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SCREENING FOR MALNUTRITION IN COMMUNITY DWELLING OLDER JAPANESE: PRELIMINARY DEVELOPMENT AND EVALUATION OF THE JAPANESE NUTRITIONAL RISK SCREENING TOOL (NRST)

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Abstract: *Background:* Early and effective screening for age-related malnutrition is an essential part of providing optimal nutritional care to older populations. *Objective:* This study was performed to evaluate the adaptation of the original SCREEN II questionnaire (Seniors in the Community: Risk Evaluation for Eating and Nutrition, version II) for use in Japan by examining its measurement properties and ability to predict nutritional risk and sarcopenia in community-dwelling older Japanese people. The ultimate objective of this preliminary validation study is to develop a license granted full Japanese version of the SCREEN II. *Participants:* The measurement properties and predictive validity of the NRST were examined in this cross-sectional study of 1921 community-dwelling older Japanese people. *Measurements:* Assessments included medical history, and anthropometric and serum albumin measurements. Questions on dietary habits that corresponded to the original SCREEN II were applied to Nutritional Risk Screening Tool (NRST) scoring system. Nutritional risk was assessed by the Geriatric Nutrition Risk Index (GNRI) and the short form of the Mini-Nutritional Assessment (MNA-SF). Sarcopenia was diagnosed according to the criteria of the European Working Group on Sarcopenia in Older People. *Results:* The nutritional risk prevalences determined by the GNRI and MNA-SF were 5.6% and 34.7%, respectively. The prevalence of sarcopenia was 13.3%. Mean NRST scores were significantly lower in the nutritionally at-risk than in the well-nourished groups. Concurrent validity analysis showed significant correlations between NRST scores and both nutritional risk parameters (GNRI or MNA-SF) and sarcopenia. The areas under the receiver operating characteristic curves (AUC) of NRST for the prediction of nutritional risk were 0.635 and 0.584 as assessed by GNRI and MNA-SF, respectively. AUCs for the prediction of sarcopenia were 0.602 (NRST), 0.655 (age-integrated NRST), and 0.676 (age and BMI-integrated NRST). *Conclusions:* These results indicate that the NRST is a promising screening tool for the prediction of malnutrition and sarcopenia in community-dwelling older Japanese people. Further development of a full Japanese version of the SCREEN II is indicated.

Key words: Nutrition screening, NRST, malnutrition, sarcopenia, community-dwelling older Japanese.

Abbreviation: NRST: Nutritional risk screening tool; GNRI: Geriatric nutrition risk index; MNA-SF: Short form of the Mini-Nutritional Assessment; SCREEN II: Seniors in the Community: Risk Evaluation for Eating and Nutrition, version II.

Introduction

Nutritional well-being, which includes healthy eating and good dietary habits, is essential for healthy aging, independence, and quality of life in older individuals (1, 2). The age-related physiological decline in food intake has been associated with progressive loss of skeletal muscle mass, strength, and functionality, which subsequently leads to various morbidities and poor health outcomes (3-5). Therefore, early and effective screening to identify the dietary factors contributing to age-related malnutrition in high-risk individuals is an essential part of providing optimal care and promoting good nutritional status in older populations.

Malnutrition is a common problem and its prevalence increases with advancing age; it is usually accompanied by various comorbidities, such as sarcopenia. Several studies have shown that the prevalence of malnutrition is 1 to 10% of the older adult population, while 41 to 48% are at risk for malnutrition (6-8). The prevalence of malnutrition and at-risk for malnutrition in community-dwelling older Japanese is reported to be 21.4% (9). Sarcopenia is the age-related progressive loss of muscle characterized by a 3–8% reduction in lean muscle mass per decade after the age of 30 years (10, 11). It is thought to affect 30% of individuals over 60 years of age and more than 50% of those older than 80 years (4, 5, 12). In Japan, the prevalence of sarcopenia determined using the European Working Group on Sarcopenia in Older People (EWGSOP) criteria was 21.8% and 22.1% in men and women aged 65 to 89 years, respectively (13). In older people, the most common risk factors for malnutrition are physical (diminished appetite, reduced mobility, and difficulties with swallowing, eating, shopping and meal preparation), psychological,

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financial, and social constraints such as eating alone (14, 15).

Despite the high prevalence and negative health consequences of malnutrition in older people, malnutrition often goes unrecognized and untreated (16, 17). Early and effective screening to identify at-risk individuals is recommended as the first step in an effective nutritional care and management system, while accurate prediction of risk allows efficient targeting of resources for nutritional assessment (3).

