Research Report

OPEN

Can the 1-Leg Standing Test Be Replaced by Self-reported Balance in the First-Time Injurious Fall Screening Tool?

Nathalie Frisendahl, MSc[1,2]; Stina Ek, PhD[3]; Erik Rosendahl, PhD[4]; Erika Franzén, PhD[2,5,6]; Anne-Marie Boström, PhD[6,7,8]; Anna-Karin Welmer, PhD[1,2,9,10]

[1]*Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet and Stockholm University, Stockholm, Sweden.*
[2]*Division of Physiotherapy, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm, Sweden.*
[3]*Unit of Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden.*
[4]*Department of Community Medicine and Rehabilitation, Physiotherapy, Umeå University, Umeå, Sweden.*
[5]*Allied Health Professionals, Medical Unit Occupational Therapy & Physiotherapy, Karolinska University Hospital, Stockholm, Sweden.*
[6]*Research and Development Unit, Stockholms Sjukhem, Stockholm, Sweden.*
[7]*Division of Nursing, Department of Neurobiology, Care Science and Society, Karolinska Institutet, Huddinge, Sweden.*
[8]*Theme Aging, Karolinska University Hospital, Huddinge, Sweden.*
[9]*Stockholm Gerontology Research Center, Stockholm, Sweden.*
[10]*Women's Health and Allied Health Professionals Theme, Medical Unit Medical Psychology, Karolinska University Hospital, Stockholm, Sweden.*

The Swedish National Study on Aging and Care is supported by the Swedish Ministry of Health and Social Affairs and the participating county councils and municipalities. This work was further supported by the Swedish Research Council (grant number 521-2014-21-96), Therese och Johan Anderssons minne, the Strategic Research Area Health Care Science at Karolinska Institutet and Umeå University, and the Doctoral School in Health Care Sciences at Karolinska Institutet.
The sponsors had no role in the design, methods, subject recruitment, data collections, analysis, or preparation of the manuscript.
The authors declare no conflicts of interest.

Address correspondence to: Nathalie Frisendahl, MSc, Division of Physiotherapy, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, 23100, 141 83 Huddinge, Sweden (nathalie.frisendahl@ki.se).

DOI: 10.1519/JPT.0000000000000362

ABSTRACT

Background and Purpose: The First-time Injurious Fall (FIF) screening tool was created to identify fall risk in community-living older men and women, who may be targets for primary preventive interventions. The FIF tool consists of 3 self-reported questions and 1 physical test (1-leg standing balance). The purpose of this study was to examine the predictive ability of the FIF tool and a modified FIF tool (in which 1-leg standing is replaced by self-reported balance) for first-time injurious falls.

Methods: A cohort of 1194 community-living people 60 years and older from the Swedish National Study on Aging and Care in Kungsholmen (SNAC-K), Sweden, was followed longitudinally for 5 years. Data on injurious falls were collected from registered data and were defined as receipt of care after a fall. The predictive ability of the FIF tool and the m-FIF tool was explored using Harrell's C statistic, stratified by sex.

Results and Discussion: The injurious fall rate per 1000 person-years was 54.9 (95% CI: 47.22-63.78) for women and 36.3 (95% CI: 28.84-45.78) for men. The predictive ability for women and men according to Harrell's C statistic was 0.70 and 0.71 for the FIF tool and the m-FIF tool. The predictive ability was 0.70 and 0.69 for 1-leg standing, and 0.65 and 0.60 for self-reported balance problems.

Conclusions: The m-FIF tool presented similar predictive ability as the FIF tool regarding first-time injurious falls. This finding could extend the usefulness of the tool to other settings, such as to electronic health (eHealth). A quickly and easily administered screening tool can help physical therapists to identify people with a high risk of falling who may need to undergo a more comprehensive fall risk assessment.

Key Words: community living, eHealth, objective measurement, older adults, subjective measurement

(*J Geriatr Phys Ther* 2023;46(2):103-109.)

CLINICAL IMPLICATIONS

- The First-time Injurious Fall (FIF) tool has shown high predictive values; however, it is not known whether the objective balance test of the FIF tool could be replaced by a self-reported question with similar diagnostic effectiveness.
- The modified FIF tool (m-FIF tool) showed similar predictive ability as the FIF tool regarding first-time injurious falls.
- The results of our study could extend the usefulness of the FIF tool to other settings, such as to e-health.

