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RESEARCH

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Translation, validity and reliability of the fall risk scale for older adults

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Abstract

Introduction Falls in older adults are a common and serious threat to health and functional independence. It can cause psychological distress, inability to participate in activities of daily living, brain injury, fractures, and even death. The aim was to analyze the psychometric properties of the self-assessed fall risk scale (FRS) that measures the risk of falls in older adults in a central region of Chile, as well as to verify the concurrent validity against functional fitness tests.

Materials and methods A descriptive cross-sectional study was carried out in 222 older adults (OA) [34 males and 188 females] with an age range of 65 to 85 years. The 13-item self-perceived fall risk scale (FRS) was validated. Anthropometric measures (weight, height and waist circumference) were assessed. Five functional fitness tests were measured (right and left hand grip strength, biceps curl, up-and-go, agility and 6-minute walk test). Validation was performed by construct validation [(exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)] and concurrent validity.

Results The EFA revealed 4 factors in the FRS scale [1: fear of falling (variance 27.1%), 2: use of assistive devices (variance 10.6%), 3: loss of sensation (variance 9.3%), and 4: limited mobility (variance 8.3%)]. Factor loadings ranged from ~0.50 to 0.83 across the 4 components. The Kaiser-Meyer Olkin sample adequacy test (KMO) reflected adequate adequacy (KMO = 0.79, chi-square (X2) = 498.806, gl = 78, $p = 0.00$). The CFA showed a satisfactory final fit [chi-square (X2) = 126.748, Root mean squared error of approximation (RMSEA) = 0.042, Tucker-Lewis Index (TLI) = 0.946, Comparative fit index (CFI) = 0.935 y Normed fit index (NFI) = 0.90. The relationships between the FRS scale and functional fitness tests (right and left hand grip strength, biceps curl, up-and-go, agility and 6-minute walk test) ranged from low to moderate (r= -0.23 to 0.41).

Conclusion The FRS scale showed acceptable validity and reliability in older adults in central region of Chile. It is expected that this scale will be useful for assessing fall risk in clinical and epidemiological settings in the aging Chilean population.

Keywords Fall risk, Validity, Reliability, Functional fitness, Older adults

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Background

A fall is defined as inadvertently falling onto the floor or other lower level, excluding intentional change of position to lean on furniture, walls, or other objects [1]. They usually commonly occur in community-dwelling older people (OA), as well as in patients with various levels of disability [2]. It is considered a common public health problem among OAs in various regions of the world.

In recent years several studies have highlighted it as a common and serious threat to the health and functional independence of OAs [3]. Causing psychological distress, inability to participate in activities of daily living [4], brain injury, internal organ damage, fractures [5], loss of independence and even, death [6].

Each year, it is estimated that 30–40% of patients over the age of 65 will fall at least once [7]. Even, the risk of falls increases as age increases [8]. Therefore, in recent years, falls prevention among the older adult is one of the priority public health issues in the rapidly aging society [9].

In that sense, in Chile the population aged 65 years and older for the year 2019 was projected to 2,260,222 people, which corresponded to 11.9% of the Chilean population [10]. In addition, it is considered one of the countries in the region whose demographic aging process has been more accelerated in relation to the rest of its neighbors in South America [11].

Consequently, due to the accelerated aging process that Chile has been undergoing in recent years, there is a clear need for methods that assess the risk of a fall in the OAs population. In fact, as far as is known, there are a variety of instruments that measure fall risk in various populations around the world [4, 12–17]. However, we highlight that the self-assessed Falls Risk Questionnaire (FRS) is a valid and reliable instrument [4] that has not been validated in the Chilean population. This instrument has been validated in other languages, such as Turkish, Italian, Thai, Chinese and Portuguese (from Portugal) given its characteristics of accessibility, ease and speed of application [18–22].

In fact, to our knowledge, no study has been validated in countries neighboring Chile, so this questionnaire could demonstrate adequate psychometric properties in a sample of older adults residing in central Chile. In addition, this information could strengthen the surveillance and monitoring systems of falls risk in intervention programs.

