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Original Article

Effect of Screening Tool as Subjective Measure to Identify Older Adults at Risk of Dependency in Japan: Multivariate Regression Analysis between Objective and Subjective Measures

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SUMMARY

Background: In terms of epidemiology and safety for older adults, self-reported questionnaires on activities of daily living, that is, screening tools are often applied as subjective measures, though objective measures provide concrete quantitative information of physical function through direct observation regardless of age. We aimed to clarify whether or not the screening tool for older adults at risk of dependency (SRD) utilized in Japan as subjective measures could predict objective measures on physical function among older adults.
Methods: The study was conducted with 81 community-dwelling older adults aged 60 years and over. They completed SRD as subjective measures and underwent physical performance battery (PPB) as objective measures. The association between SRD and PPB was statistically explored.
Results: SRD was significantly associated with one of the four domains in PPB; locomotion of the whole body, $F(4, 73) = 8.04$, $p < .001$. The significant predictors were falling experience, $\beta = 0.25$, $t = 2.42$, $p = .018$, and falling anxiety, $\beta = 0.24$, $t = 2.27$, $p = .026$, in SRD. The significant regression models explained 23% of the association.
Conclusions: The two questions of SRD could predict objective measures on locomotion of the whole body among older adults. SRD needs to be revised to ensure every aspect of activities of daily living, not only locomotion, also change of posture, manipulation of the upper limb, and manual dexterity. Self-reported questionnaires can be utilized to identify older adults at risk of dependency, only if with appropriate questions.

1. Introduction

The population of older adults aged 60 years or over increases not only in the developed countries but also in the developing countries. It will reach two billion by 2050 throughout the world.[1] The rate of population growth of older adults goes up more rapidly in the East Asian countries than the other countries.[2] Japan is the only country where the population of older adults aged 60 and over is already over 30%.[3] Even with the definition of older adults for the developed countries, the population of older adults aged 65 and over reached 27.7% in 2017[4,5] in Japan. Though longevity itself should be considered as one of the greatest achievements for the humanity as well as the country's development, it is now a critical challenge in terms of social security with the limited budget.[2] It is important not only to support older adults who are already with disability or physical function limitation, but also to support well-dwelling older adults to maintain their independency, and screen those who are at risk of dependency and engage them in prevention programs.

Since 2006 the Japanese government has prioritized the prevention-oriented system targeting older adults who do not yet depend on any help or care, even if they do, whose level of required help or care is still very low.[6,7] The Ministry of Health, Labour and Welfare of Japan developed the screening tool for older adults at risk of dependency (SRD) (Kihon Checklist in Japanese)[8,9] as a part of Comprehensive Geriatric Assessment (CGA), which is a self-report questionnaire composed of seven categories: daily living situation, physical function, nutritional status, oral function, housebound status, cognitive status, and depression status. By the end of 2013 SRD had been conducted on 49.0% of older adults all over Japan through local governments or public insurance bodies.[10] Sixty-three percent of them, about ten million older adults, responded. Of those who were independent, about three million people, which was 9.5% of the whole older population, turned out to be at risk of dependency. They were further advised to get engaged in the prevention programs.[11]

SRD was reported to detect the risk of dependency among older adults in cross-sectional studies[12–14] and longitudinal studies.[15,16] However, looking into the physical function, objective measures were generally more proper than subjective measures to assess physical activity, even activities of daily living among older adults.[17–19]

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In fact, self-reported questionnaires on activities of daily living are expected to be screening tools in terms of epidemiology and safety for older adults.

In this study, we aimed to clarify whether or not the assessment of physical function in SRD could predict objective measures.