INTRODUCTION

More than one-third of community-living older adults fall each year and about 10% out of those require medical care as a result of an injurious fall.[1] Fall-related injuries in the older population are a major public health problem due to their economic and medical consequences.[1] Due to aging of the population, the number of individuals seeking care in the event of an injurious fall is expected to increase in the future.[2]

The most prominent risk factor for falls is having experienced a previous fall, suggesting that we may be able to reduce the total number of falls in the population by delaying or preventing first-time falls.[3] Considering the consequences of injurious falls, being able to delay or prevent that first injurious fall through preventive efforts will have important effects on public health as well as on the daily lives of older adults.

Present guidelines for fall risk prevention in community-living older adults recommend 3 sequential stages: screening to identify people at increased risk of falls, multifactorial fall risk assessment for those identified as at risk, and implementation of personalized interventions.[4] Physical therapists can play a crucial part in the primary prevention of injurious falls in older adults. A quickly and easily administrated screening tool can help physical therapists to prioritize who should undergo a more comprehensive fall risk assessment. Several methods are available for fall risk screening, assessment, and intervention.[5-7] Current screening methods are likely to classify people without a history of falls as having a low risk of falling. However, a substantial number of falls may still occur among older adults without a history of falls.[8]

We recently developed a new screening tool for prediction of risk of first-time injurious falls in community-living older adults, called First-time Injurious Fall (FIF) screening tool.[9] It was constructed by combining previously identified risk factors from reviews and meta-analyses,[10] and by weighting risk scores differently for men and women, based on previous research.[11,12] The FIF tool, which is quickly and easily administered, consists of 3 self-reported questions and 1 physical test (5-second 1-leg standing balance with eyes open) (Figure 1). The FIF tool has been validated in

First-time Injurious Falls – the FIF screening tool

			Women	Men
How old are you?	60-69	□	0	0
	70-79	□	1	2
	80-89	□	2	3
	90+	□	4	4
Do you live with someone?	Yes	□	0	0
	No	□	1	1
Do you need help in any or several of the following:	Yes	□	2	1
	No	□	0	0
• managing finances • using telephone • grocery shopping • using public transportation • preparing meals • cleaning • doing laundry				
Physical test (eyes open - 2 attempts/leg - best attempt counts)				
One-leg standing	<5 seconds	□	1	1
	≥5 seconds	□	0	0
	Total score =		___ /8	___ /7

Low fall risk	High fall risk
0-2 p	3+ p

Figure 1. First-time Injurious Fall screening tool. This figure is available in color online (www jgeript.org).

2 other cohorts other than the development cohort,[13] and the results show high predictive values (Harrell's C statistic ≥0.75 for both men and women).

Ganz et al[3] suggested that asking a binary question about gait or balance should be done for patients who have not had a previous fall when screening for fall risk. According to the Stopping Elderly Accidents, Deaths and Injuries (STEADI) initiative, it is recommended for physical therapists to ask patients whether they experience a feeling of unsteadiness when screening for risk of falls.[14,15] Self-reported measures are often preferred in electronic health (eHealth) settings.[16] Hence, it is likely that eHealth (ie, the use of information and communication technologies in health-related fields)[17] will be part of the future solution to enable provision of high-quality physical therapy with high accessibility. If the balance assessment (1-leg standing) of the FIF tool could be replaced by a self-reported question with similar diagnostic effectiveness, this could extend the usefulness of the screening tool to such settings.

In this study, the purpose was to examine the predictive ability of the FIF tool and a modified FIF tool (in which 1-leg standing balance is replaced by self-reported balance) for first-time injurious falls.

