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Validation of the Fall Risk Tracking Tool (FRRISque) in elderly community dwellers

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Abstract *This study aimed to validate of Fall Risk Tracking Tool (FRRISque) in elderly community dwellers. A cross-sectional evaluative screening study was carried out on a sample of 854 elderly. In addition to the pilot version of FRRISque, the QuickScreen® tool was applied as a standard reference in order to validate a concurrent criterion, determining sensitivity and specificity values. Most of the elderly people were female (57.6%) with an average age of 71.87 years. The multivariate logistic regression analyses showed that only 10 FRRISque items contribute to increased elderly fall risk and they refer to the risk factors of previous falls, use of a walking aid device, polypharmacy, use of psychotropic substances, difficulty to ascend and descend a slope, difficulty to walk for a distance of 100 meters, visual and hearing impairment, low physical activity and poorly lit environment. This risk stratification model assumes sensitivity values of 91.3% and specificity values of 73.4%. The FRRISque is defined as a valid, simple, low-cost and of easy and rapid application tool that can be used by all primary health care professionals, including community health workers.*

Key words *Elderly, Fall-related accidents, Risk factors, Validation studies*

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Introduction

Falls are a geriatric syndrome and can have serious consequences, compromising the health and quality of life of the elderly. In addition, it is a problem in practice in general, due to its high prevalence[1]. In Brazil, the prevalence of falls is 27.6% in elderly living in the community[2]. Fall is defined as "an unexpected event in which individuals drop to the ground or to a lower level"[3].

Falling involves intrinsic and extrinsic risk factors[4]. In a more detailed way, intrinsic and extrinsic factors can be classified into four realms: biological, socioeconomic, behavioral and environmental[5].

Biological factors include individual characteristics that are relevant to the human body and some of them are not modifiable, such as gender, age and ethnicity. They are also associated with the physiological changes and typical conditions of the elderly, such as muscle weakness, gait change, postural instability, cognitive impairment, functional limitation, visual impairment, chronic diseases and depression[4-7]. Behavioral risk factors include the use of several medications, alcohol use, sedentarism, fear of falling, use of inappropriate footwear and use of gaiters[4,5]. Socioeconomic risk factors include factors such as low income, low level of schooling, inadequate housing conditions, impaired social interaction and limited access to health[5]. Environmental factors include domestic and public environment hazards such as slippery surfaces, carpets, poor lighting, lack of support bars in bathrooms and corridors, public road with irregularities and poorly maintained[5,8].

Most elderly falls result from a complex interaction between risk factors, with impairment of the systems involved in maintaining balance[4]. Falls can have several consequences such as injuries, fractures, functional disabilities, loss of independence, institutionalization and even death[4]. While they are a serious public health problem, elderly falls are preventable, representing great possibilities for health professionals and researchers to design and implement interventions to prevent them.

However, employing such prevention strategies implies being equipped with a tool to screen or assess the risk of elderly falls. In the primary care setting, health professionals require tools that enable them to identify the risk of falls. In other words, they need a simple but consistent device that identifies older people with lower and higher risk of falls and, thus, can develop strategies for the prevention of such events in this population, in order to prioritize those at greater risk.

Although there is some consensus in specific scientific literature regarding risk factors for falls in the community, an assertive assessment of these factors in the elderly becomes relevant. The availability of a valid tool may favor their identification and the most appropriate decision-making regarding proposed interventions to prevent falls of elderly living in the community, with a view to preserving their quality of life, maintaining their security, non-institutionalization and, consequently, reducing secondary and tertiary care costs.

In view of the above, this study evaluates the validity of concurrent criteria of the Fall Risk Tracking Tool (FRRISque) in elderly people living in the community.

Methods

This is an evaluative screening study[9]. FRRISque was developed in a previous study[10,11] and assessed face, content and semantic validity[11]. Once referred to as EARQUE (Fall Risks Evaluation Scale), this tool was renamed FRRISque considering that the term tracking is the identification of people at greater risk of falls, while assessment corresponds to the identification of factors that increase the risk of a fall[12]. That is, the scale identifies people from the community with lower and higher risk of falls and can trigger a more comprehensive, detailed assessment. FRRISque involves fall-related risk factors, which are biological, behavioral, social and economic.

This study was developed in Alfenas-MG, which has a population of 79,222 inhabitants, of which 9,113 are elderly, representing 12.5% of the total population[13]. Considering that the tool was developed to be applied by health professionals, we decided to apply it at the household of the elderly enrolled in the Family Health Strategy (ESF) facilities.

The defined study population was based on the universe of elderly enrolled in the 14 ESF establishments of the urban area of Alfenas-MG. A list of the elderly enrolled in the ESF facilities enabled access to the total number of subjects per facility. Four ESF establishments were defined as the field of study because they had the largest number of elderly people – 1,826 subjects – and because it is a field of practice and teaching that is closer to the main researcher.

At first, we defined that the sample of this study would be comprised of 1,000 elderly people selected through a stratified random sampling process with proportional sharing. An additional

10% was used for losses and refusals. Nunnaly[14] states that it is not possible to say, beforehand, how many subjects are required to obtain data for validation of the items of a measuring tool. However, the author prescribes a minimum of 300 cases, preferably 1,000 or more, and warns that the result may be misleading in the statistical analysis process if there are not at least five cases per item.

The number of elderly individuals from each stratum was 334 in ESF 1 (total of 555 elderly), 293 in ESF 2 (total of 486 elderly), 255 in ESF 3 (total of 423 elderly) and 218 in ESF 4 (total of 362 elderly). Of the 1,100 elderly people randomly selected, 28 did not agree to participate in the study, 33 died, 46 changed their address and 139 presented one of the exclusion criteria, such as cognitive alterations, lower limbs fracture, total loss of vision and hip and knee arthroplasty in the last three months. Considering the achievement of a representative sample, the difficulty of recruiting field researchers and at the end of the estimated period for data collection, no new drawings were made. Thus, the final sample consisted of 854 participants.

