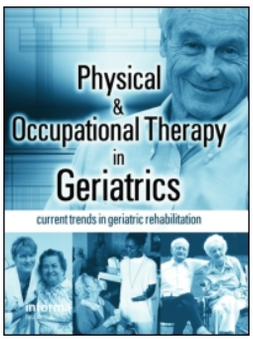

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Validated Fall Risk Assessment Tools for Use with Older Adults: A Systematic Review

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ABSTRACT

Aims: to find and describe, through a systematic review, validated assessment tool that evaluate the fall risk in older adults. *Methods:* MEDLINE, PEDro, CINAHL, and PsycINFO were consulted and no restrictions were applied to the year or country of publication but the searches were limited to studies published in English. Two authors independently identified eligible studies on the basis of inclusion criteria and extracted data. *Results:* Fifty-five eligible studies were identified, out of which 33 valued risk assessment tools emerged. The tools used the most were the Falls Efficacy Scale International and the Activities-specific Balance Confidence Scale with 15 and 6 studies respectively. *Conclusions:* The large number of tools reflects a strong tendency to create new instruments, with only a few of them recommended. To reach a gold standard, it would be good to try to validate the existing scales in more countries instead of creating new ones.

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Fall risk assessment; aged; older; validation questionnaire; adults; systematic review

Introduction

Falls and fall-related injuries are a common and serious problem for older adults. People 65 and older have the highest risk of falling, with 30% of people older than 65 and 50% of people older than 80 falling at least once a year.[1]

The human cost of falling includes distress, pain, injury, loss of confidence, loss of independence, and mortality. Falling also affects the family members and carers of people who fall, carers may experience similar fall concern as older persons with regard to the risk of falling. Several studies showed that a history of falls in the person being cared for was associated with increased caregiver burden, even after controlling for functional status and comorbidities. Carers of persons who had fallen subsequently changed their social and work engagements for fear of leaving their care recipients

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alone.[2] Therefore, falling has an impact on quality of life, health, and healthcare costs.[1] Older adults are particularly vulnerable to falls owing to age-related musculoskeletal and joint weakness. Older adults are also susceptible to fracture injuries, which account for about half of all fall-related injuries.[3] Apart from the physical burden of a fall, older people who survive falls tend to experience anxiety, loss of confidence, and fear of falling again. These feelings are associated with restriction or avoidance of daily activities, loss of independence, and reduced social activity or quality of life.[3]

Screening tools have generally been found to do a poor job at discriminating fallers from nonfallers.[4,5] Nevertheless, some tools may be useful in particular settings, indeed most of them are designed for a particular environment (eg. hospital environment, nursing homes, extra-hospital environment, emergency departments). Moreover, fall risk assessments have demonstrated greater utility when combined with sound clinical judgment. A focused and user-friendly review of fall risk assessments should help clinicians and others use and potentially adopt current instruments more effectively. The data available in the literature allows for the identification of different fall risk assessment tools. Internationally, the tools used the most are the Falls Efficacy Scale International (FES-I) and the Activities-specific Balance Confidence Scale (ABC), both of which evaluate the fear of falling in community-dwelling older adults.

The purpose of this study was to find and describe, through a systematic review of observational cohort and cross-sectional studies, the questionnaires used for fall risk assessment in older adults at an international level. Specifically, this study aimed to identify the validated fall risk assessment tools and assess their settings, language, pathology, and psychometric properties.

Methods

Criteria for considering studies for this review: Types of studies, types of participants and types of outcomes

Studies that validated fall risk assessment tools in older adults were considered for review. Therefore, observational cohort and cross-sectional studies were included. Studies that validated fall risk assessment tools already utilized in their country of origin were excluded. Studies were limited to older adults who were healthy or had pathologic conditions and were living in a community or were hospitalized. Studies were included if the participants were 60 years or over, or if the range was extended to 60 and over. The primary outcome was the number of fall risk assessment tools that had been validated at an international level. Secondary outcomes were the psychometric properties of the tools. Therefore, the tools were stratified by setting.

Search methods for identification of studies, electronic searches

The following electronic databases were searched and all potential studies were identified by two authors (MR, GG): MEDLINE, PEDro, CINAHL and PsycINFO

The Medical Subject Headings of the United States National Library of Medicine (MESH) was used to determine which search terms to use. The MESH terms used were (ACCIDENTAL FALL) and (AGED), from which the following results were obtained: (Falling; Falls; Falls, Accidental; Accidental Fall; Fall, Accidental; Slip and Fall; Fall and Slip; Aged; Elderly). The search strategy is shown in figure 1. It was constructed for MEDLINE and adapted to other databases.

