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Incidence and predictive factors of falls in community-dwelling elderly: a longitudinal study

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Abstract *This study aimed to estimate the incidence of falls among the elderly and to determine the predictive factors of falls and recurrent falls. This is a longitudinal study (2014-2016) conducted with 345 elderly in the urban area of Uberaba -MG. A structured tool related to socioeconomic data and occurrence of falls, Katz and Lawton -Brody Scales, the Short Physical Performance Battery (SPPB) and Falls Efficacy Scale-International (FES-I) Brazil were used. The multinomial logistic regression analysis was performed ($p < 0.05$). The incidence of falls in the follow-up period was 37.1%, with 20% recurrent falls and 17.1% single-event falls. The final model showed that the increase in one SPPB unit decreased by approximately 15% and 17%, respectively, the probability of falls and recurrent falls. The highest FES-I Brazil score was associated with a higher occurrence of recurrent falls. The results found on the occurrence of falls and recurrent falls and their association with worse physical performance and fear of falling provide subsidies for actions directed to the monitoring and control of the interfering factors.*

Key words *Elderly, Fall accidents, Risk factors, Psychomotor performance, Primary health care*

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Introduction

Population ageing is widespread in several regions of the world, including Brazil, which results from declining fertility and mortality over the years. Thus, change in the age structure of the Brazilian population entails a change in the epidemiological profile, with the prevalence of chronic degenerative diseases[1].

The occurrence of chronic degenerative diseases tends to aggravate the structural and functional losses inherent to senescence, which may contribute to an increased risk of falls, an event of concern for this population[2].

Falling is understood as "unintentional contact with the support surface, resulting from the change of position of the individual to a level lower than his initial position, without there being an intrinsic determining factor or unavoidable accident and without loss of consciousness"[3].

In a survey of elderly people living in Omaha, Nebraska, the incidence of falls was 59% in women and 71% in men[4]. A systematic review study identified that the incidence of falls in Chinese elderly ranged from 14.7% to 34% per year[5].

It should be emphasized that there are still few studies available in the Brazilian elderly population on this subject. Available national surveys were conducted with specific populations, such as hospitalized elderly[6] and with a cross-sectional design[7,8].

The occurrence of falls is related to multifactorial, intrinsic or extrinsic circumstances that act on the instability, such as gender, advanced age, comorbidities, especially musculoskeletal diseases[7], depression, low self-efficacy to avoid falls[8], uneven surfaces, slippery floor, inadequate lighting and ladder without handrail[2]. In relation to the factors mentioned above, we observed that the extrinsic ones are often related to a single fall. On the other hand, intrinsic factors, which are the focus of this paper and are related to individual's own characteristics, such as physiological changes resulting from ageing, morbidities and use of medications are associated with recurrent falls[1]. The increased occurrence of falls among the elderly can lead to impairment in elderly health and negative impact on the quality of life, in addition to fear of further falls, which can gradually result in dependency conditions, social isolation, progressive loss of functional capacity and recurrent new falls[9,10].

It is essential to consider physical issues in addition to behavioral changes, since the elderly person who suffers a fall is more likely to have fractures, sprains and injuries, which end up burdening social and health services when they do not result in death[9,11].

Considering the shortage of longitudinal studies and the need to understand better the predictive factors of falls in the elderly, this study aimed to estimate the incidence of falls among elderly in the community and to determine the predictive factors of falls and recurrent falls.

Methods

This is a quantitative, observational and longitudinal survey conducted with elderly residents in the urban area of Uberaba-MG. Baseline data was collected from January to April 2014, and follow-up occurred from April to July 2016.

For the baseline, sample size calculation considered a prevalence of falls of 33.3%[12], an accuracy of 3.4% and a confidence interval of 95% for a finite population of 36,703 elderly residents of the urban area of Uberaba-MG, reaching a sample of 724 subjects.