METHODS

Study Population

We used data of adults 60 years and older from an ongoing longitudinal population-based Swedish National Study on Aging and Care in Kungsholmen (SNAC-K).[18] A total of 3363 individuals (73.3% of all eligible individuals) participated in the baseline examination between year 2001 and 2004. The SNACK-K used stratified sampling; the population was stratified by age, and a random sample was then selected from each age group (ages 60, 66, 72, 78, 81, 84, 87, 90, 93, 96, and ≥99 years). Follow-up has been performed every sixth year for younger cohorts (60-78 years) and every third year for older cohorts (≥78 years).[19]

This study used baseline data from the fourth wave of follow-up between 2010 and 2012, when a question about self-reported balance problems was included in the cohort study. In total, 1520 individuals from 5 age groups (60, 81, 84, 87, and ≥90) were examined during this period. Since this study aimed to identify community-living older adults at risk of a first-time injurious fall, we excluded those who lived in an institution (n = 54), had missing data on accommodation (n = 1), or had experienced an injurious fall within 3 years before the examination date (n = 197). Of the remaining 1268 participants, 74 participants were excluded due to missing data on instrumental activities in daily life (IADL) (n = 22), test of 1-leg standing (n = 35), or self-reported balance problems (n = 17). The final analytical sample consisted of 1194 individuals. The excluded participants were significantly more likely to be women, older, and to have a lower educational level than the analytical sample ($P < .05$) (Figure 2).

Data Collection

Nurses and physicians collected data through structured interviews, clinical examinations, and physical function tests. The research protocol was approved by the Regional Ethics Review Board in Sweden, and written consent was obtained from all participants.

FIF tool

The development and external validation of the FIF tool has been described in detail elsewhere.[9,13] Briefly, it was constructed by combining previously established risk factors from reviews and meta-analyses. The tool was

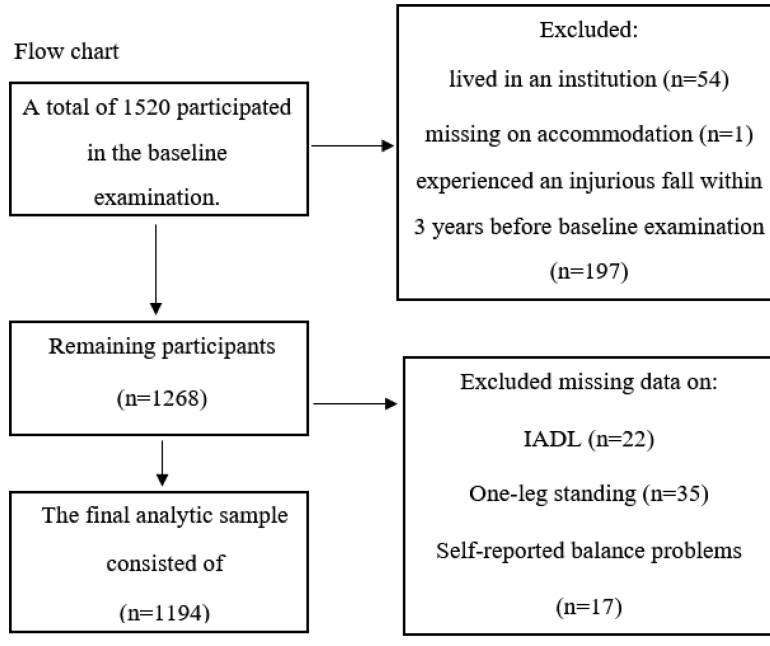

Figure 2. Population flowchart for baseline assessment.

formulated based on the β coefficients from sex-specific multivariate Cox proportional hazards models. The maximum scores are 8 points for women and 7 points for men. Low risk was assigned to less than 3 and a high risk 3 or more points according to the Youden index.[20]

The variables included in the FIF tool are age, cohabitation status, IADL, and balance (1-leg standing).[9] *Age* in the FIF tool is categorized into 4 age groups: 60 to 69, 70 to 79, 80 to 89, and 90 and more. However, since the fourth wave did not include participants in their 70s, this study included age groups 60 to 69, 80 to 89, and 90 and more. *Cohabitation status* was classified into "living alone" for those who were unmarried, divorced, or widowed and "cohabitating" for those who lived with a spouse or were married. Functional dependency was defined as being dependent in one or more of the *IADL* items: managing finances, using the telephone, grocery shopping, using transportation, preparing meals, cleaning, and doing laundry. *One-leg standing* was measured as the time in seconds that the participants could stand on 1 leg with their eyes open (up to 60 seconds). The participants had to have no shoes on, their arms hanging along their sides, and they each chose which leg to stand on first. The test was attempted 3 times per leg, and the best overall score was used. The 1-leg standing test is a reliable and validated measurement for balance.[21,22] A 1-leg standing time of less than 5 seconds was chosen as the cut-off for balance impairment, as indicated by Vellas et al.[23] It has been shown that not being able to stand on 1 leg for 10 seconds is associated with a higher risk of suffering a hip fracture.[24]