An effective nutritional screening tool should be simple, cost-effective, and easy to use with readily available data. Such a tool would be superior to the conventional nutritional risk assessment methods, which include non-invasive anthropometric (BMI, weight loss) and biochemical (serum albumin level and lymphocyte count) measurements. These measurements are not always reliable tests for malnutrition, and some must be conducted by a specialist. To date, various nutritional risk screening tools have been developed and are frequently used in both clinical settings and community-based studies; these include the MUST (Malnutrition Universal Screening Tool), MNA (Mini-Nutritional Assessment), MNA-SF (short form of the Mini-Nutritional Assessment), and GNRI (Geriatric Nutrition Risk Index) (18-20). It is noted that early detection and management of malnutrition is also of great importance in community-dwelling older individuals. Therefore, HH Keller, et al. developed a simple nutritional risk screening tool, SCREEN II (Seniors in the Community: Risk Evaluation for Eating and Nutrition, version II). This validated, 14-item questionnaire, which is the copyright of Dr. Heather Keller, is designed to assess nutritional risk in community-dwelling adults over 65 years old (21-24). The SCREEN II assesses not only anthropometric measures, but also a wide range of dietary habits, such as food preparation, eating behavior, and dietary components; it is easy and convenient to administer to older people living in the community. At present, the SCREEN II has been translated into several languages (http://www.flintbox.com/public/project/2750/) and is widely used for nutritional risk screening in community-living older people.

There is "Japanese Nutritional Intervention Manual for Geriatric Care and Management" (http://www.mhlw.go.jp/topics/2009/05/dl/tp0501-1_1.pdf), which has been developed and practically used in many institutions in Japan since 2009. This nutrition intervention manual includes a number of nutritional assessment items being overlapped with the items used in original SCREEN II questionnaire. However, no scoring system has been established for these nutritional assessment items in Japan, and the validity and utility of this screening tool in the older Japanese community has not yet been studied. Therefore, we picked up these overlapped items for NRST scoring and this study was performed to evaluate the NRST, an adaptation of the original SCREEN II, for use in Japan by examining its measurement properties and ability to predict nutritional risk and sarcopenia in community-dwelling older Japanese people. The ultimate objective of this preliminary validation study is to develop a licensed Japanese version of the SCREEN II.

Methods

Subjects

This was a cross-sectional study of 2044 functionally independent, community-dwelling older Japanese people (age > 65 yr) residing in Kashiwa city, Chiba, Japan (the Kashiwa Study) (25). The Kashiwa study is a prospective cohort study designed to characterize the biological, psychosocial, and functional changes associated with aging in community-dwelling older adults. For the purposes of this study, participants with chronic liver disease, renal disease, or edema were excluded and data from 1921 (976 men and 945 women) subjects were used in the analyses. This study was approved by the ethics review committee of the National Institute of Health and Nutrition and the Graduate School of Medicine, The University of Tokyo. Written informed consent was obtained from all participants.

Assessment of Nutritional Risk and Sarcopenia

The assessments included a medical history, a dietary variety score (DVS), anthropometric measurements, and serum cholesterol and serum albumin concentration determination. The methods of data collection and measurements have already been described in detail elsewhere (25). The dietary variety score (DVS) was based on the frequency of daily consumption of 10 food groups (meat, fish and shellfish, eggs, milk, soybean products, potatoes, green yellow vegetables, fruits, seaweed, and fat and oil), which was obtained from food frequency questionnaires. The DVS ranged from 0 to 10 with higher scores indicating a more varied diet, which has been associated with a reduced risk of frailty in community-dwelling older adults (26). Nutritional risk was assessed by the GNRI and the MNA-SF (Japanese version). The GNRI is an objective scale in which scores are calculated from the serum albumin concentration and body weight using a formula developed by Bouillanne et al. (27) as follows: GNRI = (14.89 × albumin (g/dL)) + (41.7 × (body weight / ideal body weight)). The ideal body weight was calculated based on the individual's height and an "ideal" body mass index (BMI) of 22, because of its validity (28-30). The ratio of actual to ideal body weight was set at 1 when the actual body weight exceeded the ideal body weight. Individuals with GNRI scores < 92 were considered to have poor nutritional status, and those with GNRI scores < or = 98 were considered at-risk for malnutrition.