We used a multi-stage sampling by conglomerate to define the population of the urban area. In the first stage, 50% of the census tracts of the municipality were arbitrarily drawn by means of systematic sampling, organizing a single listing of tracts, but identifying the district to which they belong. The number of urban census tracts in the city of Uberaba-MG is 409, of which 204 were selected. The sampling interval (SI) was calculated using the following formula: SI = Ncs/ncs; where Ncs is the total number of census tracts and ncs the number of census tracts drawn (IA ≈ 2). The first census tract was randomly drawn and the others according to SI. The listing of the sectors was sorted in ascending numerical order, for draw purposes.

In the second stage, the number of elderly people to be interviewed according to a sample calculation (724) was divided by the number of census tracts drawn in the first stage (204), obtaining the value of 3.55 elderly people, rounded up to four elderly per census tract. In this context, considering the sample calculation, 204 census tracts and 4 people per tract, we started with a sample of 816 elderly.

The sample consisted of individuals who met the following inclusion criteria: age equal to or greater than 60 years, resident in the urban area (community); participation in the two stages (2014 and 2016); have no cognitive decline; abi-

lity to walk, allowed to use a walking aid device (cane, crutch or walker) and agree to participate in the research by signing the Informed Consent Form. Exclusion criteria were: elderly not found after three attempts by the interviewer; change of city, hospitalized and with neurological diseases that hinder evaluations.

Therefore, for the baseline (2014), when considering the study criteria and losses (those who did not complete all the tests and tracts without elderly, homes and that did not complete the number of elderly), 705 elderly were interviewed.

For follow-up (2016), all the elderly people who participated in the first stage of the research (n = 705) in their respective households were contacted. Considering the sample and study criteria and losses (40 refusals, 42 deaths, 85 with cognitive decline, 62 not found after three visits, 53 changed address, 10 were hospitalized, 68 for other reasons – such as address not found and incomplete data for the tests); this investigation considered 345 elderly people in both stages (2014 and 2016).

At the expense of possible difficulties in reading or understanding the items described in the collection tools and visual problems shown, the interview was performed in the presence of the elderly (face to face). Data were collected at the respective homes of the elderly, in a single moment, making two stages: the first one to obtain data through interview, and the second consisting of anthropometric evaluation and physical performance tests.

To this end, interviewers (undergraduate and graduate students) were selected and received training, qualification and approach to ethical issues related to the research. Meetings between field supervisors (faculty), undergraduate and graduate students were held periodically for guidance and resolution of possible difficulties.

Initially, cognitive evaluation was performed through the Mini Mental State Examination (MMSE), translated and validated for Brazil[11]. The cutoff point for cognitive decline considered the level of education of the respondent, corresponding to 13 points for illiterates, 18 points or less for those with 1-11 years of schooling and 26 points for schooling over 11 years[13].

A structured tool to characterize sociodemographic and economic data, self-reported morbidities, hospitalization in the last year and self-perceived health was used.

Functional capacity was evaluated through the activities of daily living. The Katz Index of Independence in Activities of Daily Living adapted to the Brazilian reality was used[14] for the basic activities of daily living (BADL). This scale consists of six items: bathing, dressing, toilet use, transfer, sphincter control and feeding, which measure people's performance in self-care activities[14]. Instrumental activities of daily living (IADL) were evaluated through the Lawton and Brody Scale (1969), adapted for Brazil[15]. This scale consists of seven items: using the telephone, traveling, shopping, preparing meals, doing housework, using medicines and handling money; with a score ranging from 7 to 21 points[15]. Functional disability was considered when the elderly had one or more partial and/or total dependence for both BADL and IADL[16].

The physical performance of lower limbs was evaluated by the Brazilian version of the Short Physical Performance Battery (SPPB). Its adaptation to the Brazilian culture resulted in a version with adequate comprehensibility, for both evaluators and the elderly, and was shown to be an easy and quickly manageable tool[17]. The total SPPB score is obtained by adding the scores of each test (balance, gait speed, and chair sit-and-stand up). The score ranges from zero (worst performance) to 12 points (best performance)[17]. SBBP score of 0-3 points represents disability or very poor performance; 4-6 points, low performance; 7-9 points, moderate performance and 10-12 points, good performance[17].