In the *modified* FIF tool (m-FIF tool), the 1-leg-standing test is replaced by a question about self-reported balance problems, in accordance with Ganz et al[3] and the STEADI recommendations.[14-15] The question in this study was derived from the nurse interview "Would you say that you have any problem with your balance? (in the past 12 months)" (yes/no).

Injurious falls

An injurious fall was defined as a receipt of inpatient care because of a fall. This information was retrieved from the National Patient Register.[25] We used discharged diagnosis from the date of the baseline examination until the end of the follow-up period (up to 5 years), and included the external cause codes (W00, W01, W05-W10, and W17-W19) from the *International Classification of Diseases, Tenth Revision*.[26] The codes represented low energy falls from the same level, with no other person involved. Information about the vital status of the participants was obtained from the Swedish Cause of Death Register.

Statistical Analysis

The differences in baseline characteristics between men and women were compared using the χ^2 test. Cox proportional hazards model was used to estimate hazard ratios (HRs) and 95% CIs of injurious falls as a function of the FIF tool, m-FIF tool, 1-leg standing, and self-reported balance problems, stratified by sex. Participants were censored at the date of the first injurious fall, death, or the end of the follow-up period (up to 5 years). The mean follow-up time was 4.25 years (SD) 1.38 years).

We applied Harrell's C statistics, to evaluate the predictive ability of the scores for the FIF tool, m-FIF tool, 1-leg standing, and self-reported balance problems, stratified by sex. For Harrell's C statistics, a value within 0.7 to 0.8 is considered as an acceptable prediction.[27]

In supplementary analyses, the diagnostic accuracy for the FIF tool and the m-FIF tool compared with first-time injurious falls during 5 years of follow-up was reported with sensitivity, specificity, and positive and negative predictive values with 95% CI for women and men. A value of 0.7 to 0.8 indicates good diagnostic accuracy.[28] Statistical analyses were performed using STATA version 15 (Stata Corp, College Station, Texas).

RESULTS

Of the 1194 participants, 740 (62%) were women (mean age 73.6 years, SD 13.1) and 454 (38%) were men (mean age 70.6, SD 12.2). The injurious fall rate per 1000 person-years was 54.9 (95% CI: 47.22-63.78) for women and 36.3 (95% CI: 28.84-45.78) for men. A total of 166 individuals died during the time period (99 women and 67 men). The characteristics of the study participants are depicted by sex in Table 1. As shown, the participating women were older, had a lower educational level, were more often living alone, and needed more help in IADL than the men. They also had more self-reported balance problems and measured balance impairments than the men.

For the FIF tool, HRs of an injurious fall for women and men, respectively, in the high-risk group were 6.69 (95% CI: 4.40-10.17) and 6.45 (95% CI: 3.69-11.27) compared with those in the low-risk group (Figure 3). For the m-FIF tool, HRs were 7.29 (4.77-11.16) for women and 6.44 (3.69-11.24) for men, compared with those in the low-risk group (Figure 3). Hazard ratios of an injurious fall for women and men with impaired 1-leg standing were 5.53 (95% CI: 3.86-7.91) and 4.90 (95% CI: 2.96-8.10) compared with those with unimpaired 1-leg standing (Figure 3). Hazard ratios of an injurious fall for women and men with self-reported balance problems were 3.34 (95% CI: 2.40-4.66) and 2.22 (95% CI: 1.40-3.52) compared with those without self-reported balance problems (Figure 3).

Predictive values for women and men according to Harrell's C statistic were 0.70 and 0.71 for the FIF tool, 0.70 and 0.71 for the m-FIF tool, 0.70 and 0.69 for 1-leg standing, and 0.65 and 0.60 for self-reported balance problems (Table 2).