The elderly selected for this sample had the following eligibility criteria: age 60 years or older; be aware, oriented and able to interact during the interview and to move around even if using some walking aid (walker, cane). The elderly with cognitive alterations detectable by the Mini Mental State Examination (MMSE)[15], infectious disease in the acute phase, fractures in the lower limbs or elderly patients with other medical condition that prevented tests from being performed, interaction and communication during the interview, such as severe hypoacusia, total loss of vision and hip and knee arthroplasty in the last three months were excluded from the sample.

Subjects were interviewed by field researchers through home visits from December 2015 to June 2016. These professionals were properly trained in the approach with the elderly, in the way of application of the tools and in the performance of tests. In total, 10 field researchers trained in the health area and experienced in the approach to the elderly and practice in field research, nine nurses and one pharmacist participated in the study. Throughout data collection, these researchers were submitted to calibration, that is, an adjustment in relation to the data collection technique and clarifying issues in order to avoid possible errors that could interfere in the validation of the tool.

In addition to a sociodemographic evaluation tool and the pilot version of the FRRISque, the QuickScreen® Clinical Falls Risk Assessment tool[16] was used as a standard reference in order to evaluate the validity of concurrent criteria, determining the sensitivity and specificity values. QuickScreen® includes performance testing, is reliable, has adequate external validity and can accurately predict multiple falls in the elderly, i.e. the probability of future falls increases 7% with the identification of none or one risk and 49% with the identification of six or more risks. It consists of eight items: fall history, use of medications, use of psychotropic drugs, visual acuity test, feet protective skin sensitivity test, semitandem position test, step test and sitting-standing test[16].

Descriptive analyses were performed to characterize the sample, using measures of central tendency, variability and frequency distribution. Data normality was verified by the Kolmogorov-Smirnov test.

The chi-square test (X^2) was used to verify gaps in proportions between FRRISque items and the groups obtained from the QuickScreen® application. The prevalence ratio (PR) and its respective 95% Confidence Interval (95% CI) were used as a measure of effect. Significant associations were deemed at a value of $p \leq 0.05$.

The third step consisted of multivariate logistic regression analysis to identify the association between the various items of FRRISque and the greater risk of falls in the elderly. Thus, all FRRISque variables were initially included in the multivariate analysis and, as variables were associated with QuickScreen® items ($p \leq 0.05$), they were selected for further multivariate analyses, consequently, those with a value of $p<0.05$ remained in the final model of the scale.

Finally, the precision measurements, namely, sensitivity, specificity, positive predictive value and negative predictive value were analyzed. The ROC (Receiver Operating Characteristic) curve was used to represent sensitivity and specificity values and to identify the best cutoff point. Data were analyzed in the statistical software Med Calc version 16.4.1. A significance level of 5% was considered for all analyses.

This study was submitted to the Research Ethics Committee (CEP) of the Hospital das Clínicas, Medical School of Ribeirão Preto, Brazil, and approved. After acceptance in participating in the study, participants signed or stamped their right thumb the Informed Consent Form.

Results

In total, 854 elderly individuals who met the inclusion criteria were divided into two groups according to the results of the gold standard test, the QuickScreen®, distributed as follows: elderly people who scored from 0 to 3 risk factors were allocated to Group I (control group or lower risk group) and those who scored 4 or more were allocated to Group II (case group or higher risk group). This distribution was made considering that a score of four or more in the application of QuickScreen® indicates an increased risk of falls[16].

Regarding the sociodemographic characteristics, it was observed that most of the elderly were female (492, 57.6%), with a mean age of 71.87 years (SD = 7.62), white (642, 75.1%) and married (523, 61.2%). In addition, 751 (87.9%) of the elderly lived with their relatives, 496 (58%) reported having attended up to fourth grade elementary school, 734 (85.9%) were retired and 341 (39.9%) had a household income of one minimum wage (Table 1). The prevalence of falls found in this study was 30.8%.

According to comparative analyses between groups (Table 2), there is evidence that items 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 31, 36 and 43 are related to an increased risk of falls in the elderly. On the other hand, there is evidence that items 27, 28, 32 and 40 are associated with fall protection.

Next, a multivariate analysis was performed by logistic regression, including the 27 items that achieved statistical association with the highest risk of falls in the elderly. The four items considered as fall protection factors were excluded from the model, since the tool to be validated is a fall risk assessment and not an evaluation of fall protective factors in the elderly.

Two multivariate analyzes were carried out. In the first one, the first 24 items were inserted (Table 3), considering that the Med Calc statistical software allows the introduction of a maximum of 24 variables per model analysis.

In the second model, the items that had a value of $p \leq 0.05$ in the first model and the other items 31, 36 and 43 (Table 4) were inserted. Finally, only 10 FRRISque items were found that contribute to increased risk of falls in the elderly.

FRRISque was analyzed for sensitivity and specificity by means of the Receiver Operator Characteristic (ROC) curve, constructed with the 10 items that remained in the final model after the multivariate analysis. This curve showed that the best cutoff point for differentiating elderly with lower and higher risk of falls is score three, which assumes sensitivity values of 91.3% and specificity of 73.4% (Figure 1).

Discussion

The highest percentage of female elderly in this study, representing 57.6% of the total respondents highlights the process of feminization of old age. On average, women in the Western Pacific region live longer than men[17]. This means that the female population grows faster than the male population, possibly due to a higher male mortality rate and a higher life expectancy in females[18]. According to the latest census, in Brazil, the female contingent over 60 years old rose from 2.2% in 1940 to 4.7% in 2000, and 6% in 2010[19].