The fear of falls syndrome was evaluated through Falls Efficacy Scale-International-Brazil (FES-I Brazil), which is a scale adapted and validated by Camargos[18] and shows questions about the concern with the possibility of falling when performing 16 activities, with respective scores of 1 to 4[19]. The total score is calculated by the sum of the values obtained in each item and can vary from 16 to 64; the lowest value corresponds to the lack of concern with the possibility of falling, and the greater value, an extreme concern with falls[19].

The occurrence of falls and the number of times the elderly mentioned falls were verified from two questions belonging to the tool elaborated by Schiavetto[20].

The following variables were used for this study: socioeconomic, demographic: gender (male and female); age range, in years (60|-75, 75 and over); years of schooling; household arrangement (living alone and with someone); number of morbidities and medications; perceived health: very bad/poor/fair (negative) and good/excellent (positive); hospitalization in the last twelve months: yes and no; functional capacity

in BADL and IADL: dependent and independent; falls: 0 (absence), 1 (occurrence of 1 event) and 2 or more (recurrent falls); fear of falling and lower limb physical performance: continuously operationalized.

A spreadsheet was created for data storage through Microsoft Office 2007 Excel®. Data collected were double entered by two people, for later verification of inconsistencies. Researchers solved any discrepancy by resuming the original interview to perform the relevant corrections. This database was imported for analysis into the software "Statistical Package for Social Sciences" (SPSS) version 17.0.

Initially, the incidence rate was calculated, and to characterize the population, a statistical analysis by means of absolute and percentage frequency distributions for the categorical variables, and centrality (mean) and dispersion (standard deviation) measurements for the quantitative variables was performed.

The bivariate and multivariate analyses were carried out using multinomial logistic regression to verify the association between the exploratory variables and the dependent variable (lack of falls, one fall and recurrent falls). The variables of interest according to the established criteria ($p < 0.10$) were included in the multivariate regression model. The predictive factors associated with falls and recurrent falls were identified using odds ratios estimates, by means of the multinomial logistic regression model, considering a significance level of 5% ($p < 0.05$) and a range of confidence interval (CI) of 95%.

The project was approved by the Human Research Ethics Committee of the Federal University of the Triângulo Mineiro (UFTM) and followed the ethical principles in Resolution no. 466/12 of the National Health Council. Subjects were invited to participate and socialize information about the nature and objectives of the research. The study was conducted following the respondent's consent and signing the Informed Consent Form.

Results

Among the 345 elderly interviewed in 2014, most were female, aged 60 ⊬5 years and lived with someone. Table 1 shows the distribution of socioeconomic, clinical and health variables according to the occurrence of falls in the baseline.

During the follow-up period (2014-2016), 20% (n = 69) of the elderly had recurrent falls, 17.1% (n = 59) a single event and 62.9% (217) no falls.

According to the established criterion ($p < 0.10$) for the selection of the variables in the bivariate analysis, gender, age, perceived health, number of diseases and medications, hospitalization in the last year, total score of FES-I Brazil and SPPB and functional disability for ADL and IADL (Table 2) were submitted to the multivariate regression model.

The final multinomial logistic regression model revealed predictive factors for falls (total SPPB score) and recurrent falls (FES-I Brazil and SPPB total score) in the follow-up period (2014-2016). The results indicated that the increase in one unit of SPPB decreased by approximately 15% and 17%, respectively, the probability of falls and recurrent falls among the elderly. Regarding FES-I Brazil, a higher score was associated with a higher occurrence of recurrent falls (Table 3).

Discussion

This study showed that improved lower limb performance reduced the probability of falls and recurrent falls during follow-up. In addition, a higher FES-I Brazil score was associated with a higher occurrence of recurrent falls. The results regarding the incidence of falls were lower than the study performed in the city of Omaha (62.5%)[4]. Similarly, research conducted in a different context of the present study, in a hospital, found an incidence of 12.6 per 1,000 patients/day (overall survival=42.0%) among elderly hospitalized patients[6].