The MNA-SF is a simple, multifunctional, non-invasive and efficient tool consisting of six key MNA items designed to assess the risk of malnutrition in older adults (20, 31). The MNA-SF is used to rate the anthropometric, dietary, global and self-perceived aspects of nutrition, and it has been reported to predict the length of hospital stays, hospitalization outcomes,

mobility and mortality, and has been associated with weight loss, functional physical status and activity of daily living (32). The MNA-SF has been validated specifically for adults over the age of 65 in both community and healthcare settings (14, 33, 34). Individuals with MNA-SF scores < or = 11 were classified as at-risk for malnutrition, while those with MNA-SF scores < 7 were defined as malnourished.

As this cohort study is a part of Kashiwa cohort study, we use the same cutoff points for the diagnosis of sarcopenia according to the criteria defined by S Ishii et al. 2014 in the previous study (25). Sarcopenia was defined according to the EWGSOP criteria (10), which is based on the presence of low muscle mass and poor muscle function (grip strength or usual gait speed). The cutoff points for low skeletal muscle index (SMI) < 7.0kg/m^2 in men and < 5.8kg/m^2 in women refer to the SMI values lower than two standard deviations below the mean values of young male and female reference groups (10, 35). The grip strength values in the lowest quintile were classified as low muscle strength (cutoff values: <30kg for men and <20kg for women). Usual gait speeds in the lowest quintile were classified as low physical performance (cutoff values: <1.26 m/s for both men and women).

NRST questionnaire

Questions on dietary habits that corresponded with the original SCREEN II (24), such as questions about appetite, eating frequency, physiological difficulties (swallowing, chewing), and functional difficulties (motivation to cook, ability to shop and prepare food), food restrictions owing to health conditions, and the social dimensions of eating (isolation and loneliness), as well as questions on weight changes, were included in the NRST scoring. Participants were asked to respond to all items using an identical 0–4 response scale. The total score of the original SCREEN II, ranging from 0 to 64 (2 to 55 for NRST score), represented the eating habits and nutritional status of each respondent with lower scores indicating higher risk of malnutrition. The measurement properties of the NRST, including concurrent validity and predictive validity were examined. We followed the scoring method described by Ishii et al. for age-integrated NRST scoring to predict sarcopenia risk (25), while BMI scoring (for age and BMI-integrated NRST) was adopted from the scoring system for the MNA-SF questionnaire (20).

Statistical Analysis

Data were analyzed by means of descriptive, parametric, and non-parametric statistics for comparison purposes using IBM SPSS Statistics for Windows ver. 22. The validity of the NRST was determined based on score comparisons with the GNRI and MNA-SF. Lower scores were considered indicative of higher risk. Receiver operating characteristic (ROC) curves were used to examine the predictive performance of the NRST for nutritional risk or malnutrition. The associations between NRST and GNRI or MNA-SF scores were determined using

Table 1
General characteristics of the study subjects

Characteristics	Total (n=1921)	Men (n=976)	Women (n=945)	P
Age (yr)	73.0 ± 5.5	73.1 ± 5.6	72.8 ± 5.5	0.190
Living alone: n (%)	211 (11.0)	55 (5.6)	156 (16.5)	<0.001
Height (cm)	158.0 ± 8.5	164.3 ± 5.8	151.5 ± 5.5	<0.001
Weight (kg)	57.1 ± 10.0	62.8 ± 8.7	51.3 ± 7.7	<0.001
BMI (kg/m^2)	22.8± 3.0	23.2 ± 2.8	22.3± 3.1	<0.001
Dietary variety score	3.8 ± 2.0	3.4 ± 2.0	4.1 ± 2.0	<0.001
Serum albumin (g/dL)	4.4 ± 0.2	4.4 ± 0.2	4.4 ± 0.2	0.846
Skeletal muscle mass index (kg/m^2)	6.6 ± 1.0	7.3 ± 0.7	5.8 ± 0.6	<0.001
Grip Strength (kg)	28.7 ±8.0	34.9 ± 6.0	22.4 ± 4.0	<0.001
Usual gait speed (m/s)	1.5 ± 0.3	1.5 ± 0.3	1.5 ± 0.3	0.382
Total GNRI	106.2 ± 4.4	106.7 ± 4.4	105.7 ± 4.3	<0.001
Total MNA-SF score	11.8 ± 1.3	12.0 ± 1.2	11.6 ± 1.3	<0.001
Total NRST score	41.6 ± 5.2	41.3 ± 5.1	41.9 ± 5.4	0.143
Nutritional Risk n (%)				
GNRI ≤98	107 (5.6)	48 (4.9)	59 (6.2)	0.233
MNA-SF ≤11	666 (34.7)	257 (26.4)	409 (43.3)	<0.001
Sarcopenia n (%)	248 (13.3)	101 (10.7)	147 (16.0)	0.001

BMI: Body mass index; GNRI: Geriatric Nutrition Risk Index; MNA-SF: Mini-Nutritional Assessment (Short form); NRST: Nutritional Risk Screening Tool; Values are shown as mean ± SD; P values shown are from Student's t test or Chi-squared test.