Selection of studies

Before starting the review duplicate papers were filtered out using Endnote. Following guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement two authors (MR, GG) first screened titles and abstracts using the following inclusion criteria: validation, cultural and retrospective adaptation studies; studies on fall risk; sample age $\geq$60 years old or with a range that was extended to the third age; tests, questionnaires, and scales that were operator-dependent and self-administered; and studies that were related to both healthy and pathologic individuals. Then studies that met the criteria were subject to a full text review to determine if they should be included in the review.

Data collection and analysis and assessment of risk of bias

For each included study, we tried to obtain the following data and psychometric properties: authors; scale; language; sample (pathology); mean age, standard deviation, age range, and gender; setting; administration; Cronbach's α; intraclass coefficient correlation (ICC); inter-item correlation

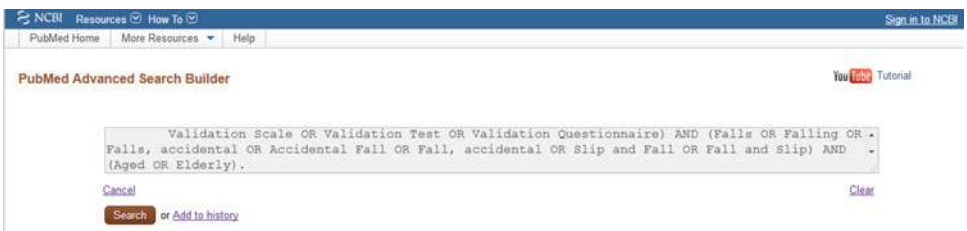

Figure 1. Search strategy.

(IIC); and receiver operating characteristic (ROC) curve, (sensitivity, specificity, positive predictive value, and negativity predictive value).

The methodological quality of each of the selected studies was assessed using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.

Results

Study selection: Description of the studies and results of the search

The research identified 420 matches, of which 65 studies were selected after reading the abstracts. After reading the full text, we excluded 10 studies (which focused mainly on motor tests). Therefore, the review presents 55 different studies. The research steps are shown in Figure 2.

After following our inclusion and exclusion criteria, 33 fall risk assessment tools that were validated at an international level were identified (Appendix 1).

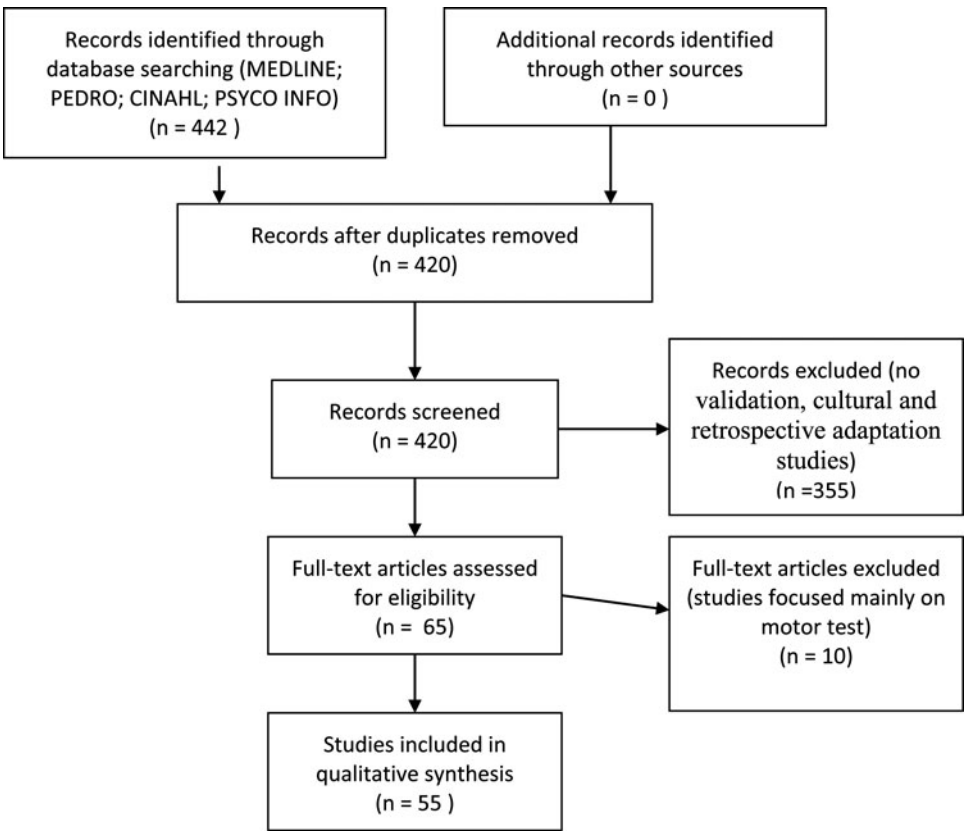

Figure 2. Flow chart.