Item 2 "Have you fallen in the last 12 months?" refers to the previous fall variable and is widely cited in the literature as a predictor for future fall[4-20]. People who have fallen are three times more likely to be at risk of falling again. Recurrent falls may be related to underlying causes, such as gait disorder, orthostatic hypotension or may be indicative of disease progression, for example Parkinson's disease or dementia. Alternatively, it may be a new acute problem, such as dehydration or infection[4].

Item 5 "Do you use a walking aid (walking stick, crutch or walker)?" Refers to the variable use of a walking aid device (WAD) and is an important risk factor for falls in the elderly[21,22]. Elderly in general are reluctant to use WAD, such as walking sticks and walkers because of the denial of need, fear of dependence and embarrassment[22]. Probably, elderly who use WAD have more mobility problems than those who do not use them[21,22]. Moreover, studies indicate that elderly people who use WAD are frailer and, therefore, at greater risk of falling and suffering an injury[22,23].

Another hypothesis that may explain this relation is the fact that elderly people acquire this equipment without adequate orientation, or are advised on the acquisition and use, but are not trained nor receive the proper use guidelines[23]. Such devices, when improperly adjusted or used cause an increase in energy expenditure and even changes in gait and balance, leading to the occurrence of falls[23]. It is worth mentioning that a WAD should be recommended by health professionals, preferably physiotherapists. In addition to the need for gait training, the indication of suitable equipment is required because it is adapted and

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Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Age (years)			
60 – 69	371 (43.4%)	325	46
70- 79	339 (39.7%)	245	94
80- 89	126 (14.8%)	81	45
90 and over	18 (2.1%)	7	11
Mean	71.87 (DP=7.62)		
Median	71		
Gender			
Female	492 (57.6%)	357	135
Male	362 (42.4%)	301	61
Ethnicity			
White	642 (75.1%)	501	141
Black	67 (7.8%)	47	20
Brown	135 (15.8%)	104	31
Yellow	8 (0.9%)	5	3
Indigenous	2 (0.2%)	1	1
Marital Status			
Single	57 (6.7%)	47	10
Married	523 (61.2%)	429	94
Divorced	44 (5.2%)	34	10
Widow/widower	230 (27.0%)	148	82
Housing situation			
Alone	98 (11.5%)	6970,4% RT	2929,6% RT
		10,5% CT	14,8% CT
		8,1% GT	3,4% GT
With relatives	751 (87.9%)	58577,8% RT	16622,2% RT
		88,6% CT	84,7% CT
		68,2% GT	19,5% GT
With friends	1 (0.1%)	1100,0% RT	00,0% RT
		0,2% CT	0,0% CT
		0,1% GT	0,0% GT
Other	4 (0.5%)	375,0% RT	125,0% RT
		0,5% CT	0,5% CT
		0,4% GT	0,1% GT

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adjusted to the height and distance of the elderly person's body[23].

Item 7 "Do you take four or more medications a day?" refers to polypharmacy. While there is no consensus on the definition, polypharmacy can be conceptualized as the use of more drugs than is clinically necessary[24]. In addition, the literature provides definitions that include the use of four or more drugs[25], as well as five or more drugs[26]. In this study, we chose to use the definition regarding the use of four or more drugs, considering that the item referring to polypharmacy in the gold standard test used in this study was based on the definition of four or more drugs.

Polypharmacy is a concern, especially when it comes to elderly, as they are more prone to age-related and disease-related pharmacokinetic / pharmacodynamic changes and therefore are more drug therapy-sensitive[27]. Elderly polypharmacy is associated with several negative health indicators, which include functional impairment, harmful drug interactions, adverse drug reactions, falls and health-related costs[28].

In this investigation, polypharmacy was the item with the highest association with the risk of falls. A study conducted in Canada comparing elderly people who did not fall with those who had two or more falls evidenced that the amount

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Schooling			
No schooling	140 (16.4%)	10172,1% RT 15,4% CT 11,8% GT	3927,9% RT 19,9% CT 4,6% GT
Brazilian Literacy Movement Education	28 (3.3%)	1760,7% RT 2,6% CT 2,0% GT	1139,3% RT 5,6% CT 1,3% GT
Primary School – 1st to 4th grade	496 (58%)	37775,9% RT 57,1% CT 44,0% GT	12024,1% RT 60,7% CT 14,0% GT
Primary School – 5th to 8th grade	88 (10.3%)	7686,4% RT 11,6% CT 8,9% GT	1213,6% RT 6,1% CT 1,4% GT
Full Primary School	12 (1.4%)	1191,7% RT 1,7% CT 1,3% GT	18,3% RT 0,5% CT 0,1% GT
Secondary School	48 (5.7%)	3777,1% RT 5,6% CT 4,3% GT	1122,9% RT 5,6% CT 1,3% GT
Supplementary Secondary School	3 (0.4%)	3100,0% RT 0,5% CT 0,4% GT	00,0% RT 0,0% CT 0,0% GT
Higher Education	29 (3.4%)	2793,1% RT 4,1% CT 3,2% GT	26,9% RT 1,0% CT 0,2% GT
Postgraduate	9 (1.1%)	9100,0% RT 1,4% CT 1,1% GT	00,0% RT 0,0% CT 0,0% GT
Labor market situation			
Employer	8 (0.9%)	8	0
Employed with a formal contract	12 (1.4%)	11	1
Employed without a formal contract	6 (0.7%)	5	1
Self-employed with social security	9 (1.1%)	8	1
Self-employed without social security	12 (1.4%)	12	0
Retired / Pensioner	734 (85.9%)	556	178
Unemployed	5 (0.6%)	4	1
Not working	66 (7.7%)	52	14
Other	2 (0.2%)	2	0

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of medication was associated with an increased risk of falls[29]. A household survey conducted with 729 elderly people from Uberaba-MG, Brazil also identified that polypharmacy was associated with falls (PR: 1.17; 95% CI: 0.81-1.68)[30].