Table 2
Comparison between known nutritional risk groups of the NRST scores of 1920 older participants

Nutrition risk group	n	NRST score (mean ± SD)	Well-nourished group	n	NRST score (mean ± SD)	P value
GNRI ≤ 98	107	39.2 ± 5.5	GNRI > 98	1813	41.7 ± 5.2	<0.001
MNA-SF≤11	666	40.4 ± 5.8	MNA-SF>11	1253	42.2 ± 4.8	<0.001
Sarcopenia	248	39.8 ± 6.1	Non-sarcopenia	1610	41.9 ± 5.0	<0.001

Nutrition risk group (expected low scores); Well-nourished group (expected high scores); GNRI: Geriatric Nutrition Risk Index; MNA-SF: Mini-Nutritional Assessment (Short form); NRST: Nutritional Risk Screening Tool; P values are from Student's t test.

Table 3
Correlations between NRST scores and nutritional parameters in 1921 older Japanese people

Nutritional status criteria	No. of Subjects	Correlation with NRST	
		r	P
Age (yr)	1920	-0.147	<0.001
BMI (kg/m^2)	1920	0.083	<0.001
Skeletal muscle mass index (kg/m^2)	1895	0.068	0.003
Grip Strength (kg)	1897	0.083	<0.001
Usual gait speed (m/s)	1900	0.156	<0.001
Prevalence of sarcopenia*	1920	-0.151	<0.001
Dietary variety score	1920	0.203	<0.001
Total MNA-SF score	1919	0.219	<0.001
GNRI	1920	0.138	<0.001
Total cholesterol (mg/dL)	1920	0.057	0.012
Serum albumin (g/dL)	1920	0.094	<0.001

BMI: Body mass index; GNRI: Geriatric Nutrition Risk Index; MNA-SF: Mini-Nutritional Assessment (Short form); NRST: Nutritional Risk Screening Tool; r: correlation coefficient; * Spearman's correlation coefficient.

Spearman's correlation tests. P values less than 0.05 were considered significant.

Results

Baseline characteristics of the study participants

The baseline characteristics of the study participants are shown in Table 1. 976 (50.8%) men and 945 (49.2%) women participated in the study. Their mean age was 73.0 ± 5.5 years. The prevalence of malnutrition or at-risk for malnutrition was 5.6% based on the GNRI or 34.7% based on the MNA-SF, and the prevalence of sarcopenia was 13.3% based on the EWGSOP criteria. There were no significant differences between men and women in age, total dietary variety score, serum albumin concentration, total NRST score and risk of nutrition or malnutrition by GNRI. The mean NRST score was 42 (ranging from 19 to 54). Table 2 shows that the mean NRST score was significantly lower in the malnutrition and at-risk for malnutrition groups than in the well-nourished groups.

