Determination of Persons at a High Risk of Falling in a Population of Healthy Community-Dwelling Elderly Japanese

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Original Article

Title:

Determination of fall risk factors to screen high fall risk in the elderly among the healthy community-dwelling Japanese population

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Abstract

Background: The problem of falling in the elderly is an important social issue. This study aimed to determine useful risk factors for screening high fall risk in the elderly. **Methods:** Participants included 965 healthy elderly individuals aged 60 years and over (349 males and 616 females, mean age: 70.1±7.1yr). We assessed fall risk in the elderly by using Demura's fall risk assessment scale (DFRA) which is composed of previous fall experience and 50 other fall risk assessment items representing the five risk factors regarding the "potential for falling," "physical function," "disease and physical symptoms," "environment," and "behavior and character" (Demura et al., 2010). Receiver-operating characteristics analysis was conducted using previous fall experience (faller or non-faller) as a dependent variable and using each fall risk factor score in the DFRA as an independent variable. **Results:** The potential for falling were obtained in the highest area under the ROC curve (AUC) (AUC=.80, sensitivity=.87, and specificity=.75). However, it was difficult to screen high fall risk in the elderly by using other fall risk factor scores. **Conclusions:** These results suggest that the potential for falling are a useful risk factor to screen high fall risk in the elderly.

Keywords: ROC analysis, cross-sectional study, prevention of falls, risk assessment

Introduction

In an aging society, the problem of falling in the elderly is an important social issue.[1)] As a result, researchers have closely examined fall risk assessment for the prevention falls in the elderly. Several performance tests or questionnaires have been reported, and cut-off values to predict falling in the future (or previous falls) have been proposed.[2-4)]

In the screening of falls based on performance tests, screening criteria is derived from the relationship between fall occurrence and fall-related physical function, such as lower limb strength and walking ability. In these procedures, it is reported that direct measurements of minimum physical function or performance requirements for fall prevention give a relatively accurate prediction of falling. In contrast, questionnaire-based fall risk assessment is marked by a simple and comprehensive evaluation of many internal- and external-risk factors of falling.

Falls are caused by multiple factors, and a comprehensive assessment based on these multiple risk factors is important. However, falls occur due to many different reasons, and the causes tend to be highly individualized.[5-8)] Especially when screening the elderly population, it is not necessarily the case that there is a clear relationship between the incidence of falls and the outcomes of assessing these risk factors. Indeed, the score of a questionnaire, which comprehensively assesses fall risk factors, could not always accurately predict falls in the future.[9)]

Both the screening assessment (discriminating high fall risk in the elderly among the population, prediction of falls in the future) and the risk profile assessment (identification of problems for individuals) are essential for fall risk assessment. In the risk profile assessment, various risk factors should be comprehensively assessed. In the screening assessment, however, there is no problem in conducting an assessment

by using a specific factor or variable which can accurately predict the incidence of falling. In the case of questionnaire-based fall risk assessment, a more effective and useful fall risk assessment is possible by discriminating the risk factors associated with high fall risk in the elderly in creating a fall risk profile. .

This study aimed to determine which risk factors from Demura's fall risk assessment scale (DFRA) to use to screen high fall risk in the elderly.

Participants and Methods

Participants and data collection

The participants participating in this study were healthy community-dwelling elderly individuals aged 60 and over, living in the Akita, Kanagawa, Ishikawa, Fukui, Nagano, Gifu, Aichi, Tottori and Fukuoka prefectures in Japan. Mail or field surveys were sent to 1770 elderly participants from which there were 1317 respondents. Among these, 965 elderly (70.3 +/- 7.1yr) showing missing values of less than 10 percent were used for data analysis in this study. This pool of participants was composed of 349 males (70.4 +/- 7.1 yr) and 616 females (69.9+/-7.1yr) with 160 of them (16.6%) having experienced a fall in the last twelve months. There were no particular gender- and age-specific biases between response participant and non-response participant. The results of this study were generalized under the limitation of this study sample.