Item 8 "Do you take psychotropic medications?" refers to the use of drugs that act on the central nervous system, such as antidepressants, hallucinogens and tranquilizers (anxiolytics and antipsychotics). A meta-analysis conducted in 2009 showed that the use of sedatives and hypnotics, antidepressants and benzodiazepines is associated with falls in the elderly[31]. The adjusted OR estimates were 1.39 (95% CI:0.94-2.00) for neuroleptics and antipsychotics, 1.36 (95% CI:1.13-1.76) for antidepressants and 1.41 (95%

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Household income			
Less than one minimum wage	5 (0.6%)	360,0% RT	240,0% RT
		0,5% CT	1,0% CT
		0,4% GT	0,2% GT
1 minimum wage	341 (39.9%)	25875,4% RT	8324,6% RT
		38,7% CT	42,3% CT
		29,8% GT	9,7% GT
Between 1 and 2 minimum wages	68 (7.9%)	5276,5% RT	1623,5% RT
		7,9% CT	8,2% CT
		6,1% GT	1,9% GT
2 minimum wages	272 (31.9%)	21177,6% RT	6122,4% RT
		32,1% CT	31,1% CT
		24,7% GT	7,2% GT
Between 2 and 3 minimum wages	33 (3.9%)	2781,8% RT	618,2% RT
		4,1% CT	3,1% CT
		3,2% GT	0,7% GT
3 minimum wages	74 (8.7%)	5979,7% RT	1520,3% RT
		9,0% CT	7,7% CT
		6,9% GT	1,8% GT
More than 3 minimum wages	57 (6.7%)	4782,5% RT	1017,5% RT
		7,2% CT	5,1% CT
		5,5% GT	1,2% GT
Don't know/Not informed	4 (0.4%)	125,0% RT	375,0% RT
		0,2% CT	1,5% CT
		0,1% GT	0,4% GT

CI:1.20-1.71) for benzodiazepines[31]. In this study, the prevalence ratio was 6.17 for psychotropics in general.

It should be emphasized that long half-life hypnotics and sedatives may cause significant residual sedation, especially in elderly people, due to changes in their tissue body composition, considering that there is a lower proportion of body water and greater adipose tissue, which may result in occurrence of dizziness and confusion, among other factors that predispose the occurrence of falls[32].

Item 12 "Do you have difficulty ascending or descending a slope?" relates to functional capacity and muscular strength. It is an important activity to perform the instrumental and advanced activities of daily life and reveals the person's ability to live independently or not outside his/her home[4]. Decreased muscular strength is associated with falls and increases fourfold the risk of falling (OR: 4.4, 95% CI: 1.5-10.3)[4]. Muscle weakness may arise due to sedentary lifestyle along with other debilitating chronic health conditions, such as heart failure and lung disease[4].

Like item 12, item 13 "Do you need help walking 100 meters?" relates to the ability of the elderly person mobility. This item is related to dependence in the activities of daily living and may depict the onset of elderly functional capacity decline and frailty[33].

Items 19 "Do you have visual impairment?" and 20 "Do you have difficulty hearing what other people tell you?' are related to the sensory system, one of the first systems to suffer the consequences of physiological ageing.

About 18% of elderly people living in the community over 70 years of age have some considerable visual impairment, with cataracts being the most prevalent disease, followed by glaucoma and macular degeneration[4,34]. A large part of the chain of visual processes related to body movement and spatial relationships involves the frontal magnocellular and parietal cerebral pathways, which are essential to postural control.

As a result, elderly people with visual impairments may show alterations in postural control and, thus, are more prone to falls[35]. Moreover, visual impairments, when associated with poorly

Table 2. Analysis of the association between the FRRISque items, considering both groups .