Psychometric properties of each scale

Falls Efficay Scale Internationl (FES-I)

The FES-I was the most represented instrument, conceived in English,[6] and validated in other 12 languages: Persian,[7] Greek,[8] Portuguese,[9] Swedish,[10] Arabic,[11] German,[12] Norwegian,[13] Dutch,[12] Chinese,[14] Spanish,[15] Italian[16] and Turkish.[17] The FES-I was developed by members of the PRevention Of FAlls Network Europe (PROFANE) an organization that works to increase knowledge and capacity so as to reduce falls amongst older people, by the implementation of evidence-based intervention. The FES-I has been used to assess the fear of falling in community-dwelling older adults, it has also been validated in several pathologies, such as multiple sclerosis, osteoporosis in women, cognitive deficits, stroke, and menopause (Table 1). The FES-I consists of 16 items, 10 from the original version of the Falls Efficacy Scale (FES) and 6 additional items that evaluate more demanding physical and social activities.[6] Falls efficacy is rated on a 4-point scale for each activity, where: 1 = not at all concerned, 2 = somewhat concerned, 3 = fairly concerned and 4 = very concerned. The total score ranged from 16 (no concern about falling) to 64 (severe concern about falling). The results suggest that the FES-I has good internal consistency with a Cronbach's α ranging from 0.78[18] and 0.98;[16] Cronbach's α was <0.90 in only two of the studies analyzed. The ICC values have a wider spectrum ranging from 0.584[19] and 0.99,[17] but in almost all the studies the values were >0.80, suggesting good reliability. The only ICC value <0.70 came from Hauer et al. (2010)[19] (ICC =0.584) and it refers to a subset of the sample; the value was related to self-administered FES-I in patients with cognitive impairment for whom the authors suggested that an interview would have been a better way to administer the questionnaire.

Other FES versions

The first version of the FES has 10 items,[20] the short FES-I has 7 items,[21] the Adapted FES versions has 11 items,[22] the Modified FES version has 12 items[23] and the Iconographical Falls Efficacy Scale (ICON-FES) presents 30-item and 10-item versions[24,25] (Tables 2-4).

Activities specific Balance Confidence Scale (ABC) 16 items and short versions

The ABC scale was developed by Powell et al. (1995).[26] It evaluates the fear of falling through personal balance confidence in older adults living in a community setting and it is easy to use. Participants rated their balance confidence on a scale of 0% (not confident) to 100% (completely confident) following a series of 16 questions regarding balance-challenging tasks. Balance confidence was scored as the mean of the responses and was reported as a confidence percentage. The 16-item version has been

Table 1. Validation data of the FES-I.

Authors	Language	Sample (pathology)	Mean age (M)/SD/Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC
Azad et al.[19]	Persian	120 (Ictus)	60.1 Mean 10.7 SD (40-80) R 45% F	Community	Interview	0.78	0.98	N.A.
Baharlouei et al.[8]	Persian	78	66.8 Mean 5.5 SD 65.4% F	Community	Self-administration	0.93	0.84	N.A.
		113	70.8 Mean 6.6 SD 20.4% F	Community	Interview	0.92	0.94	N.A.
Billis et al.[9]	Greek	89	72.87 Mean 6.04 SD (61-90) R 43.8% F	Community	Self-administration	0.925	0.951	N.A.
Camargos et al.[10]	Portuguese (Brazil)	163	73.44 Mean 5.51 SD 77.91% F	Community	Self-administration	0.93	0.84 e 0.91	N.A.
Delbaere et al.[40]	English (Australia)	500	77.4 Mean 6.08 SD (70-90) R 55.8% F	Community	Self-administration	0.79	N.A.	N.A.
Halvarsson et al.[11]	Swedish	81 (women with osteoporosis)	77 Mean (65-87) R 100% F	Community	Self-administration	0.94	0.88	N.A.
Halaweh et al.[12]	Arabic	108	67.3 Mean 8.06 SD (60-84) R 56.5% F	Community	Interview	0.92	N.A.	N.A.
Hauer et al.[20]	German	156 (75 cognitive impairments)	81.7 Mean 6.1 SD 72% F	Geriatric clinic	Interview	0.94 and 0.925 (cognitive group)	0.909 and 0.744 (cognitive group)	N.A.
					Self-administration	0.957 and 0.947 (cognitive group)	0.923 and 0.584 (cognitive group)	N.A.
Helbostad et al.[14]	Norwegian	563 (4 clinical groups)	N.V.	Community	Self-administration with assistance	0.95	N.A.	0.54 IIC
Kempen et al.[13]	German	94	77.5 Mean 4.7 SD (70-91) R 54% F	Community	Self-administration	0.9	0.79	N.A.
	Dutch	193	76.6 Mean 5.3 SD (70-92) R 61% F			0.96	0.82	N.A.
	English	178	76.3 Mean 5.1 SD (70-90) R 65% F			0.97	N.A.	N.A.
Kwan et al.[15]	Chinese	399	74.9 Mean 6.4 SD (61-93) R 71% F	Community	Interview	0.94	0.89 e 0.95	N.A.
Lomas-Vega et al.[16]	Spanish	100 (menopause)	57.51 Mean 3.97 SD (50-65) R 100% F	Community	Self-administration	0.94	0.972	N.A.
Ruggiero et al.[17]	Italian	157	79.43 Mean 5.76 SD 66.2 % F	Community	Interview	0.97 t_1 and 0.98 t_2	N.A.	0.74 t_1 and 0.77 t_2
Ulus et al.[18]	Turkish	70	69.7 Mean 4.59 SD (65-81) R 81.4% F	Community	Self-administration	0.94	(0.97-0.99)	N.A.
van Vliet et al.[41]	English (Australia)	169 (multiple sclerosis)	50.6 Mean 10.9 SD (21-73) R 69.8% F	Community	Self-administration	0.94	N.A.	0.51