Therefore, the aim of this study was to analyze the psychometric properties of the self-assessed Fall Risk Scale (FRS), which measures the risk of falling in older adults in central region of Chile.

Materials and methods

Type of study and sample

A cross-sectional study was carried out in 222 OAs (34 males and 188 females) from the central region of Chile (Maule region) with an age range of 65 to 85 years. The sample was non-probabilistic (accidental), whose participants belonged to 06 senior citizens' clubs in the region.

To be eligible, the OAs had to be 65 years of age or older, self-sufficient (walking independently), read and understand the indications of the scale. OAs with severe visual and hearing impairment were excluded. This information was recorded on the adults' registration form.

All volunteers were informed of the objectives of the study and gave informed consent to participate in the project. All the older adults were professionals with higher education who were invited to participate in the study. They were contacted by telephone and then signed the informed consent form in person. The study was conducted in the period from October to November 2022, according to the indications of the Ethics Committee of the Catholic University of Maule (UCM-93/2022), and the guidelines of the Declaration of Helsinki for human subjects.

Techniques and procedures

Assessments of anthropometric measurements, functional fitness tests, and application of the fall risk scale (FRS) were performed in a closed laboratory of the Universidad Católica del Maule (Chile).

Fall risk

To assess the risk of falls, we employed a survey technique, utilizing the Fall Risk Scale (FRS) initially proposed by Rubenstein et al. [23].

Adaptation of the instrument

Authorization was obtained from the author to adapt the questionnaire. The English version was used for the US population. This version was subjected to the process of linguistic adaptation, so the questionnaire was translated (English-Spanish) by two independent translators and the reconciled version was retranslated.

The retranslated version was compared with the original instrument. With this information, the research team prepared the final applied format.

This scale presents 13 questions with two alternatives (know and don't know). A higher score indicates a higher risk of falling (for example, <3 points: low risk of falling and >4 points: high risk). This procedure was performed in the classic pencil-and-paper manner. An experienced surveyor carried out this procedure, orienting and guiding the OAs. The procedure lasted approximately 6 to 8 min per person.

Anthropometry

Anthropometric measurements were evaluated according to the recommendations of Ross, Marfell-Jones [24]. This procedure was performed by an experienced evaluator. Body weight (kg) was assessed using a scale (SECA, Hamburg) with an accuracy of 0.1 kg. Standing height (cm) was measured using a stadiometer (SECA, Hamburg) with an accuracy of 0.1 cm. Waist circumference (WC) was measured at the midpoint between the lower ribs and the top of the iliac crest using a Seca metal tape measure, graduated in millimeters, to the nearest 0.1 cm. Body Mass Index (BMI) was calculated using the formula [BMI=weight (kg)/height (m)2].

Functional fitness tests

Four tests from the senior fitness test battery proposed by Rikli, Jones [25] were applied. These tests are: right arm strength (RFBD), chair stand (up-and-go), agility, and the 6-minute walk test (6MWT). Additionally, we evaluated the hand grip strength (HGS) of both hands.

Right arm strength endurance (RFBD) or also known as biceps curl, was evaluated using a dumbbell (2.0 kg) for females and 3.0 kg for males). The subject must be seated in a chair with a backrest. The number of repetitions was evaluated for 30 s. Time was recorded using a Casio Casio brand stopwatch (1/100 sec).

The chair stand test (up-and-go) evaluates leg strength and was measured for 30 s. The subject must be seated in a chair with a backrest with the hands crossed at the chest. The test consists of standing up and sitting down. The number of repetitions is counted. A Casio stopwatch (1/100 sec) was used to record the time.

The agility test evaluated the time it took the subject to get up from a chair and walk to a cone located 2.44 m away (turn and sit down again). A Casio stopwatch (1/100 sec) was used to record the time in the tests.

Aerobic fitness was measured using the 6-minute walk test (6MWT). A distance of 30 m was demarcated. Subjects were to walk in one direction back and forth. The terrain is demarcated with colored adhesive tapes with three-meter spacing between the lines. Adults should walk the greatest number of meters during the six minutes.