	FRRISque items	PR	CI 95%	p-value
1	Gender	1.63	1.24 - 2.13	0.0003
2	Have you fallen in the last 12 months?	2.85	2.37 - 3.42	< 0.0001
3	Have you fallen two or more times in the last 12 months?	3.42	2.38 - 4.90	< 0.0001
4	Have you had a broken hip or leg (broken bone) in the last 12 months?	4.64	2.31 - 9.30	< 0.0001
5	Do you use a walking aid (walking stick, crutch or walker)?	6.69	3.82 - 11.71	< 0.0001
6	Do you live alone?	-	0.80 - 1.86	0.34
7	Do you take four or more medications a day?	2.54	2.25 - 2.87	< 0.0001
8	Do you take psychotropic medications?	3.55	2.84 - 4.42	< 0.0001
9	Do you have feelings of loss of balance?	2.08	1.78 - 2.44	< 0.0001
10	Do you have weakness in your legs?	1.8	1.56 - 2.08	< 0.0001
11	Do you have difficulty ascending or descending the stairs?	2.2	1.88 - 2.58	< 0.0001
12	Do you have difficulty ascending or descending a slope?	2.17	1.88 - 2.51	< 0.0001
13	Do you need help walking 100 meters?	5.14	3.28 - 8.06	< 0.0001
14	Do you need help with bathing?	4.49	1.92 - 10.50	0.0002
15	Do you need help getting into or out of bed?	3.35	1.19 - 9.44	0.0015
16	Has anyone already said that you are forgetful?	1.7	1.36 - 2.13	< 0.0001
17	Is this forgetfulness getting worse in the last few months?	2.21	1.67 - 2.92	< 0.0001
18	Is this forgetfulness preventing you from carrying out some activity in your daily life?	-	0.98 - 2.36	0.057
19	Do you have visual impairment?	1.39	1.12 - 1.59	< 0.0001
20	Do you have difficulty hearing what other people tell you?	1.73	1.36 - 2.21	< 0.0001
21	Are you afraid of falling when you perform your personal care or housework?	1.59	1.38 - 1.84	< 0.0001
22	Are you afraid of falling when you perform outdoor activities?	1.68	1.48 - 1.92	< 0.0001
23	When you feel like urinating, do you need to hurry to get to the bathroom?	2.01	1.58 - 2.56	< 0.0001
24	Do you feel sad?	1.41	1.11 - 1.80	0.005
25	Have you lost interest in activities that were once enjoyable?	2.81	1.87 - 4.22	< 0.0001
26	Do you have any difficulty sleeping?	1.58	1.29 - 1.93	< 0.0001
27	Do you climb on benches or chairs to reach objects at the top of cabinets?	0.48	0.38 - 0.59	< 0.0001
28	Do you get down the stairs carrying heavy objects?	0.37	0.27 - 0.52	< 0.0001
29	Are you walking barefoot around the house?	-	0.74 - 1.57	0.6705
30	Are you walking with socks barefoot around the house?	-	0.56 - 1.98	0.8595
31	Do you exercise during the week?	1.26	1.16 - 1.37	< 0.0001
32	Do you drink alcohol?	0.52	0.36 - 0.75	0.0002
33	If necessary, can you count on the help of family members?	-	0.49 - 2.34	0.8603
34	If necessary, can you count on the help of neighbors or friends?	-	0.58 - 1.41	0.6773
35	Are there uneven floors such as loose floor tiles or broken floors?	-	0.86 - 1.45	0.3783
36	Are there smooth floors?	1.12	1.02 - 1.21	0.0167
37	Are there carpets?	-	0.85 - 1.18	0.9569
38	Are there loose wires / objects on the ground preventing free passage?	-	0.78 - 1.83	0.4123
39	Is there furniture preventing free passage?	-	0.94 - 1.56	0.1403
40	Are there grab bars in the bathroom?	0.9	0.84 - 0.97	0.0031
41	Are there grab bars in the corridors?	-	0.94 - 1.01	0.2798
42	Are there pets around the house?	-	0.81 - 1.18	0.8567
43	Is environment poorly lit (When lying down, do you have to stand up to switch on the light - switch away from the bed or difficult to see, no lamp, no hallway light on at night)?	1.36	1.08 - 1.72	0.0098
44	Are there stairs?	-	0. 85 - 1.15	0.9585

Table 3. Results of the multivariate analysis of the first model with 24 items.

EARQUE items	PR	CI 95%	p-value
1 Gender	0.90	0.53 -1.53	0.7155
2 Have you fallen in the last 12 months?	7.93	4.43 - 14.20	< 0.0001
3 Have you fallen two or more times in the last 12 months?	0.57	0.27 -1.22	0.1501
4 Have you had a broken hip or leg (broken bone) in the last 12 months?	1.54	0.57 - 4.18	0.3906
5 Do you use a walking aid (walking stick, crutch or walker)?	4.24	1.74 - 10.31	0.0014
7 Do you take four or more medications a day?	12.45	6.696 – 22.24	< 0.0001
8 Do you take psychotropic medications?	6.18	3.74 – 10.20	< 0.0001
9 Do you have feelings of loss of balance?	1.30	0.74 - 2.28	0.3460
10 Do you have weakness in your legs?	0.95	0.54 - 1.66	0.8615
11 Do you have difficulty ascending or descending the stairs?	0.62	0.23 - 1.63	0.3373
12 Do you have difficulty ascending or descending a slope?	2.93	1.10 - 7.82	0.0313
13 Do you need help walking 100 meters?	3.36	1.50 - 7.54	0.0031
14 Do you need help with bathing?	1.55	0.12 - 19.36	0.7312
15 Do you need help getting into or out of bed?	0.57	0.03 - 10.77	0.7089
16 Has anyone already said that you are forgetful?	0.88	0.50 - 1.56	0.6845
17 Is this forgetfulness getting worse in the last few months?	1.08	0.59 - 1.98	0.7952
19 Do you have visual impairment?	2.35	1.44 - 3.85	0.0006
20 Do you have difficulty hearing what other people tell you?	1.87	1.10 - 3.19	0.0198
21 Are you afraid of falling when you perform your personal care or housework?	0.86	0.38 - 1.95	0.7338
22 Are you afraid of falling when you perform outdoor activities?	1.56	0.67 - 3.61	0.2985
23 When you feel like urinating, do you need to hurry to get to the bathroom?	1.35	0.79 - 2.28	0.2621
24 Do you feel sad?	0.50	0.26 - 0.93	0.0288
25 Have you lost interest in activities that were once enjoyable?	2.22	0.97 - 5.10	0.0589
26 Do you have any difficulty sleeping?	0.92	0.57 - 1.50	0.7635

Table 4. Results of the multivariate analysis of the second model.

