Factors associated with functional capacity in the elderly enrolled in the Family Health Strategy

Lorrane Brunelle Moreira (https://orcid.org/0000-0002-1656-181X) [1]
Silvia Lanziotti Azevedo da Silva (https://orcid.org/0000-0002-2323-2029) [1]
Ana Emília Fonseca de Castro (https://orcid.org/0000-0003-0273-1053) [1]
Sara Souza Lima (https://orcid.org/0000-0002-0215-4746) [1]
Dayane Oliveira Estevam (https://orcid.org/0000-0001-7327-342X) [1]
Flávia Alexandra Silveira de Freitas (https://orcid.org/0000-0002-2246-9518) [1]
Érica Leandro Marciano Vieira (https://orcid.org/0000-0002-4147-5614) [2]
Daniele Sirineu Pereira (https://orcid.org/0000-0002-4868-9244) [1]

Abstract *The study investigated the prevalence of functional capacity decline and its associated factors in the older people enrolled in the Family Health Strategy (ESF) in a city in the south of Minas Gerais. This is an observational, cross-sectional, population-based study with 406 elderly (70.49 years ± 6.77). The functional capacity was evaluated by the Short Physical Performance Battery (SPPB), and its associated factors were evaluated by a structured questionnaire including sociodemographic, economic, clinical and physical aspects. The analysis of plasma levels of inflammatory mediators was performed by the ELISA method. Multiple linear regression was used for the analyses (p < 0.05). The prevalence of functional decline in the sample was 57.6% and factors associated with functional capacity were advanced age, female gender, number of medications, depressive symptoms, high plasma concentrations of the soluble receptor of tumor necrosis factor alpha 1 (sTNFR1) and low handgrip strength. The results demonstrated that functional capacity was associated with a network of multidimensional factors. This study contributes to the practice of ESF professionals by indicating the main factors that can guide actions to promote and prevent the decline of functional capacity in the elderly population.*

Key words *Elderly health, Primary Health Care, Elderly, Inflammatory mediators*

[1] Instituto de Ciências da Motricidade, Universidade Federal de Alfenas. Av. Jovino Fernandes Sales 2600, Santa Clara. 37133-840 Alfenas MG Brasil. daniele.sirineu@gmail.com
[2] Faculdade de Medicina, Universidade Federal de Minas Gerais. Minas Gerais MG Brasil.

Introduction

World population ageing is one of the significant challenges today. In Brazil, an estimated 17.6 million people are over 60 years of age, and according to the World Health Organization (WHO)[1], Brazil will be the sixth country in the world with the highest number of seniors by 2025. Population aging is a result of changes in health indicators, particularly the declining fertility and mortality rates and increased life expectancy[2].

Age advancement leads to decreased individual physical, psychological and behavioral capacities and to the body's lower adaptation to stressful events. Senescence is characterized as a heterogeneous, individual and irreversible process, and is determined by several factors, from genetic predisposition, habits and lifestyle, health conditions to environmental conditions[3]. The increased life expectancy may then be accompanied by physical or cognitive impairments, increased chronic diseases, disabilities and functional decline[4].

Aging entails changes in the immune system, with significant repercussions for the health of the elderly. One of these, called inflammaging, is characterized by the imbalanced production and release of inflammatory mediators. Studies have shown a two to four-fold increase in plasma levels of interleukin-6 (IL-6), tumor necrosis factor alpha (TNF-) and its soluble receptors, interleukin 8 (IL-8), C-reactive protein, among others, characterizing a low-level chronic inflammatory process in the elderly organism[5,6]. Elevated levels of these pro-inflammatory mediators are related to several adverse health conditions, such as cardiovascular diseases, diabetes mellitus, fragility, sarcopenia, decreased functional capacity and increased mortality[7,8].

Together, changes resulting from aging have repercussions not only on the physical realm but also on the activities and social participation of the individual, which can generate essential consequences, such as functional dependence, institutionalization and lower quality of life[9]. Knowledge of the factors that affect the functionality of the elderly is thus fundamental for the planning and implementation of prevention and intervention measures, especially in Primary Health Care (PHC), which is responsible for the coordination of individual and community care[10].

At the first level of healthcare, professionals should focus on the functionality of the elderly to develop care strategies. Such a perspective goes beyond the biomedical paradigm, geared to chronic diseases, allowing not only to advance towards comprehensive care for the elderly but also to consider actions consistent with the particularities of aging[11]. Therefore, the logic of care for the elderly must incorporate a provision of care aimed at maintaining functional capacity, based on an expanded view of the individual, considering its associated factors. Functional capacity is a multidimensional construct, defined as the ability to perform the activities of daily living independently[12]. Studies have shown that functional capacity may be influenced by demographic and socioeconomic factors, as well as health conditions and psychoemotional aspects[12-17]. However, few Brazilian studies include the investigation of inflammatory mediators as one of the possible determinants of the functional capacity of the elderly.

