = 0,046; p = 0,003; $r^2_{ajustado}$ = 0,087) para o sexo masculino, mas não para o sexo feminino. **Conclusões:** Indicadores antropométricos de estado nutricional foram relacionados a força de preensão manual em homens idosos, mas não em mulheres.

Palavras-chave: Antropometria. Estado Nutricional. Força da Mão. Índice de Massa Corporal. Saúde do Idoso.

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