Table 2. Validation data of the FES and other versions.

Authors	Version	Language	Sample (pathology)	Mean age (M)/SD/Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC
Gazibara et al.[42]	FES	Serbian	201 (Parkinson)	62 Mean 9.8 SD (25-80) R 35.3% F	Community	Self-administration with assistance	0.98	0.795	0.831
Hauer et al.[20]	FES	German	156 (75 cognitive impairments)	81.7 Mean 6.1 SD 72% F	Geriatric and rehabilitation clinic	Interview	0.910 and 0.896 (cognitive group)	0.844 and 0.807 (cognitive group)	N.A.
						Self-administration	0.923 and 0.890 (cognitive group)	0.878 and 0.824 (cognitive group)	N.A.
Büla et al.[24]	Adapted FES	French (Switzerland)	70	81.1 Mean 8.6 SD (65-99) R 65.7% F	Rehabilitation clinic	Interview	0.9	0.97	N.A.
Edwars et al.[23]	Modified FES	French (Canada)	551	73.9 Mean 7.56 SD 76% F	Community	Interview	0.88	N.A.	N.A.
Mosallanezhad et al.[43]	FES (S)	Persian	81	74 Mean 6.5 SD (65-98) R 49% F	Community	Interview	0.75	0.99	N.A.

Table 3. Validation data of the short FES-I.

Authors	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC
Delbaere et al.[40]	English (Australia)	500	77.4 Mean 6.08 SD (70-90) R 55.8% F	Community	Self-administration	0.63	N.A.	N.A.
Helbostad et al.[14]	Norwegian	563	N.A.	Community	Self-administration with assistance	0.89	N.A.	0.54
Kwan et al.[15]	Chinese	399	74.9 Mean 6.4 SD (61-93) R 71% F	Community	Self-administration	0.88	0.87	N.A.
Ruggiero et al.[17]	Italian	157	79.43 Mean 5.76 SD 66.2% F	Community	Interview	0.94 t_1 and 0.95 t_2	N.A.	0.75 t_1 and 0.78 t_2
Van Vliet et al.[41]	English (Australia)	169 (multiple sclerosis)	50.6 Mean 10.9 SD (21-73) R 69.8% F	Community	Self-administration	0.86	N.A.	0.47

Table 4. Validation data on the ICON FES-I.

Authors	Version	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC
Delbaere et al.[25]	ICON-FES and ICON-FES short (Iconographical Falls efficacy scale)	English (Australia)	250	80.2 Mean 5.1 SD 53.2% F	Community	Interview	0.96 and 0.87 short ICON FES	0.9	0.45
Delbaere et al.[26]	ICON-FES and ICON-FES short (Iconographical Falls efficacy scale)	English (Australia)	50 (Moderate cognitive impairments)	82.1 Mean 5.9 SD 52% F	Community	Interview	0.97 and 0.91 short ICON FES	N.A.	(0.30-0.70)

Table 5. Validation data of the ABC scale.