Thus, this study aimed to investigate the prevalence of declining functional capacity and its associated factors in the elderly enrolled in the Family Health Strategy.

Methods

This is an observational, cross-sectional, population-based study with community-dwelling elderly enrolled in the Family Health Strategy of the city of Alfenas (MG), Brazil. The study is part of the project titled *Biological markers associated with the identification and development of the frailty syndrome, sarcopenia and risk of falls in the elderly attended by the primary and secondary health care services*, approved by the Research Ethics Committee of the Federal University of Alfenas (UNIFAL-MG). Participants in the study signed an informed consent form, as per the principles contained in the Declaration of Helsinki of the World Medical Association (1964, reformulated in 1975,1983, 1989, 1989, 1996 and 2000).

The sample calculation considered the prevalence for a random stratified proportional sample, with 95% confidence and 5% error. Probabilistic sampling was based on the distribution of the elderly in the 14 PHC facilities that adopted the Family Health Strategy in the municipality of Alfenas (MG) in 2015, ensuring the population representativeness of the results. Older adults were randomized by a computer program for each PHC facility from the municipal lists of enrollees.

The sample size was defined from a sample calculation from a pilot study with 114 elderly

from the 14 PHC facilities of the municipality, considering = 0.05 and a power of 80%, and a sample size of 350 elderly was required. The data collected in the pilot study were not included in the analysis of this study. Data were collected at the elderly's home from July 2015 to July 2016.

The inclusion criteria of the study were to be 60 years old or older and to be enrolled in the PHC facilities of the city of Alfenas (MG). Exclusion criteria were elderly individuals with cognitive alterations detectable by Mini-Mental State Examination[18], acute inflammatory or infectious disease; neoplasms in the last five years; use of immunosuppressive drugs; amputations in the lower limbs; surgeries or fractures in the lower limbs in the last six months; presence of neurological diseases or sequelae that prevented the performance of the proposed tests.

Functional capacity was evaluated by the Short Physical Performance Battery (SPPB), a standardized and multidimensional instrument with high reliability and sensitivity to the changes in the elderly's functionality[19]. SPPB consists of three tests that evaluate, in the following order: standing static balance, gait speed at usual pace and, indirectly, lower limbs muscular strength by getting up and sitting on the chair five times without the help of upper limbs. The total SPPB score is obtained by adding the scores for each test and can range from 0 to 12 points. The classification of the performance of the elderly is 0-3 points - individual incapacitated or very poor performance; 4-6 - poor performance; 7-9 - moderate performance and 10-12 - good performance[20].

A structured questionnaire was developed to evaluate the functional capacity determinants, with the following variables: demographic and socioeconomic aspects, lifestyle habits, clinical aspects, physical aspects, self-perceived health and inflammatory mediators.

Demographic and socioeconomic aspects included age, gender, schooling, marital status, family structure and income. Life habits were obtained through objective questions about tobacco and alcohol use, while the level of physical activity was assessed by the Minnesota Leisure Time Activity questionnaire. This instrument considers the kilocalories expenditure by the individual during the activities carried out in the last two weeks and has already been translated and adapted for the Brazilian elderly population[21].

The clinical aspects were investigated through objective questions, covering the presence of co-morbidities, drug use, pain, visual changes (use of

corrective lenses). The Geriatric Depression Scale (GDS), a 15-item version translated and adapted for the Brazilian population, was used for the screening of depressive symptoms, with cut-off points 5/6 (no case/case). This scale has been widely used in the geriatric population, evidencing valid and reliable psychometric measures[22].

Regarding the physical aspects, the Body Mass Index (BMI), waist circumference (WC) and handgrip strength were measured. The BMI was calculated with the relationship of the measures of weight/height^2 (Kg/m^2). Waist circumference was analyzed as an indicator of cardiovascular risk, obtained at the midpoint between the iliac crest and the last rib. The cut-off points for WC were as per those adopted by the Brazilian Obesity Guidelines (Abeso)[23], increased risk for women (WC > 80 cm) and men (WC > 94 cm). The handgrip strength was measured in Kgf (Kilograms-force) with the Jamar® Manual Dynamometer, accepted as a standard instrument for grip strength measurement. The average of three measurements was taken, with an interval of one minute between them. For the measurements, the participants were placed in a chair without arms; the dominant limb was kept with the shoulder in a neutral position, elbow at 90° flexion and wrist in a neutral position[24]. Use of standardized verbal stimulus was used to achieve the highest isometric contraction value.