Table 3 shows the diagnostic values for women and men with the FIF tool and the m-FIF tool compared with first-time injurious falls during 5 years of follow-up. The sensitivity and specificity for the FIF tool were 37% and 93% for women, and 29% and 94% for men, and 38% and 93% for women, and 29% and 94% for men for the m-FIF tool. The positive and negative predictive values for

Table 1. Baseline Characteristics of Participants by Sex

	Women, n (%) n = 740	Men, n (%) n = 454	*P* Value
Age, y			<.001
60-69	352 (47.52)	262 (57.71)	
80-89	324 (43.78)	172 (37.80)	
≥90	64 (8.65)	20 (4.40)	
Education			.004
Elementary	73 (9.86)	37 (8.13)	
High school	326 (44.05)	163 (35.82)	
University	341 (46.08)	254 (55.82)	
Living alone	436 (58.92)	144 (31.72)	<.001
IADL dependency	224 (30.27)	82 (18.06)	<.001
FIF tool—high-fall risk	386 (52.16)	193 (42.51)	<.001
m-FIF tool—high-fall risk	381 (51.49)	194 (42.73)	.003
Impaired 1-leg standing	332 (44.86)	176 (38.77)	.039
Self-reported balance problems	353 (47.70)	154 (33.92)	<.001

Abbreviations: IADL, instrumental activities in daily life; FIF, First-time Injurious Fall; m-FIF, modified FIF.

the FIF tool were 85% and 58% for women and 78% and 64% for men, and for the m-FIF tool, 85% and 59% for women and 78% and 64% for men.

DISCUSSION

In this study, we found that predictive values for first-time injurious falls did not differ between the FIF tool and the m-FIF tool and HRs were similar for both tools. However, when examined separately self-reported balance showed slightly lower predictive values and HRs than the 1-leg standing. Predictive values for the FIF tool found in this study were lower than those found in our previous studies.[9,13] A possible explanation is the lack of participants at the age of 70. There is a chance, had they been included, that there would have been more individuals scoring in the middle range that would have been directed into either the low- or high-risk group.

We used the 1-leg standing test in the FIF tool for measuring balance performance.[29] Our result indicates that the 1-leg standing by itself is a good predictor of first-time injurious falls. Indeed, the 1-leg standing test is considered to be a good indicator of balance ability,[24] and a sensitive test for older adults when trying to distinguish fallers from nonfallers.[30]

Results of diagnostic accuracy showed that the FIF tool and the m-FIF tool had low sensitivity but excellent specificity for detection of first-time injurious falls. In clinical settings, a low specificity may be beneficial to make sure that the invested time and money are efficiently spent. However, high sensitivity may be desirable for a public health fall prevention intervention, to include as many people as

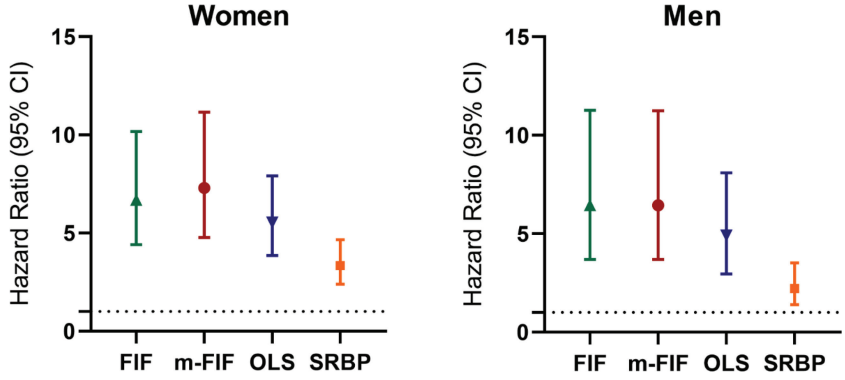

Figure 3. Hazard ratios and 95% CIs for first-time injurious fall in women and men up to 5 years after baseline in association with to the First-time Injurious Fall (FIF) tool, modified FIF (m-FIF) tool, 1-leg standing (OLS), and self-reported balance problems (SRBP). This figure is available in color online (www.jgeript.org).