Fall risk assessment

Demura's fall risk assessment chart (DFRA) is composed of previous fall experience and 50 fall risk assessment items representing the five risk factors regarding the "potential for falling," "physical function," "disease and physical

symptoms," "environment," and "behavior and character".[10] The "potential for falling" that a fall is currently happening is a concept regarding the occurrence of precursors that are related to falls, such as the act of stumbling. We assessed the potential for falling by asking the participants to answer the following three questions: "Have you often stumbled?" "In the past year, have you felt like you might fall down?" and "Have you ever been told that you look like you might fall down?" Physical function was assessed using 22 items selected from three categories (fundamental function, advanced function, and gait) and eight elements (muscular strength, lower limb strength, balancing ability, walking ability, going up and down stairs, changing and holding posture, upper limb function, and gait). Diseases and physical symptoms were assessed using thirteen items selected from six categories (dizziness and instances of blackout, medication, sight/hearing and cognitive disorder, cerebral vascular, arthritic and bone disease, and circulatory disease). The environment was assessed using four items selected from two categories (surrounding environment, and clothing). Behavior and character was assessed using eight items selected from four categories (inactivity, frequent urination, fear of falling, and risky behavior).

The validity of the DFRA has been examined in the previous study[9], and it has been confirmed that this fall risk scale has a greater discriminant ability for predicting the previous fall experience compared with the existing fall risk scale which is used widely in Japan. In the result of examining test-retest reliability of DFRA for 172 elderly, high intra-class correlations were obtained for total and each risk factor scores as followed; total score (0.956), potential for fall score (0.904), physical function score (0.957), diseases and physical symptoms score (0.925), behavior and character score (0.923) and environment score (0.874).

All questions were responded to on a dichotomous scale (yes or no), and with 1

point being assigned to each response falling into the “high risk” category. A risk factor score was calculated by summing the scores of structural items of each risk factor.

Statistical analyses

Receiver-operating-characteristic (ROC) analysis was used to compare accuracy for screening high fall risk in the elderly among the fall risk factors. ROC analysis is one of useful tools to statistically confirm accuracy among several screening tests.[11,12)]

Because of cross-sectional data setting in this study, ROC analysis was conducted using previous fall experience (faller or non-faller) as a dependent variable and using each fall risk factor score in the DFRA as an independent variable. We performed the ROC analysis on all of the trial models, and determined the area under the ROC curve (AUC) and calculated a positive likelihood ratio, 95% confidence interval, and cut-off points for maximizing the sensitivity and specificity for each score. A cut-off point was defined as a point with farthest plots of sensitivity and specificity from the bottom-right corner.

Results

Table 1 and Figure 1 show the results of ROC analyses and ROC curves for each fall risk factor. The “precursor of falling” showed the highest AUC (.80; 95%CI: .76 - .83) and sensitivity (.87) values. The AUC values of the other risk factors were less than .70. Especially, it is difficult to distinguish high fall risk elderly by “environment” which showed the lowest AUC value (.54).

Discussion

This study aimed to determine useful fall risk factors to screen high fall risk in the elderly through ROC analysis. The ROC analysis is a useful statistical tool to determine the most useful screening test from several tests, and to set a criterion (cut-off point) for screening. The AUC, which is calculated in ROC analysis, is an indicator of discriminant power, and it is interpreted by the following guidelines: non-informative test equal to chance (AUC = 0.5), less accurate (0.5 < AUC < 0.7), moderately accurate (0.7 < AUC < 0.9), highly accurate (0.9 < AUC < 1.0), and perfect discriminatory test (AUC = 1.0).[13,14] In previous studies, an AUC of 0.8 has been stated to represent a reasonably powerful model.[15]

Among the fall risk factors, in this study, a sufficient AUC value was only found in "potential for falling" (.80), and lower AUC values were found in other fall risk factors (physical function: .63; diseases and physical symptoms: .63; environment: .54; behavior and character: .67). A similar trend has been reported in a previous study, which attempted to determine high fall risk in the elderly based on discriminant analysis.[9] Thus, the highest discriminant probability was obtained in potential for falling, and it was difficult to discriminate high fall risk in the elderly by using the other four risk factors (physical function, disease and physical symptoms, environment, and behavior and character).

In this study, the sensitivity coefficient of the potential for falling (.87) was higher than those of other risk factors, but the specificity value of the potential for falling was not very high (.66). Sensitivity ("positivity in disease") refers to the proportion of subjects who have the target condition (reference standard positive) and give positive test results. Specificity ("negativity in health") is the proportion of subjects without the target condition and which gives negative test results.[11] In the assessment of fall risk among the elderly population, high sensitivity corresponds to

high negative predictive value (proportion of “true negative”/ (“false negative” + “true negative”), and it should be given high priority, comparing with high specificity. Thus, moderate specificity should be considered within an allowance in fall risk assessment.