Self-perceived health was investigated from the question: "How is your health in general?", with the following answer options: "poor/very poor"", "fair" and "good/very good/excellent".

We performed the dosing of the soluble receptor of tumor necrosis factor alpha 1 (sTN-FR1) and interleukin (IL-8) from blood collection of 10 ml of peripheral blood in vacuum tubes with EDTA (Ethylenediaminetetraacetic acid). The procedure was performed by a qualified professional with disposable material and all norms for the use of sharps were followed for the disposal of materials. After collection, the tubes were centrifuged at 4000 rpm for 10 minutes and the plasma removed in a sterile environment in Eppendorf tubes and stored in a freezer at -80° C. Plasma concentrations were measured using the enzyme-linked immunosorbent assay (ELISA) using the DuoSet ELISA kit (R&D Systems, Minnesota, MN) as per manufacturer's instructions.

Statistical analysis

A descriptive analysis was performed for the characterization of the sample using mean and

standard deviation values for continuous and discrete variables, and frequency distribution for categorical variables. The normal distribution of data was analyzed by the Kolmogorov-Smirnov test, and none of the variables evidenced a normal distribution.

Factors associated with functional capacity were investigated by a multiple linear regression model with the backward method, and the functional capacity was a dependent variable evaluated by the SPPB score. According to statistical criteria, the independent variables included in the model were those that correlated with functional capacity ($p < 0.05$). The correlation between the variables was verified using Spearman's correlation coefficient.

The multiple determination coefficient (R^2) was used to quantify the strength of the association between functional capacity and independent variables. The F-test was used to determine the statistical significance, considering $p < 0.05$. Regarding the model's assumptions, the presence of multicollinearity was considered when the Variance Inflation Factor (VIF) was > 10 and Tolerance < 0.2; the homoscedasticity was verified through the chart observation predicted values and observed values, and also the normality of the non-standardized residual. The SPSS program for Windows (Version 20.0) was used for all analyses.

Results

A total of 521 older adults were evaluated, 115 elderly were excluded, 25 due to cognitive alteration and 90 because they did not perform the blood collection for the dosage of the inflammatory mediators. The sociodemographic and clinical characteristics of the 406 elderly included in the analyses are shown in Table 1. In general, the sample was mostly female, with low educational level, non-smokers and physically inactive. The most common comorbidities were systemic arterial hypertension (77.1%), diabetes mellitus (39.9%) and osteoarthritis (31.8%). The sample was also overweight and with high cardiovascular risk as per waist circumference. Regarding functional capacity, 57.6% of the sample evidenced low performance with scores under six points in SPPB.

The bivariate analysis between functional capacity and demographic, socioeconomic, life habits, clinical, physical and inflammatory aspects variables is shown in Table 2. These results

determined the independent variables included in the model ($p < 0.05$): age, gender, schooling, marital status, income, comorbidities, number of medications, alcohol use, level of physical activity, depressive symptoms, self-perceived health, handgrip strength and plasma levels of sTNFR1.

The results of the regression model are shown in Table 3. The model was able to explain 29.2% of the variability of "Functional Capacity".

We observed that older age, a higher number of medications, the presence of depressive symptoms, lower HGS and higher plasma concentrations of sTNFR1 were associated with worse functional capacity. Regarding gender, being a woman was associated with lower SPPB scores.

Table 1. Sociodemographic and clinical characteristics of the sample evaluated.

Variables	Total Sample (n = 406)
	Mean ± SD; Median
Age (years)	70.5 ± 6.8; 70.00
Gender	**% (n)**
Male	37.9% (154)
Female	62.1% (252)
Marital Status	**% (n)**
With companion	66.7% (271)
Without companion	33.3% (135)
Schooling (years)	3.8 ± 3.4; 4.0
Income (minimum wage)	3.0 ± 8.4; 2.0
Physical activity (Kcal/ week)	2850.8 ± 3418.5; 1773.0
Self-perceived health	**% (n)**
Good/Very Good/ Excellent	52.2% (212)
Poor/Fair	47.8% (194)
HGS (Kgf)	26.5 ± 10.0; 25.2
IMC (Kg/m2)	27.8 ± 5.21; 27.34
WC (cm)	97.4 ± 14.1; 98.0
sTNFR-1 (pg/ml)	1641.1 ± 739.4; 1471.1
IL-8(pg/ml)	5.7 ± 6.5; 3.9
SPPB	7.0 ± 1.9; 7.0

HGS: Handgrip strength; BMI = Body Mass Index; WC: Waist Circumference; In the categorical variables (Gender, marital status, tobacco use, alcohol use, self-perceived health): percentage and frequency. In the continuous variables (age, schooling, level of physical activity, comorbidities, medicines, depressive symptoms, HGS, BMI, WC and inflammatory mediators): mean, standard deviation and median.