Table 2. Predictive Capacity of Injurious Falls During 5 Years of Follow-up According to Harrell's C Statistic for the FIF Tool, m-FIF Tool, 1-Leg Standing Test, and Self-reported Balance Problems

	Women, n = 740			Men, n = 454		
	n	Cases	Harrell's C	n	Cases	Harrell's C
FIF tool						
Low risk	354	26	0.70	261	16	0.71
High risk	386	144		193	56	
m-FIF tool						
Low risk	359	25	0.70	260	16	0.71
High risk	381	145		194	56	
1-leg standing						
Normal	408	39	0.70	278	22	0.69
Impaired	332	131		176	50	
Self-reported balance problems						
No	387	49	0.65	300	37	0.60
Yes	353	121		154	35	

Abbreviations: FIF, First-time Injurious Fall; m-FIF, modified FIF.

possible who are at an elevated risk and may need further assessments by a physical therapist. The FIF tool could be part of a larger screening battery to increase the sensitivity, for example by including questions about fear of falling and previous falls, in line with the STEADI recommendations.[14-15] The FIF tool and the m-FIF tool screen for fall risk over time, while diagnostic tests do not consider time to event. Furthermore, diagnostic tests are designed to compare a screening test with a reference (gold) standard test (eg, screening for cancer as compared with a diagnosis of cancer).[31] Thus, the diagnostic accuracy must be interpreted with that in mind. The results for the diagnostic accuracy are, in turn, comparable with previous studies on fall risk screening.[7,15]

Our results indicate that the m-FIF tool may be suitable to use in eHealth settings, which may expand its usefulness. A self-managed screening test could be performed by the older adult herself/himself at home or in the waiting room at the primary care center. The result of the screening would then be reviewed by a physical therapist who can evaluate that specific patient's need for a full fall risk assessment and act accordingly. Another option could be to use the m-FIF tool in public health surveys, which are being administrated digitally.

The strengths of this study include the long follow-up period, which is necessary when the focus is to predict future falls and identify people in need of primary prevention.[8] Another strength is that we have used the objective measure of seeking health care due to a fall from high-quality registers as our outcome, thus limiting potential recall bias.[25] The limitations of the study are that not all people who suffer an injurious fall seek health care, which might lead to potential misclassification of the outcome. This study is based on SNAC-K participants—an urban, well-educated population, thus possibly limiting the generalizability. Also, the validity of self-reported balance may be limited by report bias, which could differ by sex or other individual differences (ie, older adults tend to underestimate their physical capabilities).[32] Another limitation of the study is that we could not include participants in their

Table 3. Diagnostic Values for Women and Men With the FIF Tool and the m-FIF Tool Compared With First-Time Injurious Falls During 5 Years of Follow-up

	First-Time Injurious Falls During 5 y of Follow-up, Diagnostic Value (95% CI)			
	FIF Tool		m-FIF Tool	
	Women, n = 740	Men, n = 454	Women, n = 740	Men, n = 454
Sensitivity	37.3 (32.5-42.3)	29.0 (22.7-36.0)	38.1 (33.2-43.1)	28.9 (22.6-35.8)
Specificity	92.7 (89.4-95.1)	93.9 (90.2-96.5)	93.0 (89.9-95.4)	93.8 (90.2-96.4)
Positive predictive value	84.7 (78.4-89.8)	77.8 (66.4-86.7)	85.3 (79.1-90.3)	77.8 (66.4-86.7)
Negative predictive value	57.5 (53.4-61.6)	64.1 (59.1-69.0)	58.6 (54.4-62.7)	63.9 (58.8-68.7)

Abbreviations: FIF, First-time Injurious Fall; m-FIF, modified FIF.

70s since they were not included in the fourth wave of data collection that we used for this study. This may limit the generalization of the results. Finally, the question about balance refers to balance in general and not specifically to the ability to stand on 1 leg. Future studies are also needed to investigate the FIF tool in clinical settings, and as part of a larger screening battery.

CONCLUSIONS

Our results suggest that the m-FIF tool has similar predictive ability for risk of first-time injurious falls as the FIF tool. However, 1-leg standing alone showed higher predictive values than self-reported balance problems. The m-FIF tool can be a good option when direct measurement of balance performance is not feasible such as eHealth settings.

