

Functional capacity and physical performance of community-dwelling elderly: a longitudinal study

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Abstract *This study aimed to verify the occurrence of changes in the functional capacity and physical performance of community-dwelling elderly and its determining factors over a two-year period. This is a quantitative, observational and longitudinal household survey conducted in 2014 and 2016, with the participation of 380 elderly from Uberaba, Minas Gerais. The following instruments were used: The Mini-Mental State Examination and questionnaires with sociodemographic/economic, clinical and life habits data. The functional capacity was evaluated through the Katz Index and Lawton-Brody's scale. Physical performance was verified through the Short Physical Performance Battery. A descriptive, bivariate and linear multiple regression analysis was conducted, with a significance level of $\alpha < 0.05$. The results showed reduced functional capacity for the instrumental activities of daily living and physical performance in a two-year period. The determining factors for both outcomes were age group, occupational activity, and physical activity. Schooling was a specific factor only for the instrumental activities of daily living, and gender and the number of medicines used, for physical performance.*

Key words *Elderly, Activities of daily living, People with disability, Limited mobility, Longitudinal studies*

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Introduction

The elderly contingent has become globally expressive, and the aging population is pointed out as one of the most relevant trends of the 21st century¹. The growing elderly population has been advancing in parallel with changes in the epidemiological profile marked by the increased incidence and prevalence of chronic noncommunicable diseases that occur even before the onset of old age².

According to the theoretical conceptual models, diseases can contribute to the onset of disability and functional limitations^{3,4}. However, other factors such as physical, environmental, socioeconomic, genetic and lifestyle habits are known to affect the elderly's functions, making them reliant on family, community and the health system⁵.

The belief that dependence is inherent to the aging process produces negative attitudes and intimidates the elderly population within a socio-cultural context that values the preservation of autonomy and independence⁶. Thus, the identification of functional disabilities and limitations, as well as their determinants are highlighted in the literature⁷⁻¹⁰, as they provide information to propose prevention and intervention measures for the functional status of the elderly.

Functional capacity is usually assessed through questionnaires of the elderly's or their caregiver/family's report on the performance of daily living activities¹¹, and the physical performance related to functional limitations is investigated through physical tests where individuals perform specific tasks, which confers greater responsiveness to relevant clinical changes¹².

No longitudinal studies that identified the occurrence of changes in functional capacity and physical performance of community-dwelling elderly concurrently were found, but only investigations on functional capacity^{7,9,13}. According to Pinheiro *et al.*¹⁴, information on the functional health of community-dwelling elderly based on direct measures (physical tests) is still scarce.

National scientific production focuses on predominantly cross-sectional studies^{5,14,15}, which are essential for practice but prevent a causal analysis¹⁶. Thus, the longitudinal design can overcome this limitation, besides reducing harm to the elderly population through the elaboration of more effective strategies¹⁵.

Considering the context of population aging and the relevance of longitudinal studies for the planning and implementation of actions aimed

at the functional status of the elderly population, this study aimed to verify the occurrence of changes in the functional capacity and physical performance of community-dwelling elderly and their determinants over a period of two years.

Methods

This is a quantitative, observational and longitudinal household survey with community-dwelling elderly residents in Uberaba, Minas Gerais, Brazil. Data were collected in 2014 (from January to April) and 2016 (from March to July) and are part of a project developed by the Public Health Research Group of the Federal University of the Triângulo Mineiro (UFTM).

The study population was determined by multi-stage cluster sampling. The elderly were selected through systematic sampling, where the first stage was based on a random draw of 50% of the census tracts of the municipality, with a single listing of the tracts and identification of the respective neighborhood¹⁷. Thus, 204 tracts were selected from 409 tracts in 2014.

The first census tract was randomly drawn, and the others were selected by sampling interval (SI), which was obtained through the formula: $SI = \text{total number of census tracts} / \text{number of census tracts drawn}$ ¹⁷. In 2014, of the 816 eligible elderly, 87 were lost and were related to incomplete tracts, leaving out 729 individuals. In 2016, for recomposition, the random draw considered 415 sectors, totaling 769 older adults, of which 613 completed the whole interview (154 were excluded due to cognitive decline in the Mini-Mental State Examination, one address was not found, and one elderly was duplicated). Of the 613, only 380 were the same elderly as in 2014.

The study included individuals aged 60 years and older residing in the urban area of Uberaba who participated in the data collection in 2014 and 2016. Elderly who were institutionalized or hospitalized and who had a cognitive decline in the Mini-Mental State Examination (MMSE), per schooling criteria¹⁸ were excluded to minimize self-reporting interferences and difficulties of understanding to answer the questionnaires and performing the physical tests.