The HGS of both hands (right and left) was evaluated according to the protocol proposed by Richards et al. [26]. Participants were evaluated one by one in a seated position (standard position in a straight-backed chair). A JAMAR brand hydraulic dynamometer (Hydraulic Hand Dynamometer® Model PC-5030 J1, Fred Sammons, Inc., Burr Ridge, IL: USA) was used. This equipment has an accuracy of 0.1 kg and a scale up to 100 kg/f. Two attempts were evaluated and the best result was recorded.

Statistics

The normality of the data was verified by the Shapiro-Wilk test. Descriptive statistics, including frequencies, percentages, range, means (X), and standard deviation (SD), were calculated. Comparisons between both sexes were performed using the t-test for independent samples.

To validate the FRS falls risk scale, construct validity and concurrent validation were used. In the first case, exploratory factor analysis (EFA) was used as a method to group the items into certain latent dimensions (factors), followed by confirmatory factor analysis (CFA) (to verify the adequacy of the model).

For the CFA, the % variance, communalities, factor loadings, Kaiser-Meyer Olkin (KMO) and chi-square (X2) tests were used. To analyze the model fit in the CFA, both incremental and absolute indices were considered. The incremental indices used were the CFI (Comparative Fit Index), GFI and TLI (Tucker-Lewis Index). The cut-off points considered [27] for CFI was greater than or equal to 0.95 is adequate, for GFI value greater than 0.89 and for TLI greater than 0.90. In relation to the absolute indexes, the RMSEA (root mean square error of approximation) was estimated, which is considered an adequate fit when it is less than and equal to 0.05.

Cronbach's alpha was used for internal consistency.

For the second case, for concurrent validation, the data were analyzed using Spearman's (nonparametric) correlations between the values of the FRS scale and the functional aptitude tests.

In all cases, $p<0.05$ was adopted. Results were processed and analyzed in Excel spreadsheets and SPSS 18.0.

Results

Table 1 shows the variables that characterized the sample of older adults studied. Males presented greater body weight, height and WC compared to female ($p<0.001$). However, there were no differences in BMI between both sexes. In relation to the physical tests, men presented higher HGS (right and left hand) and Biceps curl, than their female counterparts ($p<0.001$). However, there were no differences in Up-and-go (30 s), agility and Walking test 6 min (m), between both sexes ($p>0.001$). There were no differences in the proportions between males and females according to educational level ($p=0.837$) and between housing type ($p=0.347$).

The reliability and CFA values can be seen in Table 2. Cronbach's Alpha on the scale ranged from 0.72 to 0.78 and on the total scale showed $\alpha=0.76$. The factor loadings grouped 4 factors: 1: fear of falling (variance 27.1%), 2: use of assistive devices (variance 10.6%), 3: loss of sensation (variance 9.3%), and 4: limitation in mobility (variance 8.2%). Factor loadings were greater than 0.50, reaching a maximum of 0.83 for all 4 components. The communalities ranged from 0.51 to 0.71

Table 1 Anthropometric and physical characteristics of the sample studied

Variables	Males (n = 34)		Females (n = 188)		p
	M	SD	M	SD	
Age (years)	74.7	7.6	71.5	10.4	0.084
Anthropometry					
Weight (kg)	80.6	12.8	68.6	11.6	0,000
Height (cm)	164.2	6.8	152.8	6.2	0,000
Waist circumference (cm)	103.6	10.3	95.5	12.3	0,000
BMI (kg/m^2)	29.8	4.4	29.4	4.8	0.596
Functional fitness					
HGS-R (kgf)	29.5	7.8	21.2	5.1	0,000
HGS-L (kgf)	28.2	8.2	20.1	5	0,000
Biceps curl (30 sec)	20.8	6.8	18.5	5.2	0.031
Up-and-go (30sec)	15.4	4.3	15.4	5	0.992
Agility (2.44m)	8.3	3.1	7.9	3.8	0.564
Walking test 6minutes (m)	448	104	426.7	95.2	0.254
Educational level	n	%	n	%	
Basic education	9	4.1	52	23.4	X^2 = 0.851; gl = 3, p = 0.837
High school education	12	5.4	78	35.1	
Higher technical education	7	3.2	29	13.1	
Higher university education	6	2.7	29	13.1	
Type of Housing					
Owned	31	14	160	72.1	X^2 = 0.883; gl = 1, p = 0.347
Borrowed	3	1.4	28	12.6	