Authors	Version	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC
Guan et al.[28]	ABC-16	Chinese Mandarin	61	76.3 Mean 7.5 SD (60-88) R 57% F	Community	Self-administration/ interview	0.94	0.98	N.A.
Franchigioni et al.[30]	ABC-16	Italian	217 (Parkinson)	71 Mean (48-83) R 54% F	Community	Self-administration	0.95 ABC16	N.A.	N.A.
	ABC-5L						0.88 ABC-5L	N.A.	N.A.
	ABC-6P						0.89 ABC-6P	N.A.	N.A.
	ABC-6ON						0.90-6ON	N.A.	N.A.
Mak et al.[29]	ABC-16	Chinese Cantonese	100	77.2 Mean 56% F	Community	Interview	0.97	0.99	N.A.
Peretz et al.[31]	ABC-16 and ABC-6	Hebrew	70 (higher level gait disorders)	78 Mean 5 SD 74.3% F	Community	Interview	0.90 and 0.81 (ABC-6)	0.88	N.A.
			68	75 Mean 6 SD 54.4% F	Community	Interview	0.83 and 0.86 (ABC-6)	0.78	N.A.
			19 (Parkinson)	72 Mean 6 SD 36.8% F	Community	Interview	0.91 and 0.9 (ABC-6)	0.83	N.A.
Schepens et al.[32]	ABC-16 and ABC-6	English (USA)	35	72.86 Mean 1.05 SD 80% F	Community	Interview	N.A.	0.76 and 0.82 (ABC-6)	N.A.
Schott et al.[33]	ABC-16 and ABC-6	Germany	384	71.1 Mean 9.7 SD (50-101) R 57.3% F	Community	Interview	0.97 and 0.95(ABC-6)	0.938 and 0.981 (ABC-6) and 0.938 (ABC/ABC-6)	N.A.
Skipper et al.[44]	ABC16 and ABC6	English (USA)	251	71.2 Mean 8.9 SD 76% F	Community	Interview	0.95 ABC-16 0.90 ABC-6	0.81	N.A.

validated in five languages: Chinese,[27,28] Italian,[29] Hebrew,[30] English,[31] and German[32] and the short version in four languages: Italian,[29] Hebrew,[30] English,[31] and German[32] (Table 5). Data from the analyzed studies support the internal consistency of the ABC scale, Cronbach's α ranging from 0.81[30] and 0.97;[32] in fact, the items are strongly homogeneous. The ICC values ranging from 0.76[31] and 0.981[32] found by various studies express the relationship between the 16-item scale and the short versions and test-retest reliability and confirm the reliability of the scale.

St Thomas Risk Assessment Tool (STRATIFY)

The STRATIFY scale, created by Oliver et al. (1997),[33] has been validated in two languages: English,[34,35] and Spanish.[36] The STRATIFY scale assesses the risk of falling in hospitals. The evaluation is based on five questions asked of both the patient and the operator; administration time is 5-10 minutes. It evaluates five elements: previous falls, agitation, visual disturbances, frequency of evacuations, and transfer/mobility. The variables are dichotomic (1 = yes and 0 = no). A score of 2 or greater indicates a high risk of falling. Webster et al. (2008)[34] used the recommended cutoff point ($\geq$ 2) where the instrument had high sensitivity and negative predictability (82% and 97%), moderate specificity (62%), but low positive predictability (18%). Papaioannou et al. (2004)[35] reported results related at two different cutoff point (sensitivity 91.2% and specificity 49.3% with cutoff $\geq$2 and sensitivity 61.8% and specificity 71.3% with cutoff $\geq$3). The third study was by Aranda-Gallardo et al. (2015),[36] and is still in progress (Table 6).

Other scales

The research found 25 other validated tools; their validation data are presented in Table 7.

Risk of bias within studies

All the studies were evaluated with the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. Only two studies[37,38] had poor results due to a marked lack of data.

Meta-analysis

Topic of the review was to identify the validated fall risk assessment tools and assess their settings, language, pathology, and psychometric properties. The identified studies are too heterogeneous, so for the reported data, specific variables of interest, specific populations characteristics we didn't consider a meta-analysis.

Table 6. Validation data of the STRATIFY scale.

Authors	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC	ROC curve (SENS. SPEC. PPV NPV)
Aranda-Gallardo et al.[37]	Spanish	2097	N.A.	Acute-care hospitals and nursing homes	Interview	N.A.	N.A.	N.A.	N.A.
Papaioannou et al.[36]	English (Canada)	620	78 Mean 7.7 SD 54.5% F	Acute unit	Interview	N.A.	0.78	N.A.	91.2% SENS. 49.3% SPEC.(cut off ≥2) and 61.8% SENS. 71.3% SPEC.(cut off ≥3)
Webster et al.[35]	English (Australia)	788 (Surgical. Medical, Oncology, GARU and long-stay medical, Mental health patients)	77.7 Mean 7.91 SD 50.6% F	Tertiary hospital	Interview	N.A.	N.A.	N.A.	82% SENS. 62% SPEC. 18% PPV 97% NPV

Table 7. Validation data of the others scales.