Falling is a multifactoral problem, and the causes of falling are highly individualized.[5-8] Therefore, in the questionnaire-based fall risk screening among the elderly population, the clear relationships may be invisible between experience of falling and risk factor scores. However, “potential for falling” means the likelihood of falling, and they indicate a high relationship with fall experience regardless of the cause of being at a high fall risk. It is considered to be a useful measure for screening high fall risk in the elderly. Although the assessment of potential for falling provides information concerning the likelihood of falling, it cannot provide information about the causes of falling or countermeasures to prevent falls in the future. To prevent falls, both assessments of risk level (screening) and a risk profile are essential. Therefore, a fall risk prolife assessment that contains comprehensive internal- and external fall risk factors is also important in concert with screening the elderly with high fall risk.

Summary

Assessment based on the score of potential for falling is useful to screen high fall risk elderly, although it is difficult to screen them with the scores of other risk factors. However, the assessment of potential for falling provides useful information to determine fall risk level but not to determine its causes and countermeasures. It is important to both screen for high fall risk in the elderly and to make assessments based on an individualized risk profile.

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References

1. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on falls prevention. Guideline for the prevention of falls in older persons. *J Am Geriatr Soc*. 2001; 49: 664-72.

2. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *N Engl J Med*. 1988; 319: 1701-07.

3. Gates S, Smith LA, Fisher JD, et al. Systematic review of accuracy of screening instruments for predicting fall risk among independently living older adults. *J Rehabil Res Dev*. 2008; 45: 1105-1116.

4. Tiedemann A, Shimada H, Sherrington C, et al. The comparative ability of eight functional mobility tests for predicting falls in community-dwelling older people. *Age and Ageing*. 2008; 37: 430-435.

5. Graafmans WC, Ooms ME, Hofstee HMA, et al. Falls in the elderly: A prospective study of risk factors and risk profiles. *Am J Epidemiol*. 1996; 143: 1129-1136.

6. Perell KL, Nelson A, Goldman RL, et al. Fall risk assessment measures: An analytic review. *J Gerontol*. 2001; 56: M761-6.

7. Pluijm SMF, Smit JH, Tromp EAM, et al. A risk profile for identifying community-dwelling elderly with a high risk of recurrent falling: results of a 3-year prospective study. *Osteoporos Int*. 2006; 17: 417-425.

8. Russell MA, Hill KD, Day LM, et al. Development of the falls risk for older people in the community (FROP-Com) screening tool. *Age and Ageing*. 2009; 38: 40-46.

9. Demura S, Sato S, Yamaji S, et al. Examination of validity of fall risk assessment

items for screening high fall risk elderly among the healthy community-dwelling Japanese population. *Arch Gerontol Geriatr*. 2011; 53: e41-e45.

10. Demura S, Sato S, Yokoya T, et al. Examination of useful items for the assessment of fall risk in the community-dwelling elderly Japanese population. *Environ Health Prev Med*. 2010; 15: 169-179.

11. Florkowski CM. Sensitivity, specificity, receiver-operating characteristic (ROC) curves and likelihood ratios: communicating the performance of diagnostic tests. *The Clin Biochem Rev*. 2008; 29: S83-7.

12. Wray NR, Yang J, Goddard ME, et al. The genetic interpretation of area under the ROC curve in genomic profiling. *PLoS Genet*. 2010; 26: 6-2, :e1000864.

13. Swets JA. Measuring the accuracy of diagnostic systems. *Science*. 1988; 240: 1285-1293.

14. Eisenmann JC, Laurson KR, DuBose KD, et al. Construct validity of a continuous metabolic syndrome score in children. *Diabetol Metab Syndr*, 2010; 28: 2-8, http://www.dmsjournal.com/content/2/1/8.