Table 2. Correlations between sociodemographic, clinical and lifestyle characteristics with functional capacity.

Functional capacity (SPPB)		
Variables	Coefficient of Correlation (rs)	P-value
Age (years)	-0.239	< 0.0001
Gender	0.276	< 0.0001
Marital Status	0.236	< 0.0001
Schooling (years)	-0.228	< 0.0001
Income	0.116	0.019
Nº Comorbidities	-0.296	< 0.0001
Nº Medicines	-0.272	< 0.0001
Tobacco use	0.032	0.524
Alcohol use	0.196	< 0.0001
Level of Physical Activity	0.176	< 0.0001
Self-perceived health	-0.219	< 0.0001
Depressive Symptoms (score)	-0.336	< 0.0001
BMI (kg/m2)	0.035	0.480
WC (cm)	-0.064	0.201
HGS (Kgf)	0.391	< 0.0001
sTNFR-1 (pg/ml)	-0.142	0.004
IL-8(pg/ml)	0.019	0.706

HGS: Handgrip strength; BMI = Body Mass Index; WC: Waist Circumference.

Table 3. Multiple linear regression for the factors associated with functional capacity.

Model	OR	p	CI 95%
Age	-0.246	< 0.0001	(-0.098) – (-0.047)
Gender	0.137	0.012	(0.125) – (0.994)
Nº Medicines	-0.132	0.003	(-0.161) – (-0.034)
GDS	-0.226	< 0.0001	(-0.229) – (-0.103)
HGS	0.203	< 0.0001	(0.019) – (0.061)
sTNFR1	-0.102	0.019	(-0.787) – (-0.071)

GDS: Geriatric Depression Scale; HGS: Handgrip strength; sTNFR1: soluble receptor of tumor necrosis factor alpha 1. Functional Capacity was the dependent variable (SPPB score). $R^2 = 0.302$; Adjusted $R^2 = 0.292$; p < 0,05.

Discussion

This study revealed a high prevalence of low functional capacity. Factors associated with this alteration were advanced age, female gender, continuous use of medications, depressive symptomatology, low handgrip strength, and elevated plasma levels of sTNFR1. According to the authors, this was the first population-based study with a Brazilian sample to include the investigation of inflammatory mediators among the factors associated with functional capacity.

The prevalence of low functional capacity was higher when compared to other Brazilian studies, which ranged from 10.96% to 45.5%[25-28]. This is possibly due to the use of different instruments for the evaluation of functional capacity. While self-report questionnaires were used in most investigations, in this study, functional capacity was assessed by an objective measure. While valid and reliable, self-reporting instruments are permeated with subjectivity, so that the elderly's perception of performance may not correspond to their actual functional capacity[29,30].

The regression model identified six associated factors, which together explained 29% of the functional capacity variability of the sample surveyed. These results evidenced the multifactorial characteristic of this construct, corroborating previous research[31,32]. However, factors associated with functional capacity differ in the literature, which may reflect variations among the samples influenced by socio-cultural and regional aspects of each study.

In the studied sample, elevated levels of sTNFR1 were associated with worse functional capacity, suggesting the participation of the chronic inflammatory process with age in the alterations of the elderly's functionality. Changes in the production of inflammatory mediators, such as sTNFR1, indicate the presence of subclinical conditions and the need to provide care that considers their identification and early interventions to prevent functional decline in the elderly.

Inflammatory mediators are involved in pathophysiological processes related to sarcopenia defined as loss of mass and muscle strength that accompanies aging[33]. In this context, evidence has shown that TNF- exerts catabolic action, stimulating proteolysis, with consequent muscular atrophy, and induces changes in muscle protein, which causes a decreased capacity to generate strength[34]. The biological activity of TNF- is modulated by its receptors, especially sTNFR1[35]. Since TNF- is short half-life, the dosage of sTNFR1 has been indicated as a more reliable marker of the inflammatory response[36].

However, few studies have investigated the relationship between functional capacity and

changes in sTNFR1 levels, especially in the Brazilian population. Moreover, the results of the studies are contradictory, since the sociocultural and regional characteristics between the samples are different. In a study by Penninx et al.[37], conducted in Pittsburgh (USA), aged 70-79 years, sTNFR1 was associated with a higher incidence of mobility limitation. In a sample of 222 Brazilian senior women, Felício et al.[38] did not find a relationship between this marker and functional capacity.