Authors	Scale	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC	ROC curve (SENS. SPEC. PPV NPV)
Bower et al.[51]	FFQ-R (Fear of Falling Questionnaire-Revised)	English (USA)	405 (hip fracture)	78 Mean 8.7 SD (60-101) R 74.6% F	Rehabilitation clinic	Self-administration	0.76 15-item and 0.8 6-item	0.93	N.A.	N.A.
			89	77.6 Mean 7.6 SD (60-93) R 67.4% F	Community	Self-administration	0.81 15-item and 0.83 6-item	N.A.	N.A.	N.A.
			42 (fear of falling)	77.9 Mean 7.3 SD (65-91) R 73.8% F	Community	Self-administration	0.72 15-item and 0.78 6-item	N.A.	N.A.	N.A.
Cattelani et al.[52]	FRAT-UP (Web-based Fall Risk assessment Tool)	Italian	1150	>65	Community	Self-administration	N.A.	N.A.	N.A.	0.642 ROC
Chow et al.[53]	MFS (Morse Fall Scale)	Chinese	954	70.2 Mean 15.44 SD (17-100) R 58.4% F	Geriatric and medical units	Interview	0.26	0.97 e 0.98	N.A.	31% SENS. 83% SPEC. (CUT OFF =45)
Delbaere et al.[54]	FALL RISK SCREENING TOOLS	English (Australia)	2005	85.7 Mean 7.1 SD (65-104) R	Nursing homes	Interview	N.A.	N.A.	N.A.	73% SENS. 55% SPEC. (sample 1) / 87% SENS. 29% SPEC. (sample 2)
Demura et al.[38]	DFRA (Demura's Fall Risk Assessment)	Japanese	1122	70.3 Mean 7.1 SD 66.13% F	Community	Interview	N.A.	N.A.	N.A.	N.A.
Filiatrault et al.[55]	FAB Scale (Falls Behavioral Scale)	French (Canada)	64	77.3 Mean 8.5 SD (61-92) R 78% F	Community	Interview	0.91	0.94	N.A.	N.A.
Forslund et al.[56]	SCI FCS (Spinal Cord Injury Falls Concern Scale)	Swedish	87	49 Mean (18-79) R 25.3% F	Community	Interview	0.954	N.A.	N.A.	N.A.

(*continued*)

Table 7. Continued.

Authors	Scale	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC	ROC curve (SENS. SPEC. PPV NPV)
Hester et al.[57]	HDS (Hester Davis Scale)	English (USA)	1904 (stroke)	49.7% F	Neurosciences unit	Interview	0.772	N.A.	N.A.	90.9% SENS. 47.1% SPEC. 3.9% PPV 99.5% NPV 0.780 AUC (cut score 10)
Jakovljevic[46]	MFAT (Modified Fall Assessment Tool)	Slovenian	83	80 Mean 7 SD 80% F	Nursing homes	Interview	N.A.	N.A.	N.A.	61.10% SENS. 80% SPEC. 45.80% PPV 88.10% NPV (cut off $\geq$20)
Mehraban et al.[58]	HOME FAST SR	English (Australia)	568	76.8 M 100% F	Community (domestic environment)	Self-administration	N.A.	N.A.	N.A.	N.A.
Mihaljcic et al.[59]	SAFRM (Self-Awareness of Falls Risk Measure)	English (Australia)	91	77.97 Mean 8.04 SD (62-93) R 58% F	Rehabilitation clinic	Interview	0.86-0.92	0.61-0.87	N.A.	N.A.
Myers et al.[45]	FRAT1 (Fall Risk Assessment Tool 1)	English (Australia)	226	84.91 Mean 8.53 DS (41-98) R 71.7% F	Geriatric and rehabilitation units	Interview	N.A.	0.85	N.A.	0.646 ROC 91% SENS. 25% SPEC. 18% PPV 94% NPV
	FRAT2 (Fall Risk Assessment Tool 2)						N.A.	0.8	N.A.	0.622 ROC 91% SENS. 27% SPEC. 18% PPV 94% NPV

(*continued*)

Table 7. Continued.

Authors	Scale	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC	ROC curve (SENS. SPEC. PPV NPV)
Nandy et al.[47]	FRAT (Falls Risk Assessment Toll)	English	343	74.4 Mean 6.4 SD (65-92) R 55% F	Community	Interview	N.A.	N.A.	N.A.	59% SENS. 80% SPEC. 43% PPV 88% NPV (WITH 2 OR MORE RISK FACTORS) 42% SENS. 92% SPEC. 57% PPV 86% NPV (WITH 3 OR MORE RISK FACTORS) 15% SENS. 97% SPEC. 58% PPV 82% NOV (WITH 4 OR MORE RISK FACTORS)
Neumann et al.[60]	LUCAS FALL RISK SCREENING	Germany	2141	82 Mean (65-100) R 69.6% F	Geriatric clinic	Interview	N.A.	N.A.	N.A.	46% SENS. 71.1% SPEC. 14.9% PPV 92.3% NPV (cut off $\geq$2)
Palese et al.[61]	CONLEY SCALE	Italian	1464	74.4 Mean 51 %	Acute medical units	Interview	0.465	N.A.	N.A.	60% SENS. 55.9% SPEC. 2.7% PPV 98.5% NPV
Peeters et al.[48]	LASA FALL RISK PROFILE	Dutch	408	77.9 Mean 7.1 SD 73.3% F	Community	Interview	N.A.	N.A.	N.A.	0.65 AUC 56.6% SENS. 71.4% SPEC. 34.1% PPV 85.6% NPV (cut off =8)

(*continued*)

Table 7. Continued.

