Original Article

Predictive Validity of Three Fall Risk Assessment Tools in Nursing Home Residents in Turkey: A Comparison of the Psychometric Properties

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Abstract

Background: In the elderly, the functional losses associated with aging and inadequacies caused by chronic diseases can cause accidents. Falls is one of the most important problems that threaten elderly individuals and necessary precautions can be taken by evaluating the risk of falling. Fall rates in nursing homes are often substantially higher than are those in community or hospital settings. Although fall risk assessment is essential to prevent falls, there is not valid and reliable tool that can be suggested to nursing home residents.
Aim: This paper is a report of a study comparing the psychometric properties of the Fall Risk Assessment (FRA), Morse Fall Scale (MFS) and Hendrich Fall Risk Model-II (HFRM-II) in nursing home residents.
Methods: Data from 159 nursing home residents were assessed using three tools to detect falls: the FRA, the MFS and the HFRM-II.
Results: The FRA at the cut-off level ≥12 and the HFRM-II at the cut-off level of>5 had strong sensitivity values of 88.24% and 80.39%, respectively. However, only the MFS had a more acceptable level of specificity (71.30%). Of the scales used in this study, the one with the highest AUC value according to the cut-off points we set for the scales was FRA (0.76 for FRA, 0.72 for MFS and 0.62 for HFRM-II).
Conclusions: When the area under the receiver operating characteristic curve (AUC) and the four validity criteria are taken into account, the FRA showed the most satisfactory results. It was also concluded that MFS could be used in nursing homes, but that FRA was more suitable for this population because of its high sensitivity and AUC values. The discriminatory power of HFRM-II was low. Therefore, it is thought that HFRM-II should not be used for determining the risks of falls in nursing home residents.

Keywords: Falls, ageing, nurse-patient, nursing assessment, older people nursing, risk management.

Introduction

Approximately 60% of all nursing home (NH) residents have fallen experience each year. Many residents had two or more falls. The average number of falls in NH is almost three times higher than in elderly people living in the community (Wagner, Scott, & Silver 2011). According to the Center for Disease Control (CDC), the most common cause of falls in NH residents is muscle weakness and walking or gait problems. By contrast, environmental hazards constitute 16-20% of falls. The CDC estimates that about 1800 NH residents die from the falls each year in the nursing home. Approximately 10% to 20% of the falls result in serious injuries while 2% to 6% of the falls result in fractures (CDC 2015). In a study performed in Turkey, the rate of falls was 14% in the intensive care units, 24% in the rehabilitation unit and 39% in the elderly rehabilitation unit. In the same study, the incidence of falls in patients hospitalized for 100 days in the rehabilitation centers was 15.9% (Capaci 2007). High fall rates in NH residents reveal the importance of fall prevention programs. To prevent falls in NHs, it is recommended to consider medical treatment, rehabilitation and environmental changes in combination (Quigley et al. 2010). Existing evidence recommends that multifactorial fall prevention programs should be administered at local and national level, but at the same time economic, cultural and political factors must be taken into account (Gillespie et al. 2012, Guo et al. 2014, McClure et al. 2005, WHO 2007). Nevertheless, in many societies, especially in developing countries, fall prevention measures are not taken into consideration and remain an issue that is not adequately emphasized (WHO 2007). In countries like Turkey, whereas policies regarding the prevention of falls in the elderly are inadequate, the fall prediction tools targeting patients in terms of fall prevention strategies have been widely used in health care organizations and NHs. Despite the lack of evidence related to the reliability of fall risk assessment tools, many NHs continue to use them (Wagner, Scott, & Silver 2011, Isik et al. 2006, Kerem et al. 2001). Although the use of such tools might be an attractive option, their use might be falsely reassuring that “something has been done” to target high-risk patients, whereas in fact it is an opportunity to focus on more effective interventions that have been missed (Jarvinen et al. 2008, Hendrich, Bender, & Nyhuis 2003).