Interestingly, lower HGS values were associated with lower SPPB scores. HGS is a strong predictor of functional decline[39] and an indicator of overall muscle strength in older adults[40]. Our results are in agreement with other studies. Pereira et al.[41] observed that elderly with lower HGS had worse functional performance evaluated by tests similar to those used in this study. HGS is a fast and straightforward measure, so its use must be considered concerning practical propositions in the context of PHC for evaluation, follow-up and prevention of reduced functional capacity of the elderly.

Older individuals were more likely to show worse performance in functional tests, in agreement with findings that identified greater difficulty in performing activities of daily living as the age group increased[42-44]. Functional capacity reflects the integration of multiple physiological systems, which decline over the years. In a study by Aires et al.[45], it was observed that the elderly with more advanced age evidenced a higher risk of developing severe dependence. Similar results were found by Fiedler and Peres[46], where the elderly over 70 years presented an increased risk of functional loss. These results together indicate the need for older adults to undergo periodic follow-up by the PHC team to prevent functional capacity decline.

Use of medication was associated with functional capacity in the studied sample, and a higher number of drugs in continuous use implied a higher probability of low functional capacity. Brito et al.[47] found that the use of one or more medicines was associated with impaired functional capacity, as did Virtuoso-Júnior and Guerra[48], who observed that the higher the number of medicines used by senior women, the higher the level of dependence. While using subjective measures to evaluate functional capacity, they observed an association between variables, corroborating our results. About 66.3% of the elderly in this study had three or more diseases. Although comorbidities have not been associated

with functional capacity, they may influence the relationship between drug use and functionality.

The regression model showed an association between the higher the number of depressive symptoms and the low performance in the functional tests. The findings in the literature are contradictory regarding depression, even when considered in the same region. Brito et al.[47], when evaluating long-living older adults in the northeast of Brazil, did not find any association between these variables. On the other hand, Maciel and Guerra[16] found that older adults with depressive symptoms residing in the Northeast were more likely to develop a functional disability.

Depression, as well as the presence of depressive symptoms that do not meet the diagnostic criteria of the disease, have a significant adverse impact on the elderly's life and is being associated with higher physical, social and functional impairment. However, both conditions have been underdiagnosed in the elderly population[49]. Depressive symptoms are often attributed to the aging process itself or confused with symptoms of other diseases[50], hindering their identification. Even screening using quick, easy and inexpensive instruments is rarely included in the evaluation of the elderly[51].

Thus, it is of paramount importance that PHC professionals include the screening of depressive symptoms in the PHC routine, aiming at early detection and implementation of actions aimed at symptom management. The implementation of physical exercise, proven effective for the reduction of depressive symptoms[51], and the establishment of mental health groups can be strategies for the operationalization of care for the elderly with this health condition.

The results regarding gender showed that being a woman was associated with worse functional capacity. Similar results were found in population studies with the Brazilian sample, even using different measures of functional capacity[46,52]. Although women live longer than men, they have a higher prevalence of disabling conditions, such as depression, osteoarthritis, osteoporosis, possibly due to worse living conditions related to low schooling and lower remuneration in adulthood, which are factors that contribute to increased problems when older. On the other hand, in a sample of 155 seniors from three regions of the State of Rio Grande do Sul, Aires et al.[53] did not find an association between gender and changes in functional capacity. Similarly, in a sample of 964 elderly, Rosa et al.[54] did not observe an association between these variables, although being a

housewife increased the likelihood of moderate/severe dependence. These gaps are possibly related to the influence of cultural, social and economic aspects of the regions of each study.

As a limitation of the study, we must consider that the cross-sectional design hindered the establishment of causal relationships. Also, the rural area was excluded because it did not have any ESF facility during the period of study. As strengths of the study, we highlight the inclusion of mediators of the chronic inflammatory process that accompanies the aging process, increasing the understanding of the factors associated with the functional capacity of the community elderly. Furthermore, the study was carried out within the context of PHC, using instruments validated and specific to the elderly population, easily and quickly applied in this scenario by their professionals for the evaluation of factors associated with functional capacity. Work done in situations close to reality can stimulate the implementation of more effective strategic actions.

Conclusion

There was a high prevalence of low functional capacity in the evaluated elderly. The low functional capacity evidenced the most advanced age, being female, a higher number of medications, depressive symptoms, low handgrip strength and high plasma concentrations of sTNFR1. This study contributes to the practice of PHC professionals by pointing out the main factors that can guide actions to promote and prevent the decline of functional capacity in the elderly population. Most of the factors associated with low functional capacity identified can be evaluated through simple, brief, low-cost measures and instruments, ensuring easy application by PHC professionals. The identification of the association of sTNFR1 and the low functional capacity reinforces the presence of subclinical conditions, pointing out the need for earlier approaches in the process of care and elderly healthcare.