Authors	Scale	Language	Sample (pathology)	Mean age (M)/SD/ Range(R)/% Gender	Setting	Administration	Cronbach's α	ICC	IIC	ROC curve (SENS. SPEC. PPV NPV)
Rubenstein et al.[62]	FRQ (Fall Risk Questionnaire)	English (USA)	40	>65	Community	Self-administration	0.795	N.A.	N.A.	96.8% SENS. 66.6% SPEC.
Tiedemann et al.[49]	ED FST (Emergency Department Falls Screening Tool)	English (Australia)	206	80.97 Mean 6.24 SD 54% F	Emergency departments	Interview	N.A.	N.A.	N.A.	0.70 AUC
			178	81.09 Mean 6.56 SD 73% F			N.A.	N.A.	N.A.	N.A.
Van Hensbroek et al.[50]	CTI (Carefall Triage Instrument)	Dutch	200	73 Mean (69-79) R 60% F	Emergency departments	Self-administration	N.A.	0.79	N.A.	N.A.
Vu et al.[63]	HOME FAST	English (Australia)	31	79.7 M 7.68 SD 69% F	Community (domestic environment)	Interview	N.A.	0.82 inter rater reliability and 0.77 reliability	N.A.	N.A.
Whitney et al.[64]	FIBS (Fall-related Impulsive Behaviour Scale)	English	109 (cognitive impairments)	84.5 Mean 8.3 SD 63% F	Nursing homes	Interview	0.77	0.93	N.A.	N.A.
Wiens et al.[39]	FRAQ (Falls Risk Awareness Questionnaire)	English (Canada)	102	73 Mean 6.3 SD 56% F	Hospital	Self-administration + interview	N.A.	N.A.	N.A.	N.A.
Woo et al.[65]	N.D	Chinese	3890	50.10% F	Community	Interview	N.A.	N.A.	N.A.	>0.70 AUC 78 % SENS. 56% SPEC. (MALE) 71% SENS. 64% SPEC.(FEMALE)
Yang et al.[66]	FVAQ (Fall Video Analysis Questionnaire)	English (Canada)	130	81 Mean 13 SD 67% F 82 Mean 10 SD 61% F	Nursing homes	N.A.	N.A.	N.A.	N.A.	N.A.

Discussion

Summary of the quality of the evidence

Falls are among the most serious problems of older adults, with high mortality and morbidity rates. Implementing preventive strategies is often effective, but it is not always possible because of poor resources. For this reason, it is crucial to properly identify individuals with a high fall risk to target resources better. In fact, medical associations and national health authorities recommend the adoption of valid fall risk assessment tools.

The first objective of the review was to identify fall risk assessment tools for older adults that have been validated on an international level. The second objective was to collect the scores of these tools, paying particular attention to the validation setting. The data available in the major databases up to February 2017 permit the identification of different fall risk assessment tools internationally. The research was conducted using keywords and no time limits were set so as not to exclude any study that could have made important contributions to the review. This review included 55 studies published between January 1979 and February 2017: 21 on the FES and its variants, 7 on the ABC scale, 3 on the STRATIFY scale, and the remaining 24 were related to other tools used less worldwide.

Falls Efficacy Scale versions

It is clear that the FES (and in particular, the international full version) is the most used tool. It has been translated into 13 different languages (English,[6] Persian,[7] Greek,[8] Portuguese,[9] Swedish,[10] Arabic,[11] German,[12] Norwegian,[13] Dutch,[12] Chinese,[14] Spanish,[15] Italian[16] and Turkish[17]) and validated in healthy older adults as well as in various pathologies and frail older adults (stroke, osteoporosis in women, menopause, and multiple sclerosis). The results suggest that the FES-I has good reliability. In only one of the analyzed studies[39] were predictive values studied and reported, the authors suggested a cutoff point to distinguish between low and strong fear of falling and two cutoff points to distinguish between low, moderate, and strong fear of falling. Future studies could investigate cutoff point in individuals with different pathologies and in different languages.