Data collection was supported by interviewers from the UFTM Public Health Research Group, who received training and guidance. After applying the MMSE, the elderly answered a structured instrument prepared by the research group containing the following sociodemo-

graphic, economic and clinical data: gender (male, female), age group (60|–80 years, 80 years and over), marital status (never married or lived with a partner; living with spouse or partner; widowed; separated; divorced), years of schooling (0; 1|–5; 5|–9; 9|–12, more than 12), retirement (yes, no), professional activity (yes, no), monthly income in minimum wages (no income; < 1; 1; 1–|3; 3–|5; more than 5), drugs of continuous use and self-reported morbidities (total number).

The question “Have you been hospitalized in the last 12 months?” (yes, no)¹⁹ was used to identify the occurrence of hospitalization in the last year and the extended version of the International Physical Activity Questionnaire (IPAQ)²⁰ was employed to investigate physical activity, by which the elderly were classified as active (≥ 150 minutes/week) or inactive (< 150 minutes/week)²¹.

The functional capacity (dependent variable) for basic (BADL) and instrumental activities of daily living (IADL) were evaluated, respectively, by the Katz Index and Lawton-Brody Scale. The BADL instrument was adapted in Brazil by Lino et al.²² and encompasses six areas of functioning related to self-care that have three response options, depending on the level of dependence to perform the activities²², and the total number of BADL that the elderly could not perform (dependent) was adopted in this study. The IADL scale has a reliability analysis and is adapted to the Brazilian reality²³. It evaluates performance in seven activities, and a total score ranging from 7 to 21 points, where the highest scores denote better functional capacity²³, is considered for the study.

The Short Physical Performance Battery (SPPB) was used to evaluate the physical performance (dependent variable), duly translated and adapted for Brazil²⁴, with three realms: balance, gait speed, and lower limb strength. This study considered the total score ranging from 0 to 12 points, where the highest score denotes the best physical performance²⁴.

Data were double-entered in the Microsoft Office Excel® program and submitted for analysis in the Statistical Package for Social Sciences (SPSS) software version 20.0. We used descriptive statistics that included absolute and relative frequencies, measures of central tendency (mean) and variability (standard deviation and amplitudes). We employed the t-test for dependent samples to identify changes in functional capacity for BADL (total number of activities that could not be performed) and IADL (total score),

and physical performance (total score) in the follow-up period.

In the bivariate analysis, the t-test for independent samples was used to verify the influence of the 2014 categorical variables (gender, age, schooling, professional activity, hospitalization in the last 12 months and practice of physical activity) on functional capacity and physical performance in 2016. The influence of the 2014 quantitative variables (number of medicines used and self-reported morbidities) on the 2016 outcomes was verified with Pearson’s Correlation Coefficient.

The independent variables (gender, age group, schooling, occupational activity, hospitalization in the last 12 months, number of medicines used and self-reported morbidities and physical activity) associated with functional capacity and physical performance were later inserted into the multiple linear regression model. The significance level was set at $\alpha < 0.05$ for all the tests.

A power analysis was performed for multiple linear regression with eight predictors, in the Power Analysis and Sample Size (PASS) application, version 13. To this end, a determination coefficient of $R^2 = 0.25$, a level of significance or type I error of $\alpha < 0.05$ and sample size of 380 elderly were considered, which allowed the achievement of sufficient statistical power for the inferences of the regression analyses (99%).

The Health Research Ethics Committee of the UFTM approved the research. The study was conducted after the consent of the elderly who signed the Informed Consent Form.

Results

Of the 380 elderly people who participated in both collections, 65.8% ($n = 250$) were women and 34.2% ($n = 130$) were men. In the two evaluations, elderly in the of 60|–80 years’ age group, who lived with a spouse or partner, had 1|–5 schooling years and were retired, but exercised some occupational activity prevailed. Only individual monthly income in minimum wages showed a small variation from 2014 to 2016, with the prevalence of one minimum wage (43.7%) and 1–|3 minimum wages (41.3%), respectively.

Concerning changes in the functional capacity and physical performance in the follow-up period, the paired t-test for dependent samples showed a statistically significant decrease in the scores of the Lawton and Brody Scale ($p < 0.001$)

and the SPPB ($p = 0.001$), indicating worse functional capacity and physical performance, respectively. There was a slight increase in the mean number of BADL that the elderly could not perform, but no statistically significant difference was found ($p = 0.78$) (Table 1).

Regarding the determinants for decreased functional capacity in the IADL, the bivariate analysis showed a statistically significant association for the elderly aged 80 and over ($p < 0.001$), who did not study ($p < 0.001$) without occupational activity ($p < 0.001$) and were inactive ($p < 0.001$) in 2014, that is, they showed lower means in the IADL in 2016, developing towards higher dependence. Pearson's Coefficient of Correlation showed that the elderly who used fewer medicines in 2014 had higher means for IADL in 2016 ($r = -0.15$; $p = 0.004$).