Among the longitudinal studies identified, none showed separately the incidence of falls (once in 12 months) and recurrent falls (two or more)[4-6], which facilitated comparison of results of this study. However, this study evidenced higher incidence of recurrent falls. The occurrence of one -off falls is attributed mainly to extrinsic factors, whereas recurrent falls occur due to intrinsic factors, accompanied by environmental risk[21].

From the results found, it is necessary to articulate among the multiprofessional health teams at all levels of care, especially primary care, in order to detect elderly with potential risks of falls and with a previous history and to minimize its occurrence. This will avoid the need for emergency medium and high complexity procedures in hospital units.

In addition, teams are trained for this evaluation, since there is a concern about the difficul-

Table 1. Distribution of socioeconomic, clinical and health variables according to the occurrence of falls in the baseline. Uberaba, Minas Gerais, Brazil, 2014 (n = 345).

Variables	Occurrence of falls (2014)			Total
	0	1	≥2	
	n (%)	n (%)	n (%)	n (%)
Gender				
Male	103(38.9)	7(20.0)	10(22.2)	120(34.8)
Female	162(61.1)	28 (80.0)	35 (77.8)	225(65.2)
Age group (in years)				
60 ⊦75	196(74.0)	22(62.9)	27(60.0)	245(71.0)
75 and over	69(26.0)	13(37.1)	18(40.0)	100(29.0)
Schooling (in years) (mean ± sd)	4.63 ± 3.8	5.2 ± 5.8	3.98 ± 3.9	4.61 ± 4.1
Household arrangement				
Living alone	50(18.9)	10(28.6)	12(26.7)	72(20.9)
Living with someone	215(81.1)	25(71.4)	33(73.3)	273(79.1)
Perceived health				
Positive	121(45.7)	14(40.0)	15(33.3)	150(43.5)
Negative	144(54.3)	21(60.0)	30(66.7)	195(56.5)
Number of diseases (mean ± sd)	5.52 ± 3.5	6.88 ± 4.4	6.37 ± 2.9	5.76 ± 3.5
Number of medications mean ± sd)	3.23 ± 2.6	3.77 ± 3.0	3.24 ± 2.2	3.28 ± 2.6
Hospitalization in the last year				
Yes	40(15.1)	8(22.9)	6(13.3)	54(15.7)
No	225(84.9)	27(77.1)	39(86.7)	291(84.3)
FES-I Brazil (total score) (mean ± sd)	23.09 ± 9.5	30.03 ± 15.5	36.04 ± 14.6	25.48 ± 11.9
SPPB (total score) (mean ± sd)	9.14 ± 2.1	7.91 ± 2.7	7.64 ± 2.6	8.82 ± 2.3
Dependence for BADL				
Yes	43(16.2)	11(31.4)	7(15.6)	61(17.7)
No	222(83.8)	24(68.6)	38(84.4)	284(82.3)
Dependence for IADL				
Yes	133(50.2)	23(65.7)	29(64.4)	185(53.6)
No	132(49.8)	12(34.3)	16(35.6)	160(46.4)

sd: standard deviation; FES-I Brazil: Falls Efficacy Scale - International in Brazilian elderly; SPPB: Short Physical Performance Battery; BADL: Basic activities of daily living; IADL: Instrumental activities of daily living.

ty of the elderly to report the occurrence of falls over a period of 12 months, especially those that did not cause injuries[22], and professionals should understand this event as a problem to be prevented and that can cause impacts that go beyond the context of health[2]. Moreover, it is essential to develop prevention work involving the whole community in order to raise awareness about this recurring event among the elderly.

Another relevant challenge regarding the occurrence of falls is to identify the predictive factors for the event of interest[21]. It is important to note that there are few available studies on falls in the Brazilian elderly population that have established its incidence, as well as those that used the longitudinal design.