It has been proven that there is a strong relationship between multiple risk factors and falls. Today, there are not many risk assessment tools that can be used reliably in different settings to determine the risk of falling accurately, and few of the available tools have been verified in more than one setting. Some of them have been tested in different settings, with incompatible results, including difficulties for common usage, validity incompatibilities between the original version and successive ones, and in the diversity of diagnostic accuracy in terms of cut-off points. If the scale that has poor methodological quality is used, the patient who are at risk of falling are detected as at more or less risk than actual risk. Thus, while resources for preventive initiatives can be allocated to patients who do not need them, patients who need them cannot access them (Aranda-Gallardo et al. 2013). For a tool to be considered "valid", it should meet the gold standard for quality risk assessment tools. In Turkey, the most commonly used FRATs in acute care settings and long-term care are the Fall Risk Assessment (FRA), Morse Fall Scale (MFS) and Hendrich Fall Risk Model II (HFRM-II). Although the FRA is not a new tool, it has not been tested on NH residents so far. However, the risk factors included in FRA are especially important for geriatric population. Although there is not a tool known as gold standard in determination of the risk of falling, we decided to compare it with the HFRM-II and MFS as widely suggested by literature and commonly used in Turkey. Therefore, the aim of the present study was to determine the psychometrics properties of the Fall Risk Assessment, Morse Fall Scale and Hendrich Fall Risk Model II in NH residents.

Methods

Study design

The present study carried out from May 2014 to December 2014 had a prospective observational design.

Sample and setting

The participants of the study were 250 elderly persons registered in a NH; therefore, of the NH residents or persons admitted to the institution during the study period, those who volunteered to participate in the study, were aged 65 years or over, were with or without cognitive impairment were included in the study. Because the data could be easily obtained from medical records, the patients with cognitive impairment were included. Of these people, those who were not monitored during the follow-up period for any reason and those who were unconscious or confined to bed were excluded from the study because it was impossible to rate some of the items (i.e. the get up and go test) in the tool for them. Therefore, this study was conducted on 159 NH residents.

Data collection

In the nursing home, the researcher performed the fall risk assessment for the residents using the FRA, MFS and HFRM-II. Assessments were made every day and the residents were monitored for 2 months. All the nursing staff was made aware of the importance of the documentation of falls for study purpose.

Study limitations

The study was limited in several ways. Firstly, it was conducted in a single center. Therefore, we cannot generalize the study findings to other settings or population. In addition, the tools that are used in the study have been developed with the aim to be used in the hospital. Therefore, it may not be appropriate to use them in NHs. Another limitation is the absence of a gold standard since risk assessment tools measure the likelihood of the current situation.

Instruments

Fall Risk Assessment (FRA)

The FRA was developed by utilizing the Nebraska's Medicare Quality Improvement Organization and Falls Management Guidelines. There are nine main variables measured by the FRA: level of consciousness/ mental status, history of falls (past 3 months), ambulation / elimination status, vision status, gait and balance, orthostatic changes, medications, predisposing diseases and equipment issues. The total scores can range from 0 to 39. A total score of 10 or higher indicates a high risk of fall (Madak 2010). The validity and reliability study of the Turkish version of the scale was conducted by Tekin et al. (2013).

Morse Fall Scale (MFS)

J.M. Morse developed the MFS as an assessment tool to detect patients at high risk for falling. When it was first developed, its validity and reliability scores were high, scoring 0.96 in reliability, 0.78 in sensitivity and 0.83 in specificity. There are six main variables measured by the MFS: history of falling, secondary diagnosis, ambulatory aid, IV or IV access, gait and mental status. The total score can range from 0 to 125. A cut-off point of 45 was recommended by the scale developers (Baek et al. 2013).

Hendrich Fall Risk Model (HFRM) II

The HFRM tool consists of seven risk factors: confusion/disorientation/impulsivity, symptomatic depression, altered elimination, dizziness or vertigo, sex (male), any prescribed, anti-epileptics or benzodiazepines and the 'get up and go' test which assess the patient's ability to stand up from a sitting position to a standing position. The maximum score is 16, a total score of 5 or higher indicates a high risk of fall. In the developmental study, sensitivity and specificity were 74.9% and 73.9%, respectively. Inter-rater reliability has not been reported (Hendrich, Bender, & Nyhuis2003). Thevalidity and reliability study of the Turkish version of the scale was performed by Atay, Turgay, & Aycan (2009) in a hospital setting.

Data analysis

Statistical analysis was performed using the SPSS 18.0 (SPSS Inc., Chicago, IL, USA). For the three FRATs, the mean values were calculated including standard deviation (SD) and 95% confidence interval (Cl 95%). The sensitivity, specificity, positive predictive values (PPV) and negative predictive values (NPV) for each score of each scale were calculated and used as coordinates for the receiver operating characteristic (ROC) curve to determine the prognostic validity of a scale, the area under the receiver operating characteristic curve (AUC) is used commonly (the higher the AUC the better the scale).

Ethical consideration

During the planning stage of the study, the written approval was obtained from the Ege University Faculty of Nursing Ethics Committee of the relevant institution (Ref. No: 2013-63). In addition, the written permission from the relevant institutions where the study to be conducted and the verbal consents from the participants were obtained. In order to administer the questionnaire, necessary permissions were obtained from the authors of the tools through e-mail.