FRRISque items	PR	CI 95%	p-value
2 Have you fallen in the last 12 months?	7.09	4.23 - 11.86	< 0.0001
5 Do you use a walking aid (walking stick, crutch or walker)?	3.65	1.54 - 8.66	0.0033
7 Do you take four or more medications a day?	13.59	7.61 - 24.26	< 0.0001
8 Do you take psychotropic medications?	6.17	3.74 -10.18	< 0.0001
12 Do you have difficulty ascending or descending a slope?	2.20	1.35 - 3.61	0.0016
13 Do you need help walking 100 meters?	4.09	1.93 - 8.68	0.0002
19 Do you have visual impairment?	1.96	1.21- 3.18	0.0062
20 Do you have difficulty hearing what other people tell you?	2.05	1.22 - 3.43	0.0064
24 Do you feel sad?	0.74	0.44 - 1.24	0.2624
31 Do you exercise during the week?	2.54	1.43 - 4.50	0.0014
36 Are there smooth floors?	1.69	0.93 - 3.06	0.0808
43 Is environment poorly lit?	2.13	1.28 - 3.55	0.0034

lit environments, favor slips and slides on irregular surfaces[34].

In this study, elderly people who reported visual impairment are 1.96 times more likely to suffer a fall. Similar to that found, the study by Perracini and Ramos[36] shows that the predictive model of recurrent falls was composed of six variables, one of which was visual impairment (OR = 1.53, 95% CI: 1.00-2.34).

On the other hand, hearing loss is also related to falls and is one of the most prevalent chronic conditions in the elderly. When associated with

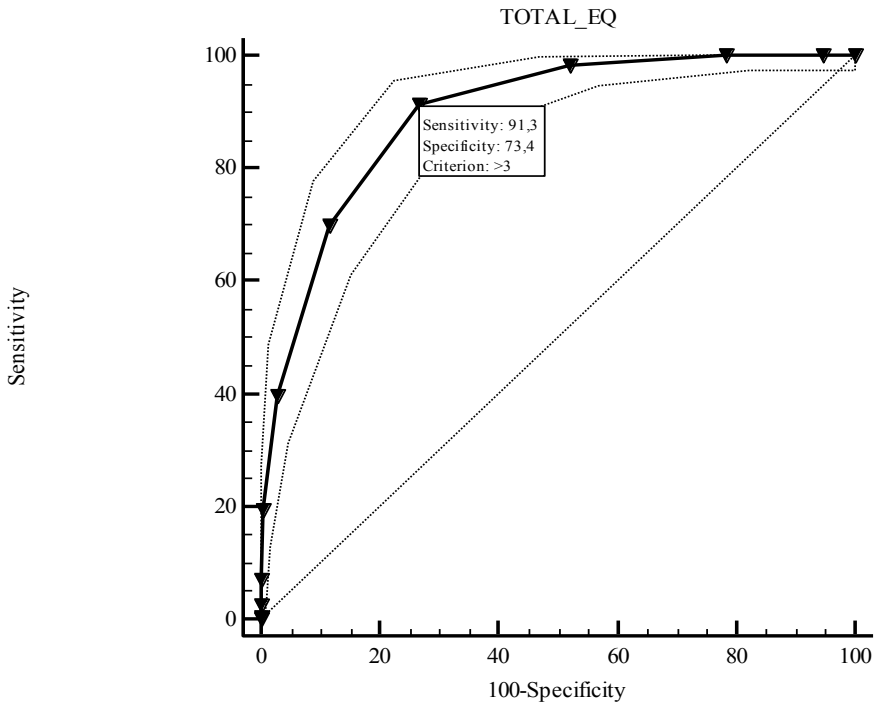

Figure 1. ROC curve constructed with the 10 items that remained in the final model after multivariate logistic regression analysis.

Source: Author's own elaboration.

the physiological ageing process, it is called presbycusis and is among the sensory deprivations with the greatest impact on the elderly's communication, since it can lead to social isolation, which compromises their quality of life[37]. Several mechanisms may explain the association between hearing loss and falls. Concomitant to the dysfunction of the cochlear system, there may be a change of the vestibular system in view of the shared location within the bony labyrinth of the ear, eventually affecting postural control. In addition, decreased auditory sensitivity may restrict perception to auditory cues necessary for environmental risk awareness[38]. A survey conducted in Finland showed that people with hearing loss were three to four times more likely to be at risk of falling compared to people with good hearing[39].

Item 31 "Do you exercise during the week?" refers to the physical exercise variable. Significant changes in muscle structure and function occur throughout the ageing process, leading to decreased muscle mass and, thus, decreased muscle strength. The causes of these muscular changes are countless and include neurological, endocrine and inflammatory aspects, as well as behavioral factors such as low performance of physical exercise[40]. Thus, physical exercise performed in a structured way and guided by a health professional plays a fundamental role in the prevention of falls and in the management of functional decline[41].

Thus, physical exercise is a fall prevention intervention widely discussed in the scientific literature. A meta-analysis by Gillespie et al.[42] showed that group physical exercise programs reduce the rate and the risk of falling (rate of 0.71; 95% CI 0.63 to 0.82 and risk rate 0.85, 95% CI: 0.76 to 0.96 versus fall rate of 0.68, 95% CI: 0.58 to 0.80 and risk rate of 0.78, 95% CI: 0.64 to 0.94).

Finally, the only environmental risk factor that remained in the final risk model for falls refers to the poorly lit environmental risk factor – item 43 "Is environment poorly lit?" Domestic environmental risk factors are considered significant for falls of elderly people living in the

community, although they may contribute to an increased risk in people with recurrent falls[43]. The "wet floor" environmental risk factor did not remain in the final model and this can be explained by the fact that older people adapt better to this risk, compensating for the risk of slipping and a probable fall. The poorly lit environment is a greater risk, especially in elderly people with visual impairment.

In short, the results of this study showed that it is possible to carry out the risk stratification of elderly people living in the community through the application of FRRISque, which contains ten items in its final version. Most of these items are risk factors for falls that are subject to interventions to eliminate or mitigate them. Thus, the identification of risk factors is an important step in the development of effective fall prevention programs for elderly community dwellers.