When the bivariate analysis considered the declining physical performance in 2016, it was possible to identify a statistically significant association for elderly who were 80 years old or older ($p < 0.001$) and were inactive ($p < 0.001$) in 2014. Elderly with a lower number of morbidities ($r = -0.15$; $p = 0.003$) and lower number of medicines used ($r = -0.28$; $p < 0.001$) in 2014 had the highest mean physical performance in 2016, according to Pearson's Correlation Coefficient.

Table 1. Changes in functional capacity (BADL and IADL) and physical performance over a two-year period – Uberaba, Minas Gerais, 2014 and 2016.

Variable	2014	2016	p
Basic Activities of Daily Living			
Mean	0.06	0.07	0.78
Standard deviation	0.44	0.41	
Minimum	0	0	
Maximum	6	5	
Instrumental Activities of Daily Living			
Mean	18.91	18.32	< 0.001
Standard deviation	2.80	2.85	
Minimum	7	8	
Maximum	21	21	
Physical performance			
Mean	8.46	8.01	0.001
Standard deviation	2.68	2.80	
Minimum	0	0	
Maximum	12	12	

Source: Authors, 2017.

The variables previously used in the bivariate analysis were included in the final multiple linear regression model to identify the determinant factors for lower functional capacity in the IADL and physical performance, according to the established criterion of $\alpha < 0.05$. Table 2 shows that decreased functional capacity for IADL in 2016 was associated with the following 2014 variables: physical activity ($\beta = -0.21$, $p < 0.001$), schooling ($\beta = -0.21$, $p < 0.001$), professional activity ($\beta = -0.22$, $p < 0.001$) and age group ($\beta = -0.25$, $p < 0.001$).

According to Table 3, the 2014 variables that were associated with the declining physical performance in 2016 were: occupational activity ($\beta = -0.16$, $p = 0.01$), gender ($\beta = -0.19$; $p = 0.003$), number of medicines used ($\beta = -0.23$, $p < 0.001$), physical activity ($\beta = -0.24$, $p < 0.001$) and age group ($\beta = -0.24$, $p < 0.001$).

Discussion

This study revealed that a decreased functional capacity in the IADL and physical performance of the community-dwelling elderly was observed over a two-year period. Furthermore, it reinforced the multifactorial nature of the process of functional disabilities and limitations in identifying the influence of sociodemographic, clinical, and life habits determinants.

Lower functional capacity for IADL was noted in the period studied, but there was no significant change in BADL. The finding corroborates longitudinal studies carried out in Belo Horizonte-MG⁷ and Botucatu-SP¹³. Similarly, cross-sectional investigations have identified a higher prevalence of disability for IADL^{15,16}. The greater dependence for IADL can be justified by the hierarchy existing between activities of daily living, where losses occur first in the IADL, which are more complicated, and later affect the BADL²⁵.

Furthermore, impaired IADL may have also occurred due to the relationship between these activities and the level of schooling²⁶, which was considered low among the elderly in this study (1|–5 years). Learning opportunities contribute to the development of the skills and confidence required to achieve healthy aging²⁷, with the maintenance of the IADL, which, when compromised, may adversely affect the autonomy and social life of the elderly, as well as of relatives, who will start to provide care to and channel financial resources to meet the demands of the dependent individual²⁶.

Table 2. Multiple linear regression final model for the 2014 variables associated with functional capacity (IADL) in 2016 - Uberaba, Minas Gerais, 2014 and 2016.

Variable in 2014	β	p
Gender	-0.09	0.15
Age group	-0.25	< 0.001
Schooling	-0.21	< 0.001
Professional activity	-0.22	< 0.001
Hospitalization	0.03	0.46
Physical activity	-0.21	< 0.001
Number of morbidities	-0.03	0.63
Number of medicines	-0.10	0.08

Source: Authors, 2017.

Table 3. Multiple linear regression final model for the 2014 variables associated with physical performance in 2016 - Uberaba, Minas Gerais, 2014 and 2016.

Variable in 2014	β	p
Gender	-0.19	0.003
Age group	-0.24	< 0.001
Schooling	-0.03	0.47
Professional activity	-0.16	0.01
Hospitalization	-0.02	0.72
Physical activity	-0.24	< 0.001
Number of morbidities	0.01	0.89
Number of medicines	-0.23	< 0.001

Source: Authors, 2017.

Similar to the IADL, physical performance declined. No national longitudinal studies with community-dwelling seniors were identified for comparison. However, research developed in an Interdisciplinary Home Care Center showed that over a year, the elderly had a lower physical performance assessed by the SPPB²⁸, in contrast to the findings of this research.

The accumulation of various cellular and molecular damages at the biological level causes gradual depletion in the physiological reserves and, consequently, a general decline in the intrinsic capacity of the elderly²⁹, and can affect the physical performance. However, it should be pointed out that, although many older adults are living with reduced function, the development of this condition is specific to each individual and may occur progressively, distributed over the years, or swing between partial or total recovery²⁹.