2. Participants and methods

2.1. Participants

The participants were community-dwelling adults aged 60 years or over (n = 81, male 37 and female 44) who were confirmed to be neurologically normal and had no physical disabilities. They were voluntarily recruited by the cooperation with a local community club for physical exercises. Written informed consents were obtained from all participants. The study proposal was assessed and approved by the institutional ethics review board of National Center for Geriatrics and Gerontology (protocol number 495), in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

2.2. Screening tool for older adults at risk of dependency (SRD)

As shown in Table 1, SRD as a self-report questionnaire consists of 25 closed-ended questions (yes/no) divided into seven categories: daily living situation, physical function, nutritional status, oral function, housebound status, cognitive status, and depression status. The category of physical function has five questions including "Do you go upstairs without using handrails or the wall for support? (Going upstairs)", "Do you stand up from a chair without any aids? (Standing up)", "Do you walk continuously for 15 minutes? (Continuous walking)", "Have you experienced a fall in the past year? (Falling experience)", and "Do you feel anxious about falling when you walk? (Falling anxiety)". The respondents who answered yes for the questions of Going upstairs, Standing up and Continuous walking, and the respondents who answered no for the other questions of Falling experience and Falling anxiety means those who are at risk of dependency.

2.3. Objective measure: Physical performance battery (PPB)

We applied the physical performance battery (PPB) as objective measure. PPB was originally developed to assess physical function of daily living among Japanese older adults,[20–22] and consists of four domains; locomotion of the whole body, change of posture, manipulation of the upper limb, and manual dexterity. Each domain was measured as follows. For locomotion of the whole body, the time required for two laps' figure-8 walk was measured by second. For change of posture, the anteversion distance in a standing position was measured by centimeter (cm). For manipulation of upper limb, the number of bicipital flexion/extension was counted for 30 seconds. For manual dexterity, the number of beans moved from one dish to another with a pair of chopsticks was counted for 30 seconds. For all domains, two trials were conducted by all participants. The better value was adopted for the analysis.

2.4. Data analysis

Descriptive statistics of physical characteristics and measure-

Table 1
Screening tool for older adults at risk of dependency (SRD).

Daily living situation		
1. Do you use public transport (bus or train) to go out by yourself?	0.Yes	1.No
2. Do you shop for daily necessities?	0.Yes	1.No
3. Do you manage financial matters such as savings or deposits by yourself?	0.Yes	1.No
4. Do you visit the homes of friends?	0.Yes	1.No
5. Do you give advice to friends or family members?	0.Yes	1.No
Physical function		
6. Do you go upstairs without using handrails or the wall for support?	0.Yes	1.No
7. Do you stand up from a chair without any aids?	0.Yes	1.No
8. Do you walk continuously for 15 minutes?	0.Yes	1.No
9. Have you experienced a fall in the past year?	1.Yes	0.No
10. Do you feel anxious about falling when you walk?	1.Yes	0.No
Nutritional status		
11. Has your weight declined by 2–3 kg in the past 6 months without dieting?	1.Yes	0.No
12. Height: _____ m Weight: _____ kg BMI less than 18.5?	1.Yes	0.No
Oral function		
13. Have you experienced more difficulty chewing tough foods than you did 6 months ago?	1.Yes	0.No
14. Do you ever experience choking or coughing when drinking soup or tea?	1.Yes	0.No
15. Do you feel uncomfortable feelings of thirst or dry mouth?	1.Yes	0.No
Housebound status		
16. Do you go out at least once a week?	0.Yes	1.No
17. Do you go out less often than you did last year?	1.Yes	0.No
Cognitive status		
18. Do others point out your forgetfulness or tell you "you always ask the same thing"?	1.Yes	0.No
19. When you want to make a call, do you usually search for the telephone number and call on your own?	0.Yes	1.No
20. Do you sometimes not know what the date is?	1.Yes	0.No
Depression status		
21. (in the past 2 weeks) You feel no sense of fulfilment in your life.	1.Yes	0.No
22. (in the past 2 weeks) You cannot enjoy things that you enjoyed before.	1.Yes	0.No
23. (in the past 2 weeks) You feel reluctant to do things that you could do easily before.	1.Yes	0.No
24. (in the past 2 weeks) You do not feel that you are a useful person.	1.Yes	0.No
25. (in the past 2 weeks) You feel exhausted for no apparent reason.	1.Yes	0.No