In order to assist health professionals in the use of FRRISque, a cutoff point was suggested for the result of its application. When analyzing the ROC curve performed with the 10 items of the last version of FRRISque, score 3 was shown as a cutoff point to differentiate the elderly people it classified. Thus, the elderly with a score of up to two points can be classified as with a lower risk for falls; those with 3 points, with moderate risk for falls; and finally, those with 4 or more points, with high risk for falls.

In the international setting and in Brazil, community elderly dwellers' fall risk evaluation, both in the context of clinical practice and in research is carried out using single-factor functional tests, mainly the Berg Balance Scale (BBS) and Timed Up and Go Test (TUGT)[44] and multifactor tests, such as Fall Risk Score[45] and most recently QuickScreen®[16].

The BBS evaluates the performance of the functional balance in 14 common items of daily life and its application requires instruments such as ladder step (or step), chair with or without arms, measuring tape, stopwatch, pen and table[44]. The TUGT evaluates mobility and balance and consists in the act of getting up from a chair, walking for three meters, turning around, going back to the chair and sitting down, measuring the time taken to perform such a task. While they are characterized as simple and low-cost tools, they require adequate materials and physical space.

The Fall Risk Score[45] tool validated for the Brazilian population showed sensitivity of 74.2% and specificity of 58.8%. It uses five items to measure the risk of falls, namely, previous falls, medications taken by the elderly, sensory impairment, mental status assessed through the MMSE and gait evaluation. The score on this scale ranges from zero to eleven points, and scores greater than or equal to three suggest that the elderly are at high risk for falls. With the use of the MMSE, about ten minutes extra time is given in its application. As mentioned earlier, QuickScreen®[16] involves performance testing, which requires extra time in its application and proper materials.

In view of the above, FRRISque appears as a promising tool in view of its psychometric properties and its easy and quick applicability in the clinic. Health professionals' choice of FRRISque as a tool to track the risk of falls in the elderly community dwellers to the detriment of existing ones is justified by its high sensitivity (91.3%) and good specificity (73.4%), because it is a simple, low cost, easy and quick application tool (two minutes), that is, it does not require longer application tests and can be used by all primary health care professionals, including community health workers (CHW), which characterizes an unprecedented contribution. In this primary care setting, CHWs stand out as important allies in fulfilling their role of identifying the most common risk situations to which the elderly are exposed[46,47], as well as transmitting such information to the health staff to optimize resources and elucidate interventions in the prevention of diseases.

We recommend that FRRISque be applied by health professionals in health facilities or at the elderly's own residence upon a home visit. It is a simple and quick application scale that lasts about two minutes.

In the application of FRRISque, each item answered as positive (yes) scores a point, that is, it is a risk factor, except item "Do you exercise during the week?", whose score is inverted, that is, the positive answer is not a risk factor and is worth zero (0). In this item, the negative answer (no) scores as a risk factor.

Final considerations

This study aimed to validate a scale to evaluate the risk of falls in elderly people living in the community with a view to filling the gap in the literature of a simple, but dense, quick application and low cost tool.

FRRISque is a valid tool. However, a limitation of this study bumps into the exclusion criteria itself established, that is, the sample did not involve high-risk populations, such as elderly people with impaired cognitive function and

dementia or Alzheimer's, for example. Thus, the results of this study cannot be generalized for elderly people with these characteristics.

Another limitation of the study refers to the fact that it did not evaluate the reliability of FRRISque. On the other hand, we propose that later studies analyze the need to evaluate the reliability of FRRISque (also called precision, reproducibility), whether comparing measurements made by the same person (intraobserver reproducibility) or by different people (interobserver reproducibility).

In addition, in order to confirm FRRISque's ability to predict future falls, it is necessary to evaluate the validity of the predictive criterion. That is, the elderly evaluated in this study must be reevaluated as to the results of applying the final version of FRRISque through a 1-2 years cohort study.

Finally, its implementation and use in clinical practice may avoid unnecessary expenses, in terms of use of the Unified Health System (SUS), in view of the serious consequences of falls, such as fractures and hospitalizations. The evaluation of the risk of falls with the implementation of FRRISque in the primary care network may be the key part of care as suggested by guidelines of geriatrics and gerontology.

Collaborations

LT Chini contributed to the design of the project; in the analysis and interpretation of the data, in the writing of the article and in the approval of the version to be published; DS Pereira contributed to the project design, data interpretation and approval of the version to be published and AA Nunes contributed to the project design, analysis, data interpretation and approval of the version to be published.

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ERRATUM

p. 2849, 2850 and 2851

which reads:

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Age (years)			
60 – 69	371 (43.4%)	325	46
70- 79	339 (39.7%)	245	94
80- 89	126 (14.8%)	81	45
90 and over	18 (2.1%)	7	11
Mean	71.87 (DP=7.62)		
Median	71		
Gender			
Female	492 (57.6%)	357	135
Male	362 (42.4%)	301	61
Ethnicity			
White	642 (75.1%)	501	141
Black	67 (7.8%)	47	20
Brown	135 (15.8%)	104	31
Yellow	8 (0.9%)	5	3
Indigenous	2 (0.2%)	1	1
Marital Status			
Single	57 (6.7%)	47	10
Married	523 (61.2%)	429	94
Divorced	44 (5.2%)	34	10
Widow/widower	230 (27.0%)	148	82
Housing situation			
Alone	98 (11.5%)	6970,4% RT 10,5% CT 8,1% GT	2929,6% RT 14,8% CT 3,4% GT
With relatives	751 (87.9%)	58577,8% RT 88,6% CT 68,2% GT	16622,2% RT 84,7% CT 19,5% GT
With friends	1 (0.1%)	1100,0% RT 0,2% CT 0,1% GT	00,0% RT 0,0% CT 0,0% GT
Other	4 (0.5%)	375,0% RT 0,5% CT 0,4% GT	125,0% RT 0,5% CT 0,1% GT