15. Kimura A. Cut-off point of physical activity for elderly hemiplegics with deconditioning. *Rigakuryho Kagaku*. 2008; 23(3): 375-382. [in Japanese]

Table 1 Summary of ROC analyses for each fall risk factor

Risk factors	AUC	p	AUC (95%CI)	Sensitivity	Specificity	Cut-off value
Potential for falling	0.80	0.00	.76～.83	0.87	0.66	1
Physical function	0.63	0.00	.58～.68	0.40	0.81	10
Diseases and Physical symptoms	0.63	0.00	.586～.67	0.30	0.87	5
Behavior and Character	0.67	0.00	.63～.72	0.53	0.75	3
Environment	0.54	0.12	.49～.59	0.78	0.27	1

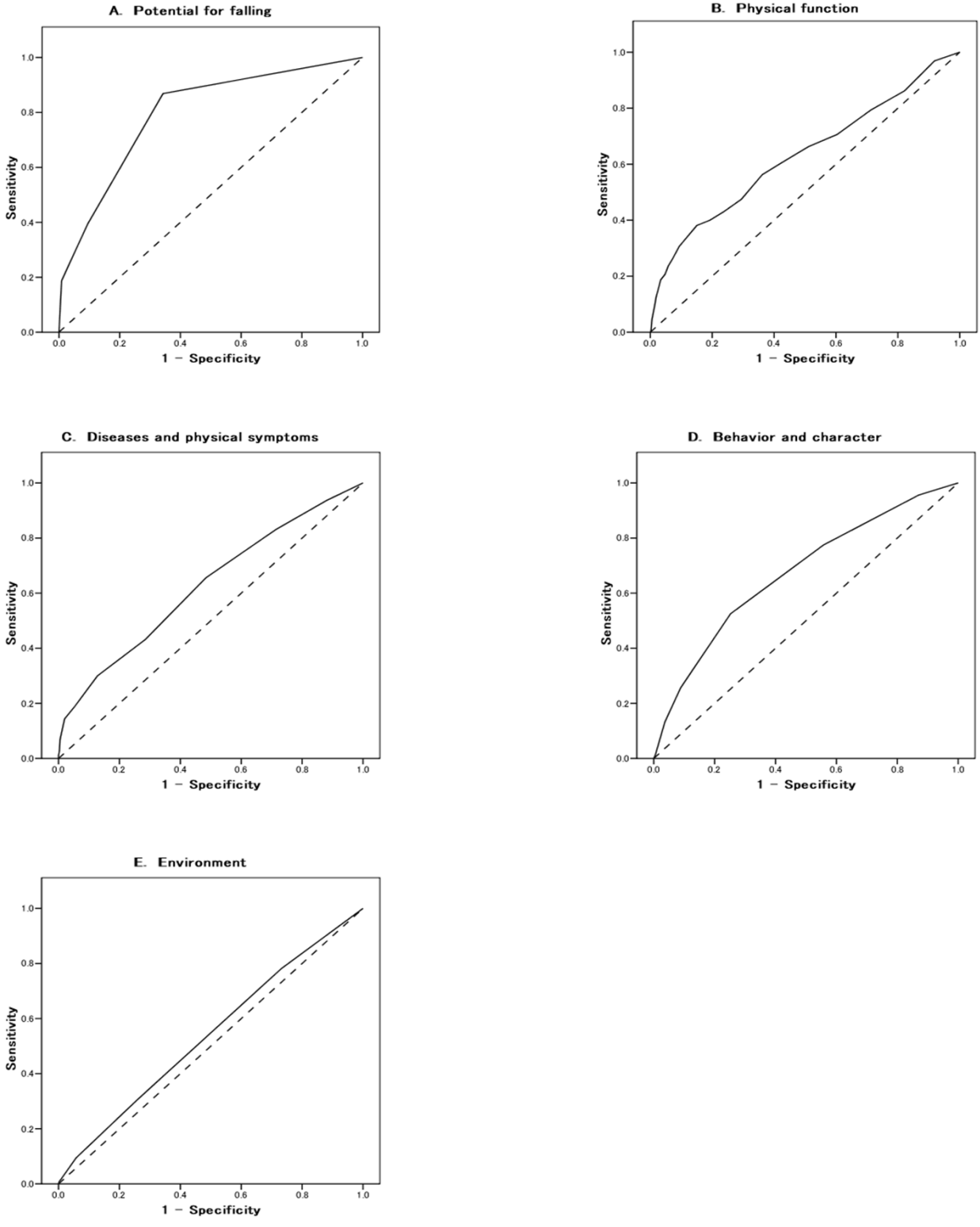

Figure1. ROC curves of each fall risk factor