The final multiple linear regression model showed that age, professional activity and physical activity were determining factors for both outcomes. Schooling was related only to the functional capacity for the IADL, and gender and the number of medicines used were related to physical performance.

The relationship between age and IADL corroborates a longitudinal study with community-dwelling elderly¹³ and cross-sectional studies in southern Brazil^{15,16}. Regarding physical performance, the literature shows that older elderly have worse results in physical tests^{14,30}. Although chronological age is not a precise marker for changes in senescence⁷, it should be noted that physical function decreases over the years and may have negative consequences for the elderly, such as impaired mobility, social isolation, decreased quality of life and disabilities that require specialized services³¹.

The professional activity was also related to the two outcomes. A study carried out in Belo Horizonte-MG showed that the elderly who worked were 2.5 times more likely to increase their independence in the IADL⁷, confirming the association of this study. We found no national surveys showing the influence of occupational activity on physical performance, but it is suggested that both outcomes may benefit from professional exercise, as according to D'Orsi et al.³², besides being a complex executive function that keeps the elderly active, it also has a protective effect through social support mechanisms, similar to the relationship with friends, that is, living with other people allows cooperation and interaction relationships.

Physical activity was also significantly associated with a decreased functional capacity for IADL and physical performance. Concerning the IADL, the finding is confirmed in other studies conducted with community-dwelling English³³ and Colombian³¹ elderly. The influence on physical performance agrees with a longitudinal study in Italy, which highlights the relevance of developing public health strategies aimed at maintaining the levels of physical activity in the active elderly and encouraging this practice among the inactive ones³⁴.

Schooling was related to lower functional capacity for IADL, as found in an epidemiological survey¹⁶, but it differed partially from a study carried out in Bagé (RS), which found an association between low educational level and a higher probability of developing functional disability for both IADL and BADL¹⁵. However, as already

stated, it is believed that the relationship between schooling and IADL is more expressive since these activities require more intellectual aspects for its implementation¹⁶.

Gender and number of medicines were determinants for reduced physical performance. The influence of gender agrees with studies carried out in communities in the Northeast¹⁴ and South of Brazil³⁰, where women evidenced greater functional limitation in the performance tests. The higher life expectancy that exposes women to the risk of developing incapacitating chronic diseases²⁷ and the vulnerability to discrimination that reflects in access to work, health care, and income distribution¹ can contribute to an intergender gap, requiring specific care and actions for this segment of the population.

Concerning the association between the number of lifelong use medicines by the elderly and lower physical performance, studies carried out in Spain with elderly in primary care centers¹⁰ and in Brazil in a group of elderly³⁵ also confirmed this association, which is still poorly explored in the literature. Health professionals should be knowledgeable about patterns of use, prescription, drug interactions, and clinical implications that may adversely affect performance components, such as mobility and balance³⁵.

Among the limitations of the present study are the scarcity of longitudinal studies at the national level on the functional capacity and physical performance of the community elderly concomitantly, which hinders the comparison of findings. Another aspect that requires attention in the interpretation, comparison and generalization of the results is the existence of various concepts and instruments used in the studies to identify the functional disabilities and limitations.

Although longitudinal studies with lower follow-up time⁷ or similar to this study have been

identified¹³, another limitation is the follow-up period (two years), which was short when compared to other studies^{8,33}. Regardless of this issue, the results of this study point to the relevance of the evaluation, follow-up, and identification of functional capacity and physical performance determinants, since the elderly evidenced losses over a short period. It is hoped that these findings will contribute to the promotion of independent aging by directing preventive measures to the functional state of the elderly considering the identified determinants and, mainly, to provide supporting elements for new investigations.

Conclusion

This study showed that the two evaluations revealed a predominance of female elderly in the 60|–80 age group living with a spouse or partner, with 1|–5 years of schooling, retired, with a professional activity and income of one minimum wage in 2014 and 1–|3 in 2016.

In two years, we found that the elderly had a declining functional capacity to perform the IADL and lower physical performance, and age group, professional activity, and physical activity have been identified as determinants common to the outcomes. Schooling was a specific factor only for functional capacity in IADL, and gender and number of medicines used, for physical performance.

The change in both functional capacity and physical performance alerts us to the relevance of early identification and follow-up of cases, and mainly of proposing interventions based on the identified factors, to prevent the onset and deterioration of incapacitating conditions that cause biopsychosocial harm to the elderly, health system expenditure, and household and community overload.

Collaborations

EM Ikegami participated in all stages of research and writing of the article. LA Souza contributed to the interpretation of the data and critical review of the article. DMS Tavares contributed to the critical review and final approval of the article. LR Rodrigues guided the development of the research and contributed to the critical review and final approval of the article.

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