ACKNOWLEDGMENTS

The authors thank all the participants for their invaluable contributions and our collection staff for their collaboration in data collection and management.

REFERENCES

1. Kannus P, Sievanen H, Palvanen M, Järvinen T, Parkkari J. Prevention of falls and consequent injuries in elderly people. *Lancet (London, England).* 2005;366(9500):1885-1893. doi:10.1016/S0140-6736(05)67604-0
2. World Health Organization. *WHO Global Report on Falls Prevention in Older Age*. Accessed December 10, 2020. http://www.who.int/ageing/publications/Falls_prevention7March.pdf
3. Ganz DA, Bao Y, Shekelle PG, Rubenstein LZ. Will my patient fall? *JAMA.* 2007;297(1):77-86. doi:10.1001/jama.297.1.77
4. Kenny R, Rubenstein LZ, Tinetti M, et al. Summary of the updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. *J Am Geriatr Soc.* 2011;59(1):148-157. doi:10.1111/j.1532-5415.2010.03234.x
5. Mello Porto J, Rodrigues Losimuta N, Freire Junior R, et al. Risk factors for future falls among community-dwelling older adults without a fall in the previous year: a prospective one-year longitudinal study. *Arch Gerontol Geriatr.* 2020;23(91):104161. doi:10.1016/j.archger.2020.104161
6. Mello Porto J, Cangussu-Oliveira L, Freire Junior R, et al. Relationship between lower limb muscle strength and future falls among community-dwelling older adults with no history of falls: a prospective 1-year study. *J Appl Gerontol.* 2021;40(3):339-346. doi:10.1177/0733464820932778
7. Park SH. Tools for assessing fall risk in the elderly: a systematic review and meta-analysis. *Aging Clin Exp Res.* 2018;30(1):1-16. doi:10.1007/s40520-017-0749-0
8. Muir SW, Berg K, Chesworth B, Klar N, Speechley M. Application of a fall screening algorithm stratified fall risk but missed preventive opportunities in community-dwelling older adults: a prospective study. *J Geriatr Phys Ther.* 2010;33(4):165-172. doi:10.1519/JPT.0b013e3181ff23cc
9. Ek S, Rizzuto D, Calderon-Larranaga A, Franzén E, Xu W, Welmer AK. Predicting first-time injurious falls in older men and women living in the community: development of the First Injurious Fall screening tool. *J Am Med Dir Assoc.* 2019;20(9):1163-1168. doi:10.1016/j.jamda.2019.02.023
10. Deandrea S, Lucenteforte E, Bravi F, Foschi R, La Vecchia C, Negri E. Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. *Epidemiology.* 2010;21(5):658-668. doi:10.1097/EDE.0b013e3181e89905
11. Chang VC, Do MT. Risk factors for falls among seniors: implications of gender. *Am J Epidemiol.* 2015;181(7):521-531. doi:10.1093/aje/kwu268
12. Ek S, Rizzuto D, Fratiglioni L, et al. Risk factors for injurious falls in older adults: the role of sex and length of follow-up. *J Am Geriatr Soc.* 2019;67(2):246-253. doi:10.1111/jgs.15657.
13. Frisendahl N, Ek S, Rosendahl E, et al. Predictive performance of the FIF screening tool in 2 cohorts of community-living older adults. *J Am Med Dir Assoc.* 2020;21(12):1900-1905. doi:10.1016/j.jamda.2020.04.037
14. Centers of Disease Control and Prevention. STEADI: Stopping Elderly Accidents, Deaths and Injuries. Accessed December 16, 2021. https://www.cdc.gov/steadi/index.html
15. Rubenstein LZ, Vivrette R, Harker JO, Stevens JA, Kramer BJ. Validating an evidence-based, self-rated fall risk questionnaire (FRQ) for older adults. *J Safety Res.* 2011;42(6):493-499. doi:10.1016/j.jsr.2011.08.006
16. Bergland A, Jarnlo GB, Wyller Bruun T. Self-reported walking, balance testing and risk of fall among the elderly. *Tidsskr Nor Laegeforen.* 2006;126(2):176-178. Accessed February 10, 2022. https://tidsskriftet.no/sites/default/files/pdf2006–176-8.pdf