Thus, it is essential that the Family Health Strategy teams consider these factors in the evaluation routine of the elderly, together with the inclusion of strategies to manage them, to avoid the development of disabilities. The regular practice of supervised physical exercise, actions directed to Mental Health and health education operative groups for the promotion of protective lifestyle habits can be implemented in the PHC facilities' routine, minimizing aspects affecting the functional capacity of the elderly.

Collaborations

DS Pereira, LB Moreira worked on the conception and design of the study, interpretation of the results; LB Moreira, AEF Castro, SS Lima, FAS Freitas, DO Estevam worked on the collection and contributed to the writing of the manuscript; DS Pereira, ELM Vieira were responsible for the analysis of inflammatory mediators and contributed to the writing of the manuscript; DS Pereira, SLA Silva were responsible for the analysis and statistical interpretation of the data.

Acknowledgments

References

1. Instituto Brasileiro de Geografia e Estatística (IBGE). *Projeções e estimativas da população do Brasil e das Unidades da Federação*. Brasil: IBGE; 2015.

2. Miranda GMD, Mendes AC, Silva ALA. O envelhecimento populacional brasileiro: desafios e consequências sociais atuais e futuras. *Rev Bras Geriatr Gerontol* 2016; 19(3):507-519.

3. Andrade FB, Costa ICC, Ferreira TLS, Silva ICFGA, Araújo IKM, Pereira DO, Assunção JRG, Dutra JIS, Cabral AL. Assessment of Comprehensive Health Care of the Elderly in Primary Health Care. *Health* 2015; 7(3):365-370.

4. Oliveira DAS, Nascimento Júnior JRA, Bertolini SMMG, Oliveira DV. Participation of elderly in social groups: quality of life and functional capacity. *Rev Rene* 2016; 17(2):278-284.

5. Krabbe KS, Pedersen M, Bruunsgaard H. Inflammatory mediators in the elderly. *Exp Gerontol* 2004; 39(5):687-699.

6. Álvarez-Rodríguez L, López-Hoyos M, Muñoz-Cacho P, Martínez-Taboada VM. Aging is associated with circulating cytokine dysregulation. *Cell Immunol* 2012; 273(2):124-132.

7. Mathur N, Pedersen BK. Exercise as a Mean to Control Low-Grade Systemic Inflammation. *Mediators Inflamm* 2008; 2008:109502.

8. Teixeira BC, Lopes AL, Macedo RCO, Correa CS, Ramis TR, Ribeiro JL, Reischak-Oliveira A. Marcadores inflamatórios, função endotelial e riscos cardiovasculares. *J Vasc Bras* 2014; 13(2):108-115.

9. Berlezi EM, Farias AM, Dallazen F, Oliveira KR, Pillatt AP, Fortes CK. Como está a capacidade funcional de idosos residentes em comunidades com taxa de envelhecimento populacional acelerado? *Rev Bras Geriatr Gerontol* 2016; 19(4):643-652.

10. Mendes E. *A construção social da atenção primária à saúde*. Brasília: CONASS; 2015.

11. Medeiros KKAS, Junior EPP, Bousquat A, Medina MG O desafio da integralidade no cuidado ao idoso, no âmbito da Atenção Primária à Saúde. *Saúde Debate* 2017; 41(3):288-295.

12. Nogueira PSF, Marques MB, Coutinho JFV, Maia JC, Silva MJ, Moura ERF. Factors associated with the functional capacity of older adults with leprosy. *Rev Bras Enferm* 2017; 70(4):711-718.

13. Brito TA, Fernandes MH, Coqueiro RS, Jesus CS, Freitas R. Capacidade funcional e fatores associados em idosos longevos residentes em comunidade: estudo populacional no Nordeste do Brasil. *Fisioter Pesq* 2014; 21(4):308-313.

14. Assis VG, Marta SN, De Conti MH, Gatti MA, Simeão SF, De Vitta A. Prevalência e fatores associados à capacidade funcional de idosos na Estratégia Saúde da Família em Montes Claros, Minas Gerais, Brasil. *Rev Bras Geriatr Gerontol* 2014; 17(1):153-163.

15. Brito KQD, Menezes TN, Olinda RA. Functional disability and socioeconomic and demographic factors in elderly. *Rev Bras Enferm* 2015; 68(4):633-641.

16. Maciel ACC, Guerra RO. Influência dos fatores biopsicossociais sobre a capacidade funcional de idosos residentes no nordeste do Brasil. *Rev Bras Epidemiol* 2007; 10(2):178-189.

17. Possatto JM, Rabelo DF. Ansiedade e depressão em idosos: associações com idade, sexo, capacidade funcional e suporte social. *Rev Kairos* 2017; 20(2):45-58.