Note. SRD = screening tool for older adults at risk of dependency. Revised "Kihon Checklist" of Working Group on Frailty in Japan Geriatrics Society.

ment values in PPB were presented with means and standard deviations. The normality of the distributions was analyzed using Shapiro-Wilk W test. Univariate regression analysis (Spearman's rank correlation coefficient) was performed to examine the strength of a correlation between each of the explanatory variables. Multivariate regression analysis to determine the association between PPB and SRD was performed with 79 participants after excluding two participants with the missing values in SRD. Dummy variables were used to compare two groups with and without risk of dependency according to SRD. The validities of the model were evaluated based on the F-value. The R-squared value (R^2) and the root mean square error (RMSE) indicate the model fit. The validities of each explanatory variable were evaluated based on the t-value and estimated beta coefficients (β) from the model. Any p-value less than .05 was considered statistically significant. Statistical analysis was carried out by JMP version 9.0 for Windows (SAS Institute, Inc.; Cary, NC, USA).

3. Results

Physical characteristics were presented as means ± standard deviations in Table 2. The age of participants was 72.8 ± 5.8 (male 72.9 ± 3.4, female 72.6 ± 7.3), and their BMI was 22.5 ± 3.2 (male 22.7 ± 2.6, female 22.3 ± 3.7) which is within the normal range (18.5 ≤ BMI < 25).[23] Table 3 presents the responses of five questions on physical function in SRD. The majority showed positive responses to the questions. The measurement values in PPB were presented as means ± standard deviations in Table 4. Although there were no significant differences between male and female participants, good performance on manipulation of upper limb was seen in male participants, and that of manual dexterity in female participants.

The univariate regression analysis showed that there was no strong correlation between each of the explanatory variables, r_s [-.06, .28] (Table 5). The multivariate regression analysis on the association between SRD and PPB was presented in Table 6. The significant association was identified between SRD and one of the four domains in PPB; locomotion of the whole body, $F(4, 73) = 8.04$, $p < .001$. The significant predictors were falling experience, $\beta = .25$, $t =$

Table 2
Physical characteristics.

Variables	Participants n = 81 mean ± SD	Male n = 37 mean ± SD	Female n = 44 mean ± SD
Age (years)	72.8 ± 5.8	72.9 ± 3.4	72.6 ± 7.3
Height (cm)	156.0 ± 8.1	162.9 ± 5.1	150.2 ± 5.1
Weight (kg)	54.9 ± 9.6	60.3 ± 7.3	50.4 ± 8.9
BMI (kg/m^2)	22.5 ± 3.2	22.7 ± 2.6	22.3 ± 3.7

Note. BMI = body mass index; SD = standard deviation.

Table 5
Univariate regression analysis in SRD.

Variables	Variables	Spearman's rank correlation coefficient (γ_s)	p-value (Prob > $\lvert\gamma_s\rvert$)
Standing up	Going upstairs	.18	.103
Standing up	Continuous walking	-.04	.748
Standing up	Falling experience	.24	.029*
Standing up	Falling anxiety	.23	.036*
Going upstairs	Continuous walking	-.05	.634
Going upstairs	Falling experience	-.01	.959
Going upstairs	Falling anxiety	.28	.014*
Continuous walking	Falling experience	-.06	.576
Continuous walking	Falling anxiety	.18	.116
Falling anxiety	Falling experience	.23	.042*

Note. SRD = screening tool for older adults at risk of dependency. Going upstairs = Do you go upstairs without using handrails or the wall for support?; Standing up = Do you stand up from a chair without any aids?; Continuous walking = Do you walk continuously for 15 minutes?; Falling experience = Have you experienced a fall in the past year?; Falling anxiety = Do you feel anxious about falling while walking?
* p < .05.

Table 3
Numbers of older adults with or without risk of dependency based on SRD.