Legend: M: mean, SD: standard deviation, HGS-R: hand grip strenght-right, FPM-L: hand grip strenght-left

for the 13 questions. The KMO variance ratio was 0.79 (X^2=498.806, gl=78, p=0.00), reflecting adequate adequacy of the data analyzed in the model.

The CFA values can be seen in Table 3. The values obtained in the model reflected adequate values for the 13-question fall risk scale [the measures of absolute fit (X^2 and RMSEA), and incremental fit (CFI, TLI, and NFI).

The concurrent validity between the values of the FRS scale with the functional fitness tests are observed in Table 4. The results have reflected low negative correlations between the FRS scale with the HGS-R and Biceps Curl tests (r= -0.23 to -0.31), whereas, with the HGS-L, Up-and-go and 6-minute walk tests the relationships were moderate and negative (r= -0.40 and −0.41) and with agility (r=0.41) the relationship was moderate and positive, respectively.

Table 3 Fit indicators of the fall risk scale (FRS) obtained through confirmatory factor analysis

Indexes	Model 13 questions
X^2	126.748
RMSEA	0.04
TLI	0.95
CFI	0.94
NFI	0.90

Legend: X2 = Chi-square Ratio, RMSEA: root mean square error of approximation, TLI: Tucker-Lewis Index, CFI: Comparative Goodness of Fit Index, NFI: = Non-Normed Fit Index, TLI: Tucker-Lewis Index

Table 4 Relationship between the values of the fall risk scale (FRS) with functional fitness tests

Functional aptitude tests	R	p
HGS-R	−0.23**	0.001
HGS-L	−0.40**	0.000
Curl de bíceps (30 seg)	−0.31**	0.000
Up-and-go (30seg)	−0.40**	0.000
Agility (2,44 m)	0.40**	0.000
Walking test 6 min (m)	−0.41**	0.000

Legend: HGS: Hand grip strength, R: right, L: left, **: significant difference

Table 2 Values of the exploratory factor analysis and reliability of the fall risk scale (FRS)

n°	Item	Cronbach's Alpha	C	Factor loadings 1	2	3	4
1	Have I had a fall in the last year?	0.76	0.57	-0.04	0.72	0.17	0.14
2	I am concerned about falls.	0.74	0.53	0.69	0.21	-0.05	-0.04
3	Do I sometimes feel unsteady when I walk?	0.72	0.53	0.54	0.34	0.20	0.29
4	When I walk inside my home, do I usually need to lean against furniture?	0.74	0.67	0.23	0.54	0.56	-0.08
5	Do I use or have I been advised to use a cane or walker to get around safely?	0.75	0.71	0.04	-0.01	0.83	0.12
6	When I am in a chair, do I need hand support to get up?	0.73	0.58	0.50	0.26	0.51	-0.05
7	Do I have trouble getting up on a step?	0.74	0.51	0.50	-0.10	0.38	0.33
8	Do I often have to rush to the bathroom?	0.76	0.54	0.34	0.52	-0.09	-0.39
9	Have I lost some feeling in my feet?	0.75	0.51	0.14	0.55	-0.11	0.42
10	Do I take medications that sometimes make me feel dizzy or more tired than usual?	0.76	0.57	-0.04	0.12	0.09	0.74
11	Do I take medications that help me sleep or improve my mood?	0.75	0.30	0.52	0.09	0.10	0.10
12	Do I often feel sad or depressed?	0.74	0.62	0.56	0.03	0.02	0.55
13	Because I can't see well, do I have difficulty avoiding hazards in my path, such as tree roots or electrical wires?	0.75	0.54	0.67	-0.12	0.16	-0.24