18. Bertolucci PH, Brucki S, Campacci SR, Juliano Y. O mini-exame do estado mental em uma população geral: impacto da escolaridade. *Arq Neuropsiquiatr* 1994; 52(1):1-7.

19. Pavasini R, Guralnik J, Brown JC, di Bari M, Cesari M, Landi F, Vaes B, Legrand D, Verghese J, Wang C, Stenholm S, Ferrucci L, Lai JC, Bartes AA, Ferrer JEM, Lim Jae-Y, Ensrud KE, Cawthon P, Turusheva A, Frolova E, Rolland Y, Lauwers V, Corsonello A, Kirk GD, Ferrari R, Volpato S, Campo G. Short Physical Performance Battery and all-cause mortality: systematic review and meta-analysis. *BMC Med* 2016; 14:215.

20. Nakano MM. *Versão brasileira da Short Physical Performance Battery – SPPB: adaptação cultural e estudo da confiabilidade* [dissertação]. Campinas: Universidade Estadual de Campinas; 2007.

21. Lustosa LP, Pereira DS, Dias RC, Britto RR, Parentoni AN, Pereira LS. Tradução e adaptação transcultural do Minnesota Leisure Time Activities Questionnaire em idosos. *Geriatr Gerontol Aging* 2011; 5(2):57-65.

22. Almeida OP, Almeida SA. Confiabilidade da versão brasileira da Escala de Depressão em Geriatria (GDS) versão reduzida. *Arq Neuropsiquiatr* 1999; 57(2B):421-426.

23. Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica (ABESO). *Diretrizes brasileiras de obesidade 2016*. 4ª ed. São Paulo: ABESO; 2016.

24. Figueiredo IM, Sampaio RF, Mancini MC, Silva FC, Souza MA. Teste de força de preensão utilizando o dinamômetro Jamar. *Acta Fisiatr* 2016; 14(2):104-110.

25. Nunes MCR, Ribeiro RCL, Rosado LEFPL, Franceschini SC. Influência das características sociodemográficas e epidemiológicas na capacidade funcional dos idosos residentes em Ubá, Minas Gerais. *Rev Bras Fisioter* 2009; 13(5):376-382.

26. Assis VG, Marta SN, De Conti MH, Gatti MA, Simeão SF, De Vitta A. Prevalência e fatores associados à capacidade funcional de idosos na Estratégia Saúde da Família em Montes Claros, Minas Gerais, Brasil. *Rev Bras Geriatr Gerontol* 2014; 17(1):153-163.

27. Barbosa BR, Almeida JM, Barbosa MR, Rossi-Barbosa LAR. Avaliação da capacidade funcional dos idosos e fatores associados à incapacidade. *Cien Saude Colet* 2014; 19(8):3317-3325.

28. Pinto AH, Lange C, Albereci Pastore C, de Llano PM, Przylynski Castro D, Santos F. Capacidade funcional para atividades da vida diária de idosos da Estratégia de Saúde da Família da zona rural. *Cien Saude Colet* 2016; 21(11):3545-3555.

29. Silva AG, Queirós A, Sa-Couto P, Rocha NP. Self-Reported Disability: Association With Lower Extremity Performance and Other Determinants in Older Adults Attending Primary Care. *Phys Ther* 2015; 95(12):1628-1637.

30. Bean JF, Olveczky DD, Kiely DK, LaRose SI, Jette AM. Performance-based versus patient reported physical function: what are the underlying predictors? *Phys Ther* 2011; 91:1804-1811.

31. Nogueira S, Ribeiro RCL, Rosado LPEL, Franceschini SCC, Ribeiro AQ, Pereira AQ. Fatores determinantes da capacidade funcional em idosos longevos. *Rev Bras Fisioter* 2010; 14(4):322-329.

32. Santos VR, Christofaro DG, Gomes IC, Codogno JS, Santos LL, Freitas Júnior IF. Associação entre massa óssea e capacidade funcional de idosos com 80 anos ou mais. *Rev Bras Ortop* 2013; 48(6):512-518.

33. Margutti KMM, Schuch NJ, Schwanke CHA. Marcadores inflamatórios, sarcopenia e seus critérios diagnósticos em idosos: uma revisão sistemática. *Rev Bras Geriatr Gerontol* 2017; 20(3):444-456.

34. Di Prampero PE, Narici MV. Muscles in micrography: from fibres to human motion. *J Biomech* 2003; 36(3):403-412.

35. Tracey KJ, Cerami A. Tumor necrosis factor: A pleiotropic cytokine and therapeutic target. *Annu Rev Med* 1994; 45(1):491-503.