Questions on physical function in SRD	n = 81 With/without risk of dependency	Male = 37 With/without risk of dependency	Female = 44 With/without risk of dependency
Going upstairs			
"Do you go upstairs without using handrails or the wall for support?"	15/65	2/34	13/31
Standing up			
"Do you stand up from a chair without any aids?"	4/77	0/37	4/40
Continuous walking			
"Do you walk continuously for 15 minutes?"	2/79	2/35	0/44
Falling experience			
"Have you experienced a fall in the past year?"	11/70	6/31	5/39
Falling anxiety			
"Do you feel anxious about falling while walking?"	23/57	8/28	15/29

Note. SRD = screening tool for older adults at risk of dependency.

Table 4
Measurement values in PPB.

Domains of PPB	n = 81 Mean ± SD	Male= 37 Mean ± SD	Female = 44 Mean ± SD
Locomotion of the whole body (seconds)[a]	26.5 ± 4.6	26.2 ± 3.6	26.8 ± 5.3
Change of posture (cm)[b]	31.6 ± 5.6	32.6 ± 5.0	30.8 ± 6.0
Manipulation of upper limb (times/30 seconds)[c]	24.4 ± 4.5	26.4 ± 4.3	22.6 ± 3.9
Manual dexterity (grains/30 seconds)[d]	13.9 ± 4.6	12.5 ± 3.6	14.9 ± 4.9

Note. PPB = physical performance battery; [a] Locomotion of the whole body, the time required for two laps figure-8 walk (seconds). [b] Change of posture, the anteversion distance in a standing position (cm). [c] Manipulation of the upper limb, the number of bicipital flexion/extension (times/30 seconds). [d] Manual dexterity, the number of beans moved from one dish to another with chopsticks (grains/30 seconds). For all domains, the better value was adopted out of two trials; SD = standard deviation.

Table 6
Multi regression analysis with SRD and PPB.

Predictors	PPB															
	Locomotion of the whole body (seconds)				Change of posture (cm)				Manipulation of upper limb (times/30 seconds)				Manual dexterity (grains/30 seconds)			
SRD	SC	SE	t	p	SC	SE	t	p	SC	SE	t	p	SC	SE	t	p
Intercept	24.78	.56	44.47	< .001*	32.85	.77	42.89	<.001*	24.85	.64	38.80	< .001*	14.05	.66	21.15	< .001*
Going upstairs	2.12	1.20	1.77	.081	-1.79	1.65	-1.09	.281	-1.36	1.38	-.99	.327	1.30	1.42	.91	.365
Standing up	3.98	2.15	1.85	.068	-3.96	2.95	-1.34	.184	-1.53	2.47	-.62	.537	.40	2.56	.16	.876
Continuous walking	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Falling experience	3.28	1.36	2.42	.018*	-2.60	1.87	-1.39	.168	.94	1.56	.60	.551	-1.02	1.61	-.63	.529
Falling anxiety	2.50	1.10	2.27	.026*	-.97	1.52	-.64	.525	-1.14	1.27	-.90	.372	-1.11	1.28	-.87	.389
Model evaluation																
F value	8.04			< .001*	2.27			.070	.89			.472	.51			.731
R^2	.31				.11				.05				.03			
RMSE	3.94				5.42				4.53				4.70			
VIF (range)	1.12–1.21				1.12–1.21				1.12–1.21				1.11–1.18			

Note. SRD = screening tool for older adults at risk of dependency; PPB = physical performance battery; p = p value; R^2 = multiple R-squared; RMSE = root mean square error; SC = standard coefficient; SE = standard error; t = t value; VIF = variance inflation factor (range).
* p < .05.

2.42, p = .018, and falling anxiety, β = .24, t = 2.27, p = .026 in SRD. For the other domains; change of posture, manipulation of upper limb and manual dexterity, there was not any significant association with SRD as F(4, 73) = 2.27, p = .070, F(4, 73) = .89, p = .472, and F(4, 74) = .51, p = .731 respectively. The equation for the estimation of locomotion of the whole body was developed as 25.09 + 3.57 × falling experience + 3.46 × falling anxiety, which explained 23% of the association (R^2 = .23). Due to exclusion of missing values, continuous walking could not be analyzed.