The results of this review shows that all FES versions have good reliability and they are validated in different languages (FES-I Short,[13,14,16,39,40] FES first version,[19,41,42] FES Modified and FES Adapted,[22,23] FES iconographical[24])

Activities Specific Balance Confidence Scale (ABC)

The second most used tool is the ABC scale. It evaluates the fear of falling through personal balance confidence in older adults living in a community

setting and it is also validated in individuals with Parkinson's disease.[29] The 16-item version has been validated in five languages: Chinese,[27,28] Italian,[29] Hebrew,[30] English,[31] and German[32] and the short version in four languages: Italian,[29] Hebrew,[30] English,[31] and German.[32] The results suggest the good reliability for all versions. Several authors[30,31,43] claimed that the short version differentiates better than the integral version the subjects at risk of falling. The hypothesis is that this difference is due to the fact that the short version includes activities with a higher difficulty rate, and with 10 more items on the integral version, the final score could swell, expressing more confidence with the activities. In any case, the short version is valid and reliable, and since it requires the shortest amount of time for its administration, it is quite suitable for very busy clinics.[30–32,43] From the analyzed studies, it is obvious that an interview is more reliable than self-administration, especially in older adults with low educational levels, because an interview allows them to understand the items and the compilation procedure better. None of the studies included in this review for the ABC scale report predictive values, future studies could investigate these aspects.

St Thomas Risk Assessment Tool (STRATIFY)

The third most represented tool is the STRATIFY scale. It has been validated in two languages: English,[34,35] and Spanish.[36] The STRATIFY scale assesses the risk of falling in hospitals in patients with medical, surgical, mental, and oncological problems. The results are not very encouraging, in particular in the study of Webster et al. (2008),[34] 82% of the patients at risk of falling did not fall (positive predictiveness 18%), which makes the scale less useful clinically. A large number of false positives, in fact, can lead to the mismanagement of resources, with unnecessary targeting of people who are not at risk. Results for the Spanish version of the STRATIFY scale are not available yet, the study by Aranda-Gallardo et al. (2015)[36] is still in progress but, according to the authors, future findings on prediction will have strong evidence thanks to the number of samples.

All scales

The research found 25 other validated tools in 9 different languages. A setting stratification for all the 33 included tools indicates that the most effective tools in the hospital environment (medical units, geriatric clinics, and rehabilitation clinics) were the two Fall Risk Assessment Tools (FRATs) of Myers et al. (2003).[44]

The lack of much data from a few studies regarding validated instruments in nursing homes does not allow a conclusion, but the instrument of Jakovljevic (2009)[45] appears to be the best analyzed. This questionnaire

investigates previous falls, cognition, impulsive behavior, use of psychotropic medicines, incontinence and urgency, and environmental hazards, and the scale presents discrete predictive values. The authors recommended its use. From the many studies concerning the extra-hospital environment and community-dwelling older adults, only the FRAT by Nandy et al. (2004)[46] and the LASA fall risk profile by Peeters et al. (2010)[47] reported all predictive values. The first investigates previous falls, drug use, neurological disorders, balance problems, and muscular strength and has a positive predictive value ranging from 43% to 58% depending on how many risk factors are present. The LASA fall risk profile investigates previous drops, dizziness, disability, grip strength, weight, pets, fear of falling, alcohol intake, and social level and has a positive predictive value of 34.1%. However, only the first was recommended by the authors.

Finally, for emergency departments, the tools of Tiedemann et al. (2013)[48] and Boele Van Hensbroek et al. (2009)[49] were validated but predictive values were not reported.

Limitations of the study

There are several limitations of this review that need to be considered. Despite having systematically searched three electronic databases, it is possible that not all relevant studies were identified. Studies may have been published in journals that were not covered by the databases. In addition, this review only included published studies; therefore, studies that have been submitted and not accepted for publication or were accepted for publication only recently would be excluded. Only English-language articles were included, making it possible that this systematic review is not a complete representation of the evidence available worldwide. Finally, studies may not have been identified with the search strategy used.

Conclusions

This study was conducted by a research group composed by medical doctors and rehabilitation professionals from the "Sapienza" University of Rome and from "Rehabilitation & Outcome Measure Assessment" (R.O.M.A.) association. R.O.M.A. association in the last few years has dealt with several systematic reviews and the validation of many outcome measures in Italy.[66–76]

The data available in the literature before February 2017 allowed for the identification of 33 different fall risk assessment tools, but it is still not possible to identify one that is usable at any time and in any setting. Even with a setting stratification, it was not possible to reach definitive

recommendations. Internationally, the most used tools are the FES-I and ABC scale. The FES-I has been validated in 13 languages; it uses 16 items to evaluate the fear of falling in community-dwelling older adults. The ABC scale has been validated in five languages; it evaluates the fear of falling through balance confidence in social and physical activities in community-dwelling older adults. Both tools are reliable. The large number of tools reflects a strong tendency to create new instruments, with only a few of them recommended. However, to reach a gold standard, it would be good to try to validate the existing scales instead of creating new ones.

Conflict of interest

The Authors declares that he has no conflict of interest.

Statement of human and animal rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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