Results

Of the residents, 64 were male and 95 female. Their mean age was 76.4 years (SD 7.9) (Table 1). The number of falls patients had was 51, with a cumulative incidence of 32%, and a fall index of 8.5 per 1000 days of hospital stay. The mean age of the fallers was 81 years (SD 8.5). The mean age of the female fallers was very close to that of the male fallers (80.7 and 81.14 years respectively). The ratio of fallers to non-fallers among females was higher than that among males (40/95 and 11/64 respectively) (Table 1). Hypertension, diabetes and heart failure were the most common diagnoses (Table 1). There was a statistically significant relationship between fallers and non-fallers in terms of use of medication and fall history ($r = 0.199$, $p = 0.012$; $r = 0.505$, $p = 0.000$, respectively). The results of the predictive validity tests of the FRA, MFS and HFRM-II are summarized in Table 2. The FRA showed the best balance between sensitivity (88.24%) and specificity (64.81%) at the cut-off level (≥12), followed by the HFRM-II (sensitivity 80.39% and specificity 43.52%) at the cut-off level of >5, comparable to that found in the development study James et al. (2014) and Hendrich, Bender, & Nyhuis (2003). However, the best cut-off point for the MFS (sensitivity 74.51% and specificity 71.30%) was 45 which was different from the developer's results. As shown in Figure 1, all tools had moderate discrimination power [0.76 (95% CI 0.68-0.84) for FRA; 0.72 (95% CI0.64-0.81) for MFS; 0.62 (95% CI0.52-0.71) for HFRM-II].

At these cut-off levels, which indicated the best balance between sensitivity and specificity, the FRA and MFS had the highest PPV (54.22% and 55.07%), and the FRA the highest NPV (92.11%); the HFRM-II had both the lowest PPV (40.20%) and NPV (82.46%).

Table 1.Characteristics of the residents (n=159) and fallers (n=51)

Characteristics	**Total** (N=159)		**Fall** Yes (n=51)		No (n=108)		**Fall**
	n	(%)	n	(%)	n	(%)	
Gender							
Female	95	(59.75)	40	(78.43)	55	(50.92)	r=0.188
Male	64	(40.25)	11	(21.57)	53	(49.08)	p=0.254
Chronic Diseases							
Yes	150	(94.33)	48	(94.11)	102	(94.44)	r=-0.007
No	9	(5.67)	3	(5.89)	6	(5.56)	p=0.934
Hypertension	100	(62.89)	37	(72.54)	63	(58.33)	r=0.137 p=0.084
Diabetes	65	(40.88)	23	(45.09)	42	(38.88)	r=0.059 p=0.460
Heart Failure	61	(38.36)	25	(49.01)	36	(33.33)	r=0.151 p=0.058
Medications							
Yes	151	(94.97)	50	(98.1)	101	(93.52)	r=0.199
No	8	(5.03)	1	(1.9)	7	(6.48)	p=0.012
History of Falls (past 3 months)							
Yes	69	(56.60)	12	(23.5)	57	(52.78)	r=0.505
No	90	(43.40)	39	(76.5)	51	(47.22)	p=0.000

Table 2. Analysis of fall assessment (n=159) and observed falls (n=51)

Fall assessment toll	**FRA**	**MFS**	**HFRM-II**
At risk of fall (cutoff score)	≥12	≥45	≥5
Number of “at risk” residents that fell (total number of residents “at risk”)	45 (83)	38 (69)	41 (102)
Number of “not at risk” residentsthatdid not fall (total number of residents “not at risk”)	70 (76)	77(9)	47(57)
Sensitivity (%) (95%CI)	88.24	74.51	80.39
	(76.13-95.56)	(60.37-85.67)	(66.88-90.18)
Specificity (%) (95%CI)	64.81	71.30	43.52
	(55.04-73.76)	(61.80-79.59)	(34.00-53.40)
PPV (%)(95%CI)	54.22	55.07	40.20
	(47.36-60.92)	(46.65-63.21)	(35.18-45.43)
NPV (%)(95%CI)	92.11	85.56	82.46
	(84.45-96.16)	(78.49-90.58)	(72.15-89.50)

Note: FRA, Fall Risk Assessment; MFS, Morse Fall Scale; HFRM-II, **Hendrich Fall Risk Model II**; PPV, Positive Predictive Value; NPV, Negative Predictive Value; CI, Confidence Interval.