4. Discussion

We considered that there was no specific participant bias in this study because the measurement values in PPB between this study and the original studies did not show a remarkable difference.[20–22] The two questions in SRD, falling experiences and falling anxiety, predicted one of the four domains in PPB, locomotion of the whole body, in this study. As reported that one of the main causes to become dependent is falls, the Ministry of Health, Labour and Welfare of Japan pays an attention particularly to locomotion.[24] In this regard, SRD is accredited to be a useful screening tool. On the other hand, though the other three questions in SRD, going upstairs, standing up and continuous walking, also ask about locomotion, these questions were not associated with locomotion of the whole body. The further studies need to be done to verify the association. As of the other three domains in PPB, change of posture, manipulation of the upper limb, and manual dexterity, could not be predicted by the questions in SRD. These domains play an essential role in basic self-care as eating, toileting, grooming, and dressing. A few questions on these domains are recommended to add to SRD.

Basic activities of daily living indexes, such as the Barthel Index,[25] the Katz Index of ADL,[26] and the Functional Independence Measure (FIM),[27] measure physical functions as SRD does. The Barthel Index is a scale of ten variables describing ADL and mobility to measure performance of individuals with neuromuscular or musculoskeletal disorders. The Katz Index of ADL is a scale to assess physical function and how it changed over the time in older adults. The FIM is used to measure the level of assistance required for individuals, originally for patients with brain injury, to perform ADL. The difference from SRD is that these indexes are generally filled in by health care professionals or primary caregivers for individuals through direct observation or interview in hospitals, rehabilitation centers, nursing homes and home care programs. They are not self-report questionnaires as SRD is.

Self-report questionnaires, such as the International Physical Activity Questionnaire (IPAQ),[28,29] the Human Activity Profile (HAP),[30] the Stanford Brief Activity Survey (SBAS),[31] have the same methodology as SRD. IPAQ is the questionnaire to find out the kinds of physical activities that people do as part of their daily lives. HAP is the questionnaire to assess individuals' performance of 94 activities and to determine the level of their aerobic fitness. SBAS is the questionnaire to assess the usual amount and intensity of physical activities an individual currently performs throughout the day. These questionnaires are used in the large epidemiologic studies, targeting individuals of all ages to evaluate outcome of physical activities. The difference from SRD is that they are developed as assessments of amount, intensity and energy expenditure of physical activities. They do not assess physical function as SRD does.

Due to the rapid increase of the aging population, a screening tool for dependency targeting community-dwelling older adults became absolutely necessary. Considering population survey, safety, easiness, cost and time efficiency, self-report questionnaires as subjective measures will be proper than the objective measures through direct observation. This study indicated that there was an association between subjective and objective measures, and that self-report questionnaire could tell us not only anxious experiences in the past, psychological anxiety in the future, but also actual decline in physical function. This study also indicated that SRD needs to be revised to ensure every aspect of activities of daily living, not only the locomotion of the whole body, but also change of posture, manipulation of the upper limb, and manual dexterity. Furthermore, in the CGA where many tools including SRD are available, optimal tools need to be developed, modified and updated by adding and extracting necessary items, avoiding duplication according to the change of lifestyles and places of living.

A limitation of this study was that the participants were recruited in physical exercises club. According to the National Health and Nutrition Survey Report,[32] the percentages of Japanese men and women aged at 60 or over who did regular exercises were 44.4% and 36.0% respectively. Although we stated that there was no specific participant bias in this study, in order to obtain the more generalized results, the further studies should be conducted with others who are more likely to have sedentary lifestyle. In addition, statistical power was not high due to the design of this study.

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Authors' contributions

AT conceived and designed the study, performed the statistical analyses, and drafted the manuscript. AT and TN interpreted the results. AT revised and finalized the manuscript. TN supervised the study. AT and TN approved the final version of the manuscript.

Conflicts of interest

All authors declare no potential financial and non-financial conflicts of interest.

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