Legend: C: communalities, 1,2,3,4: rotated components

Discussion

The present study verified the validity and reliability of the Fall Risk Scale (FRS) in a sample of OAs in Chile. For this purpose, construct validity was used, where the FRS was grouped into 4 factors (1: fear of falling, 2: use of assistive devices, 3: loss of sensibility, and 4: limitation of mobility). These four factors reflected adequate adequacy in the model, where the factor loadings of the FRS Scale are acceptable (above 0.46) as described by Knekta et al. [27].

Moreover, these values were similar to other validation studies in OAs from various geographical regions [28, 29].

In fact, having explored the 4 factors, we next opted to confirm through the CFA, where the fit of the initially proposed theoretical model was assessed. This model evidenced a satisfactory fit for the 4 factors and the 13 questions, allowing us to highlight adequate psychometric properties, so that the FRS scale is valid for the sample of OA in Chile. These results obtained in the five fit indicators (RMSEA, TLI, CFI an NFI) were consistent with other validation studies [28, 30].

Overall, the 4 factors determined in this study, are closely related to the risk factors for falls suggested by the International Classification of Functioning, Disability and Health [World Health Organization International Classification of Functioning, and Health (WHO-ICF)] [31, 32], which serve to categorize and identify independent OAs living in the community.

These components according to WHO [32] are based on a solid scientific basis summarized as (1) body functions and structures that refer to bodily functions, impairments or disabilities, (2) activities and participation involving social participation, lifestyle activities and mobility, (3) personal factors that include the demographic characteristics of individuals (age, sex, previous falls, fear of falling) and (4) environmental factors, which have to do with footwear, domestic hazards, personal consumption of medications and other environmental factors.

In relation to reliability, the results indicate that the scale reflected internal consistency among its items ($\alpha=0.76$). Even, the values obtained in this study are consistent with other studies with similar characteristics [2, 18, 33].

Concurrent validity was verified through correlations between FRS scale values with functional fitness tests. We verified that there were low negative relationships with HGS (right) and biceps curl, (r= -0.23 to -0.31), and moderate with HGS (left) (r=-0.40), Up-and-go (r=-0.40), agility ($r=0.40$) and the 6-minute walk test (r= -0.41).

These results showed that the self-assessed FRS scale demonstrated acceptable levels of concurrent validity against the agility tests, Up-and-go, and the 6-minute walk test. These findings are similar with previous studies that have verified moderate correlations with agility and 6-minute walk tests [20, 34–37]. In general, the results indicate that there is an inverse relationship between physical fitness and the risk of falls in the adults studied: as physical fitness improves, the risk of falls decreases, and vice versa.

Several previous studies have shown that agility improves postural stability [38, 39] and walking improves lower extremity muscle strength, increasing balance performance and psychological conditions of OAs [37, 40, 41].

Overall, the results of the study show that the FRS scale has acceptable concurrent validity in relation to several functional fitness tests. Although the correlations range from low to moderate. The consistency of these correlations with previous studies support the utility of the scale for assessing functional fitness in older adults [37, 40, 41].

In particular, the moderate correlations with tests such as the 6-minute walk, agility, and the Up-and-go test suggest that the scale may be a useful tool for identifying individuals at increased risk for falls based on their physical performance. Although further exploration is recommended to fully understand the observed relationships.

In that context, we highlight that fall risk is an essential component of both primary and secondary fragility fracture prevention strategies [20] so its assessment is essential among OAs.

In fact, the FRS scale constitutes a simple, inexpensive and rapid screening tool to assess fall risk among OAs. For generally, many OAs do not undergo a comprehensive fall risk assessment or receive targeted prevention strategies [42]. So its use and application is available for personal falls prevention as well as collectively in health, social and community services [2].