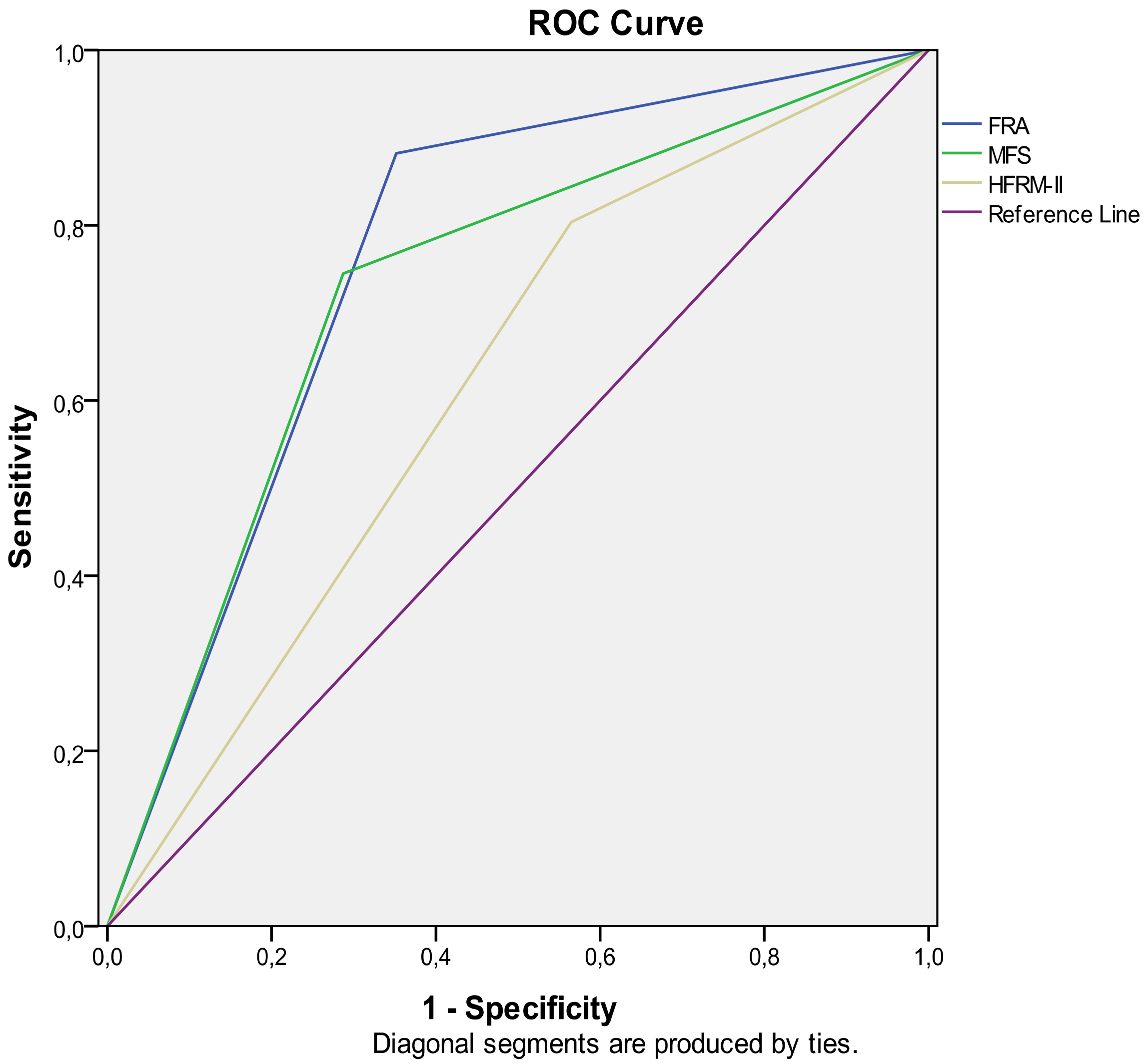

Figure 1. Receiver Operating Characteristics Curves of the three fall risk assessment scales. Note: FRA= Fall Risk Assessment; MFS= Morse Fall Scale; HFRM-II= Hendrich II Fal Risk Model.