it continues

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Schooling			
No schooling	140 (16.4%)	10172,1% RT 15,4% CT 11,8% GT	3927,9% RT 19,9% CT 4,6% GT
Brazilian Literacy Movement Education	28 (3.3%)	1760,7% RT 2,6% CT 2,0% GT	1139,3% RT 5,6% CT 1,3% GT
Primary School – 1st to 4th grade	496 (58%)	37775,9% RT 57,1% CT 44,0% GT	12024,1% RT 60,7% CT 14,0% GT
Primary School – 5th to 8th grade	88 (10.3%)	7686,4% RT 11,6% CT 8,9% GT	1213,6% RT 6,1% CT 1,4% GT
Full Primary School	12 (1.4%)	1191,7% RT 1,7% CT 1,3% GT	18,3% RT 0,5% CT 0,1% GT
Secondary School	48 (5.7%)	3777,1% RT 5,6% CT 4,3% GT	1122,9% RT 5,6% CT 1,3% GT
Supplementary Secondary School	3 (0.4%)	3100,0% RT 0,5% CT 0,4% GT	00,0% RT 0,0% CT 0,0% GT
Higher Education	29 (3.4%)	2793,1% RT 4,1% CT 3,2% GT	26,9% RT 1,0% CT 0,2% GT
Postgraduate	9 (1.1%)	9100,0% RT 1,4% CT 1,1% GT	00,0% RT 0,0% CT 0,0% GT
Labor market situation			
Employer	8 (0.9%)	8	0
Employed with a formal contract	12 (1.4%)	11	1
Employed without a formal contract	6 (0.7%)	5	1
Self-employed with social security	9 (1.1%)	8	1
Self-employed without social security	12 (1.4%)	12	0
Retired / Pensioner	734 (85.9%)	556	178
Unemployed	5 (0.6%)	4	1
Not working	66 (7.7%)	52	14
Other	2 (0.2%)	2	0

it continues

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

Variables	n (%)	Group I	Group II
Household income			
Less than one minimum wage	5 (0.6%)	360,0% RT 0,5% CT 0,4% GT	240,0% RT 1,0% CT 0,2% GT
1 minimum wage	341 (39.9%)	25875,4% RT 38,7% CT 29,8% GT	8324,6% RT 42,3% CT 9,7% GT
Between 1 and 2 minimum wages	68 (7.9%)	5276,5% RT 7,9% CT 6,1% GT	1623,5% RT 8,2% CT 1,9% GT
2 minimum wages	272 (31.9%)	21177,6% RT 32,1% CT 24,7% GT	6122,4% RT 31,1% CT 7,2% GT
Between 2 and 3 minimum wages	33 (3.9%)	2781,8% RT 4,1% CT 3,2% GT	618,2% RT 3,1% CT 0,7% GT
3 minimum wages	74 (8.7%)	5979,7% RT 9,0% CT 6,9% GT	1520,3% RT 7,7% CT 1,8% GT
More than 3 minimum wages	57 (6.7%)	4782,5% RT 7,2% CT 5,5% GT	1017,5% RT 5,1% CT 1,2% GT
Don't know/Not informed	4 (0.4%)	125,0% RT 0,2% CT 0,1% GT	375,0% RT 1,5% CT 0,4% GT

reads up:

Table 1. Distribution of the elderly according to age, gender, ethnicity, marital status, housing situation, schooling, labor market situation and household income, considering both groups (Group I and Group II) "continued".

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Indigenous	2 (0.2%)	1	1
Marital Status			
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Divorced	44 (5.2%)	34	10
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Housing situation			
Alone	98 (11.5%)	69	29
With relatives	751 (87.9%)	585	166
With friends	1 (0.1%)	1	0
Other	4 (0.5%)	3	1
Schooling			
No schooling	140 (16.4%)	101	39
Brazilian Literacy Movement Education	28 (3.3%)	17	11
Primary School – 1st to 4th grade	496 (58%)	377	120
Primary School – 5th to 8th grade	88 (10.3%)	76	12
Full Primary School	12 (1.4%)	11	1
Secondary School	48 (5.7%)	37	11
Supplementary Secondary School	3 (0.4%)	3	0
Higher Education	29 (3.4%)	27	2
Postgraduate	9 (1.1%)	9	0

it continues

Table 1. Distribution of the elderly according to age. gender. ethnicity. marital status. housing situation. schooling. labor market situation and household income. considering both groups (Group I and Group II).

Variables	n (%)	Group I	Group II
Labor market situation			
Employer	8 (0.9%)	8	0
Employed with a formal contract	12 (1.4%)	11	1
Employed without a formal contract	6 (0.7%)	5	1
Self-employed with social security	9 (1.1%)	8	1
Self-employed without social security	12 (1.4%)	12	0
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Unemployed	5 (0.6%)	4	1
Not working	66 (7.7%)	52	14
Other	2 (0.2%)	2	0
Household income			
Less than one minimum wage	5 (0.6%)	3	2
1 minimum wage	341 (39.9%)	258	83
Between 1 and 2 minimum wages	68 (7.9%)	52	16
2 minimum wages	272 (31.9%)	211	61
Between 2 and 3 minimum wages	33 (3.9%)	27	6
3 minimum wages	74 (8.7%)	59	15
More than 3 minimum wages	57 (6.7%)	47	10
Don't know/Not informed	4 (0.4%)	1	3