The study presents some strengths that deserve to be recognized, for example, it is one of the first studies to validate the FRS scale for OA in Chile. The procedures used for the quality control of the validation were of three types: exploratory factor analysis, confirmatory, and concurrent validation with functional aptitude tests. In addition, the results obtained in this study can serve as a baseline for future comparisons and to verify changes over time with neighboring regions of the country. Notwithstanding the above, some limitations that deserve to be described stand out, since the sample selection was non-probabilistic, which prevents generalizing the scale to other sociocultural contexts. Furthermore, the type of study used (cross-sectional), does not allow inferring causal relationships between functional aptitude tests and the FRS scale, so future studies should consider longitudinal investigations with probabilistic samples.

Another relevant aspect to highlight is the low number of male participants in the study. This could limit the generalizability of the results, since, in Chile, females often participate more actively than males in health studies and intervention programs. This could bias the findings and not adequately represent the older male population.

Future studies should take into account cultural and social factors that could contribute to a higher participation rate of males in these types of studies. This will allow for a more balanced representation and ensure that the findings are applicable to the entire OA population.

It is also highlighted that future studies should include in their measurement variables, indicators such as medical history, physical activity levels and medication intake. Since this information may be relevant, not only to characterize the sample studied, but also to contrast with other studies.

Conclusions

The FRS scale showed acceptable validity and reliability in OA in central Chile. It is expected that this scale will be useful to assess the risk of falls in clinical and epidemiological contexts. Its use and application is suggested to strengthen surveillance systems and to monitor the risk of falls with a view to possible interventions in the aging population.

Appendix

n°	Spanish instrument used	Instrument in its original language
1	Have I had a fall in the last year?	I have fallen in the last 6 months.
2	I am concerned about falls.	I am worried about falling.
3	Do I sometimes feel unsteady when I walk?	Somethimes, I feel unsteady when I am walking.
4	When I walk inside my home, do I usually need to lean against furniture?	I steady myself by holding onto furniture when walking at home.
5	Do I use or have I been advised to use a cane or walker to get around safely?	I use or have been advised to use a cane or walker to get around safely
6	When I am in a chair, do I need hand support to get up?	I need to push with my hands to stand up from a chair.
7	Do I have trouble getting up on a step?	I have some trouble stepping up onto a curb.
8	Do I often have to rush to the bathroom?	I often have to rush to the toilet.
9	Have I lost some feeling in my feet?	I have lost some feeling in my feet.
10	Do I take medications that sometimes make me feel dizzy or more tired than usual?	I take medicine that sometimes makes me feel light-headed or more tired than usual.
11	Do I take medications that help me sleep or improve my mood?	I take medicine to help me sleep or improve my mood.
12	Do I often feel sad or depressed?	I often feel sad or depressed.
13	Because I can't see well, do I have difficulty avoiding hazards in my path, such as tree roots or electrical wires?	Because I don't see well, I have difficulty avoiding hazards in the path, such as tree roots or electrical cords.

Abbreviations

CFA Confirmatory factor analysis
CFI Comparative fit index
EFA Exploratory factor analysis
FRS Fall risk scale
KMO Kaiser Meyer Olkin
NFI Normed fit index
OA Older adults
RMSEA Root mean squared error of approximation
TLI Tucker-Lewis Index

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Author contributions

M.C.B., R.G.C., L.F.C., and M.R.L contributed to the design of the research study. R.V.E. J.C.B., L.U.A and C.L.R., collected data, contributed to the discussion, wrote the manuscript and reviewed/edited the manuscript. M.C.B., R.G.C., R.V.E., L.F.C., L.U.A., M.R.L., and C.L.R., edited, and reviewed the manuscript. M.C.B., R.G.C., and L.F.C., analyzed data and/or reviewed/edited the manuscript. M.C.B., R.G.C., and L.F.C., reviewed/edited the manuscript. All authors revised and agreed on the views expressed in the manuscript.

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Data availability

The data will be available by contacting the corresponding author.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the Universidad Católica del Maule (93-2022). All experiments were conducted in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki). All participants signed written informed consent, acknowledging their consent to participate and their understanding of the research procedures and objectives.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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