36. Bradley JR. TNF- mediated inflammatory disease. *J Pathol* 2008; 214(2):149-160.

37. Penninx BW, Kritchevsky SB, Newman AB, Nicklas BJ, Simonsick EM, Rubin S, Nevitt M, Visser M, Harris T, Pahor M. Inflammatory markers and incident mobility limitation in the elderly. *J Am Geriatr Soc* 2004; 52(7):1105-1113.

38. Felicio DC, Pereira DS, Assumpção AM, Jesus-Moraleida FR, Queiroz BZ, Silva JP, Brito Rosa NM, Dias JM, Pereira LS. Inflammatory mediators, muscle and functional performance of community-dwelling elderly women. *Arch Gerontol Geriatr* 2014; 59(3):549-553.

39. McGrath RP, Ottenbacher KJ, Vincent BM, Kraemer WJ, Peterson MD. Muscle weakness and functional limitations in an ethnically diverse sample of older adults. *Ethn Health* 2020; 25(3):342-353.

40. Martin FG, Nebuloni CC, Najas MS. Correlação entre estado nutricional e força de preensão palmar em idosos. *Rev Bras Geriatr Gerontol* 2012; 15(3):493-504.

41. Pereira LC, Prestes J, Melo GF, Neto LS, Funghetto SS, Pires AB, Boff G, Alves AT, de Oliveira Karnikowski MG. A influência da composição corporal na força de homens idosos brasileiros. *Rev Bras Med Esporte* 2015; 21(3):196-199.

42. Del Duca GF, Silva MC, Hallal PC. Incapacidade funcional para atividades básicas e instrumentais da vida diária em idosos. *Rev Saude Publica* 2009; 43(5):796-805.

43. Millán-Calenti JC, Tubío J, Pita-Fernández S, González-Abraldes I, Lorenzo T, Fernández-Arruty T, Maseda A. Prevalence of functional disability in activities of daily living (ADL), instrumental activities of daily living (IADL) and associated factors, as predictors of morbidity and mortality. *Arch Gerontol Geriatr* 2010; 50(3):306-310.

44. Pereira GN, Bastos GAN, Del Duca GF, Bós AJG. Indicadores demográficos e socioeconômicos associados à incapacidade funcional em idosos. *Cad Saude Publica* 2012; 28(11):2035-2042.

45. Aires M, Paskulin LMG, Morais EP. Capacidade funcional de idosos mais velhos: estudo comparativo em três regiões do Rio Grande do Sul. *Rev Lat Am Enfermagem* 2010; 18(1):11-17.

46. Fiedler MM, Peres KG. Capacidade funcional e fatores associados em idosos do Sul do Brasil: um estudo de base populacional. *Cad Saude Publica* 2008; 24(2):409-415.

47. Brito TA, Fernandes MH, Silva Coqueiro R, Jesus CS, Freitas R. Capacidade funcional e fatores associados em idosos longevos residentes em comunidade: estudo populacional no Nordeste do Brasil. *Fisioter Pesq* 2014; 21(4):308-313.

48. Virtuoso Júnior JS, Guerra RO. Incapacidade funcional em mulheres idosas de baixa renda. *Cien Saude Colet* 2011; 16(5):2541-2548.

49. Diniz BSO, Volpe FM, Tavares AR. Nível educacional e idade no desempenho no mini-exame do estado mental em idosos residentes na comunidade. *Rev Psiq Clin* 2007; 34(1):13-17.

50. Souza RA, da Costa GD, Yamashita CH, Amendola F, Gaspar JC, Alvarenga MRM, Faccenda O, Oliveira MAC. Funcionalidade familiar de idosos com sintomas depressivos. *Rev Esc Enferm USP* 2014; 48(3):469-476.

51. Pereira DS, Queiroz BZ, Miranda AS, Rocha NP, Felício DC, Mateo EC, Favero M, Coelho FM, Jesus-Moraleida F, Gomes Pereira DA, Teixeira AL, Máximo Pereira LS. Effects of physical exercise on plasma levels of brain-derived neurotrophic factor and depressive symptoms in elderly women--a randomized clinical trial. *Arch Phys Med Rehabil* 2013; 94(8):1443-1450.

52. Alves LC, Leite ID, Machado CJ. Fatores associados à incapacidade funcional dos idosos no Brasil: análise multinível. *Rev Saude Publica* 2010; 44(3):468-478.

53. Aires M, Paskulin LMG, Morais EP. Capacidade funcional de idosos mais velhos: estudo comparativo em três regiões do Rio Grande do Sul. *Rev Lat Am Enfermagem* 2010; 18(1):11-17.

54. Rosa TE, Benício MH, Latorre MD, Ramos LR. Fatores determinantes da capacidade funcional entre idosos. *Rev Saude Publica* 2003; 37(1):40-48.