The results of the preliminary analysis are consistent with other studies that showed that a single fall is associated with a higher number of diseases[4], worse physical performance of lower limbs[7] and disability for ADLs[23,24]. Recurrent falls are associated with females[8,10], age 75 years and over[8], negative self-perceived health[7,10], greater number of diseases, worse physical performance of lower limbs[4,7], low self-efficacy for falls[7] and functional disability for IADL.

Better physical performance of lower limbs was a protective factor for falls and recurrent falls among the elderly, respectively ($p < 0.039$, $p < 0.14$). With regard to recurrent falls, low self-efficacy for falls remained a risk factor ($p < 0.001$).

Early identification of changes related to declining physical performance, even among younger and community-dwelling elderly, and adequate intervention are essential for the prevention of falls[25], contributing to a sustained

Table 2. Bivariate analysis for the predictive factors associated with falls and recurrent falls among elderly in the community. Uberaba, Minas Gerais, Brazil, 2014-2016 (n = 345).

Variables	Falls			Recurrent Falls		
	OR	CI95%	p*	OR	CI95%	p*
Gender						
Male		1			1	
Female	1.72	0.92-3.21	0,090	2,73	1,43-5,21	0,002
Age group (in years)						
60 ├75		1			1	
75 and over	1.22	0.64-2.32	0,541	2,19	1,24-3,86	0,007
Schooling (in years)	0.98	0.91-1.05	0,535	0,94	0,87-1,01	0,104
Household arrangement						
Living with someone		1			1	
Living alone	1.34	0.67-2.66	0,411	1,40	0,73-2,67	0,303
Perceived health						
Positive		1			1	
Negative	1.79	0.98-3.25	0,055	2,30	1,27-4,04	0,006
Number of diseases	1.15	1.05-1.24	0,001	1,15	1,06-1,24	<0,001
Number of medications	1.10	0.99-1.23	0,069	1,07	0,97-1,19	0,176
Hospitalization in the last year						
Yes	0.52	0.25-1.05	0,069	0,95	0,44-2,05	0,889
No		1			1	
FES-I Brazil (total score)	1.03	1.0-1.05	0,065	1,07	1,05-1,10	<0,001
SPPB (total score)	0.80	0.70-0.90	<0,001	0,71	0,63-0,81	<0,001
Dependence for BADL						
Yes	2.41	1.20-4.83	0,013	1,96	1,0-3,87	0,054
No		1			1	
Dependence for IADL						
Yes	1.22	0.68-2.17	0,502	2,06	1,17-3,62	0,013
No		1			1	

OR: Odds Ratio; CI: Confidence Interval; 1: Reference category; *p<0.1; FES-I Brazil: Falls Efficacy Scale - International in Brazilian elderly; SPPB: Short Physical Performance Battery; BADL: Basic activities of daily living; IADL: Instrumental activities of daily living.

independence and participation in community and social activities. A review of literature found that physical performance evaluation has been performed using different tests, such as the functional mobility test – Timed Up and Go Test (TUG), the six-minute walk test (6MWT), the Shuttle test (ST), the ergonometric test (ET) and the Short Physical Performance Battery (SPPB)[26] used in this research. Although the SPPB test is widely used, it is worth noting that few studies have used their results to understand causal relationships with recurrent falls[27].

Health professionals should be prepared to identify the elderly who are more likely to fall, especially through the application of validated protocols, as well as to plan interventions[6] and make appropriate referrals according to the specific demands of each elderly, with a view to maintaining important functions, such as physical performance.

In addition, health professionals should involve elderly caregivers in this process to facilitate the exchange of information on important issues of the elderly[28]. The family is one of the main strategies to support the elderly in the changes caused by ageing, as well as to assist them in adhering to the guidelines for falls prevention[2].

Concerning the fear of falling, a divergent result was found in a study conducted in Cuiabá -MT, where it remained a predictor of single falls only[8]. However, a study performed in Natal (RN) found a similar result to this study, in which the fear of falling (PR=1.21) remained a predictor in the final model of recurrent falls[7].