17. World Health Organization. *WHO Guideline: Recommendations on Digital Interventions for Health System Strengthening*. Accessed October 1, 2021. https://www.who.int/publications/i/item/9789241550505
18. Lagergren M, Fratiglioni L, Hallberg IR, et al. A longitudinal study integrating population, care and social services data. The Swedish National study on Aging and Care (SNAC). *Aging Clin Exp Res.* 2004;16(2):158-168. doi:10.1007/BF03324546
19. Stenhagen M, Ekstrom H, Nordell E, Elmståhl S. Falls in the general elderly population: a 3- and 6- year prospective study of risk factors using data from the longitudinal population study "Good ageing in Skane." *BMC Geriatr.* 2013;7(13):81. doi:10.1186/1471-2318-13-81
20. Youden WJ. Index for rating diagnostic tests. *Cancer.* 1950;3(1):32-35. doi:10.1002/1097-0142(1950)3:1<32::aid-cncr2820030106>3.0.co;2-3
21. Franchignoni F, Tesio L, Martino MT, Ricupero C. Reliability of four simple, quantitative tests of balance and mobility in healthy elderly females. *Aging (Milano).* 1998;10(1):26-31. doi:10.1007/BF03339630
22. Jonsson E, Seiger Å, Hirschfeld H. One-leg stance in healthy young and elderly adults: a measure of postural steadiness? *Clin Biomech (Bristol, Avon).* 2004;19(7):688–694. doi:10.1016/j.clinbiomech.2004.04.002
23. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, Rubenstein LZ, Garry PJ. One-leg balance is an important predictor of injurious falls in older persons. *J Am Geriatr Soc.* 1997;45(6):735-738. doi:10.1111/j.1532-5415.1997.tb01479.x
24. Lundin H, Sääf M, Strender L-E, Nyren S, Johansson S-E, Salminen H. One-leg standing time and hip-fracture prediction. *Osteoporos Int.* 2014;25(4):1305-1311. doi:10.1007/s00198-013-2593-1
25. Bergstrom MF, Byberg L, Melhus H, Michaelsson K, Gedeborg R. Extent and consequences of misclassified injury diagnoses in a national hospital discharge registry. *Inj Prev.* 2011;17(2):108-113. doi:10.1136/ip.2010.028951
26. Welmer AK, Rizzuto D, Laukka EJ, Johnell K, Fratiglioni L. Cognitive and physical function in relation to the risk of injurious falls in older adults: a population-based study. *J Gerontol A Biol Sci Med Sci.* 2017;72(5):669-675. doi:10.1093/gerona/glw141
27. Hosmer DW Jr, Lemeshow S, Studivant RX. *Applied Logistic Regression*. 3rd ed. Wiley; 2013.
28. Simundic A-M. Measures of diagnostic accuracy: basic definitions. *EJIFCC.* 2009;19(4):203-211. Accessed February 10, 2022. https://www-ncbi-nlm-nih-gov.proxy.kib.ki.se/pmc/articles/PMC4975285/pdf/ejifcc-19-203.pdf
29. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Age Ageing.* 2006;35(suppl 2):ii7-ii11. doi:10.1093/ageing/afl077
30. Kozinc Ž, Löfler S, Hofer C, Carraro U, Šarabon N. Diagnostic balance tests for assessing risk of falls and distinguishing older adult fallers and non-fallers: a systematic review with meta-analysis. *Diagnostics (Basel).* 2020;10(9):667. doi:10.3390/diagnostics10090667
31. Altman DG, Bland JM. Diagnostic tests 2: predictive values. *BMJ.* 1994;309(6947):102. doi:10.1136/bmj.309.6947.102
32. Kamitani T, Yamamoto Y, Fukuma S, et al. Association between the discrepancy in self-reported and performance-based physical functioning levels and risk of future falls among community-dwelling older adults: the Locomotive Syndrome and Health Outcomes in Aizu Cohort Study (LOHAS). *J Am Med Dir Assoc.* 2019;20(2):195-200. doi:10.1016/j.jamda.2018.09.009