Discussion

A FRAT should be sufficiently competent to distinguish between at-risk and non-at-risk patients in order to target preventive nursing interventions appropriately. When a tool is selected, it should be considered where the tool will be used and for what purpose. If the target is to identify high-risk populations, using of the tool should be easy and quick, and also it has good sensitivity and specificity (Scott et al. 2007). Criteria for demonstrating 'high' predictive values for FRATs are suggested by Perell et al (2001) as those that have sensitivity measures above 80% and specificity above 75%. However, Oliver et al. (2004) report that a 70% cut-off for sensitivity and specificity shows a 'high' predictive value. Based on these predictive values, the sensitivity of all tools, except for the MFS (74.51%), was quite high (88.24% for the FRA; 80.39% for the HFRM-II). In the literature, only one study conducted by James et al. (2014) reported that the FRA as a whole is an appropriate tool that significantly predicts the likelihood of a fall in home care clients. However, in that study, the predictive validity of this tool was not investigated, therefore, we were not able to compare our results. Similar findings indicating high sensitivity values of the HFRM-II were observed in other studies conducted in acute care settings which also served as the setting for the development of HFRM-II

(Hendrich, Bender, & Nyhuis 2003, Kim et al. 2007, Lovallo et al. 2010). Although the setting in the current study was not similar to those in aforementioned studies, we found the HFRM-II to have strong sensitivity. Higher sensitivity values determined in the presents study for the FRA and HFRM-II could be related to the fact that the risk factors included in these scales are more relevant to geriatric population. However, the MFS had a low value of sensitivity while other studies reported much higher values (O'Connell & Meyers 2002, Kim et al. 2007, Schwendimann et al. 2006, Ozden et al. 2012). The low level of sensitivity of the MFS determined in the current study could be explained by the fact that not all the risk factors included on the MFS were predictive of falls in the NH setting. For example, intravenous therapy/heparin lock may be the predictive of falls in an acute hospital setting where the tool was developed (Kim et al. 2007, Schwendimann, Milisen, & De Geest 2006). However, it may not relevant in a nursing home setting, thereby limiting the predictive validity.

Although the MFS had an acceptable specificity value (71.30%), the specificity values of the FRA and HFRM-II were lower than 70% (64.81% for the FRA and 43.52% for the HFRM-II). These results suggest that the predictive validity values of both scales especially that of the HFRM-II, were low. In the literature, although the cause is not precisely defined, men are more likely to fall and gender is stated as a risk factor (Hendrich, Bender, & Nyhuis 2003), and in the HFRM-II model used in this present study, male gender was among the risk criteria in the scale or scoring system. However, that 78.4% of the patients who fell were female in the present study proves that the discriminatory power of the HFRM-II in risk determination was low. This was an expected result because other studies have often found specificity values lower than those determined in the original studies because settings and population were different (Vassallo et al. 2005, Kim et al. 2007). The specificity of a measurement tool is important for the accurate identification of the patients at risk (Lalkhen & McCluskey 2008). Low specificity for the HFRM-II was also observed in Ozden, Karagozoglu, & Kurukız's (2012) (46%) and Ivziku, Matarese, & Pedone's (2011) (43%) studies. If the specificity is poor, fewer people are correctly determined as "not-at-risk", thereby it will result in the unnecessary use of preventive interventions (Kim et al. 2007, Vassallo et al. 2005). Due to low specificity values, fall prevention programs may lose some of their significance if nurses perceive that too many residents are diagnosed at high risk for falls (Ivziku, Matarese, & Pedone2011). In this present study, the PPV values of the three scales were not very high. This is probably because the nursing home where the study was conducted had no official policy to prevent or reduce the falling risk of it residents. However, the nurses working there must have taken precautions for the residents who they thought were at high risk of falling, which may have affected our results. The area under the ROC curve is considered the best indicator of the success of a test in distinguishing between diseased and healthy individuals. Approximation of the area under the curve to 1 indicates that the discriminative power of the scale is high. Of the scales used in this study, the one with the highest AUC value according to the cut-off points we set for the scales was FRA (0.76 for FRA, 0.72 for MFS and 0.62 for HFRM-II) (Figure 1). On the other hand, while MFS had acceptable values, the discriminatory power of HFRM-II was low. Therefore, it is thought that HFRM-II should not be used for determining the risks of falls in nursing home residents.

Conclusion

So as to suggest the most useful fall risk assessment tool with high predictive validity in NH residents in Turkey, three fall risk assessment tools were selected in this study; FRA, MFS and HFRM-II. Furthermore, when the AUC and the four validity criteria are taken into account, the FRA showed the most satisfactory results. It was also concluded that MFS could be used in nursing homes, but that FRA was more suitable for this population because of its high sensitivity and AUC values.

In the light of these results, it is recommended that similar studies should be carried out with larger samples in different nursing homes, that in order to find out the most appropriate tool to be used in determining the risks of falls in elderly people living in nursing homes, comparative studies involving different risk assessment tools should be carried out, that the fall risk assessment tools which are suitable for Turkish population should be developed and that these risk assessment tools should be compared with the clinical decisions of the nurse.

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