Table 3. Final multinomial logistic regression model for the predictive factors associated with falls and recurrent falls among community-dwelling elderly. Uberaba, Minas Gerais, Brazil, 2014-2016 (n = 345).

Variables	Falls			Recurrent falls		
	OR	CI95%	p*	OR	CI95%	p*
Gender						
Male		1			1	
Female	1.29	0.65-2.54	0,463	1,45	0,70-2,99	0,316
Age group (in years)						
60 ⊢5		1			1	
75 and over	1.09	0.54-2.22	0,802	1,86	02,95-3,62	0,069
Perceived health						
Positive		1			1	
Negative	1.16	0.59-2.30	0,666	1,31	0,65-2,67	0,452
Number of diseases	1.09	0.96-1.23	0,172	1,11	0,98-1,26	0,078
Number of medications	0.96	0.83-1.11	0,618	0,89	0,76-1,03	0,131
Hospitalization in the last year						
Yes	0.53	0.25-1.13	0,099	0,89	0,37-2,12	0,787
No		1			1	
FES-I Brazil (total score)	1.01	0.98-1.04	0,586	1,05	1,03-1,08	**<0,001**
SPPB (total score)	0.85	0.73-0.99	**0,039**	0,83	0,72-0,96	**0,014**
Dependence for BADL						
Yes	1.60	0.71-3.62	0,257	1,06	0,45-2,52	0,894
No		1			1	
Dependence for IADL						
Yes	0.76	0.39-1.47	0,415	1,03	0,53-2,02	0926
No		1			1	

OR: Odds Ratio; CI: Confidence Interval; 1: Reference category; *p<0.05; FES-I Brazil: Falls Efficacy Scale - International in Brazilian elderly; SPPB: Short Physical Performance Battery; BADL: Basic activities of daily living; IADL: Instrumental activities of daily living.

This fact may be justified by anxiety causing difficulties in maintaining attention to threatening and irrelevant stimuli during the performance of daily activities and, consequently, compromising the efficiency of the resources of working memory[29]. In addition, because of lower confidence in the walking ability, anxiety, feelings of helplessness, social isolation and behavioral changes that affect functional mobility promote physical dependence and even early institutionalization[30].

Thus, health professionals can facilitate the establishment of spaces that allow the development of strategies to address the issue with the elderly; the clarification of this condition and its repercussions on family members and caregivers; the intervention in relation to modifiable risk factors and the training of daily activities[31].

It is also recommended that professionals who are able to do so intervene in relation to working memory, especially the visual-spatial memory of environmental characteristics; the dynamic nature of the task, involving posture in the orthostatic position and ambulation; the (sustained and divided) attention, during the execution of tasks[29] and the practice of physical exercises, since they can increase confidence and security in walking around and improving body balance and flexibility[32].

An important limitation of this study is to have considered cognitive decline as an inclusion criterion, since this condition can interfere in the falls outcome. In addition, the fact that it was a closed population cohort prevented the size and distribution of the variables of interest from being constant throughout the follow-up.

Data allow us to conclude that the incidence of falls corresponded to 37.1% and that the better physical performance of lower limbs is associated with a lower probability of falls and recurrent falls among the elderly. In addition, the fear of falling is associated with a higher occurrence of recurrent falls.

The results of this study can contribute to increased knowledge about the predictors of falls

in the elderly, a recurrent event in this population. The findings reinforce the need for health professionals to properly assess elderly's physical performance and fear of falling.

In addition, they emphasize the importance of interdisciplinary actions involving individual and/or collective interventions that consider physical and psychological aspects, such as the fear of falling, given that this condition may lead the elderly to limit their participation in essential and desired activities.

Collaborations

AQ Souza, JS Nascimento and PB Oliveira contributed to the design, outline and writing of the paper. MS Pegorari contributed to data analysis and writing of the paper. DMS Tavares contributed to design and outline, critical review and approval of the version to be published.

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