Validity and Reliability

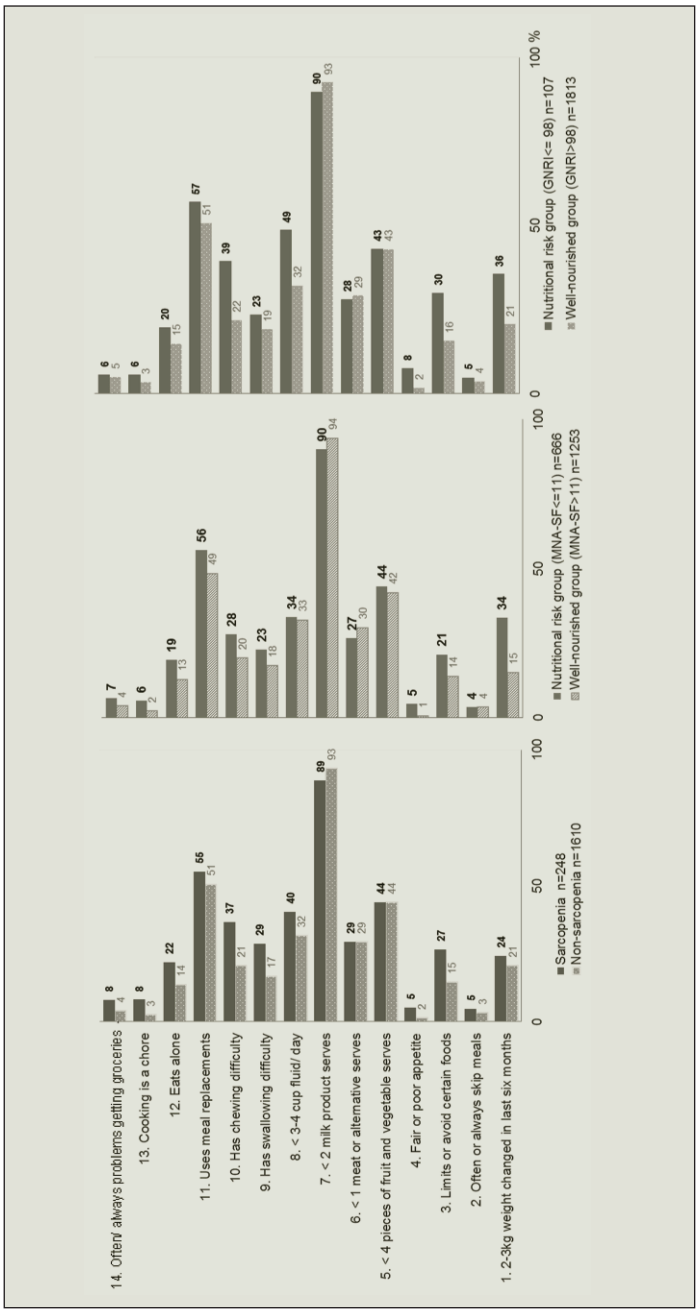
Concurrent validity analysis showed that the correlations between total NRST score and anthropometric values, dietary variety score, serum albumin concentrations and cholesterol levels (criterion-related validity) were weak but significant (Table 3). The NRST score was significantly correlated with the GNRI (r = 0.138, P < 0.001) and MNA-SF (r = 0.219, P < 0.001) scores, and with sarcopenia (r = –0.151, P < 0.001). The correlations still remain significant after adjustment for age and gender (data not shown). Cronbach's alpha coefficient (reliability) was 0.504.

Figure 1 compares the proportion of subjects with NRST item-specific scores less than or equal to two out of a maximum score of four, which are considered indicators of nutritional risk, between groups. A higher proportion of the subjects with NRST risk items (score < 2) were found in the nutritional risk (both GNRI and MNA-SF) and sarcopenic groups than in the well-nourished or non-sarcopenic groups (Figure 1). However, among 14 NRST risk items, the proportion of the subjects who skipped meals, ate less servings of fruits and vegetables, and ate fewer servings of meat or milk did not differ between the malnourished and well-nourished or sarcopenic and non-sarcopenic groups.

Performance of the NRST in predicting malnutrition as determined by the GNRI and MNA-SF

The area under the receiver operating characteristic curve (AUC) for the performance of the NRST in the prediction of nutritional risk as determined by a GNRI score < or = 98 was 0.635 (0.581–0.688) and by an MNA-SF score < or =11 was 0.584 (0.557–0.612). The AUCs for the performance of age-integrated NRST and age, BMI-integrated NRST to predict malnutrition as determined by a GNRI score < or = 98 were 0.639 (0.582–0.696) and 0.687 (0.633–0.740), respectively. Similarly, the AUCs for the performance of age-integrated NRST and age, BMI-integrated NRST to predict malnutrition as determined by MNA-SF were 0.528 (0.500–0.556) and 0.582 (0.554–0.609), respectively. These are shown in Figure 2a and b.

Figure 1
Proportion of participants (%) with specific NRST item scores indicative of nutritional risk

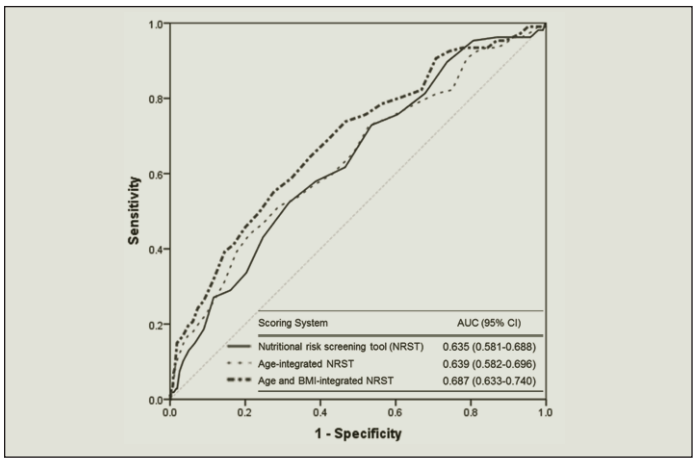


Performance of NRST in predicting sarcopenia

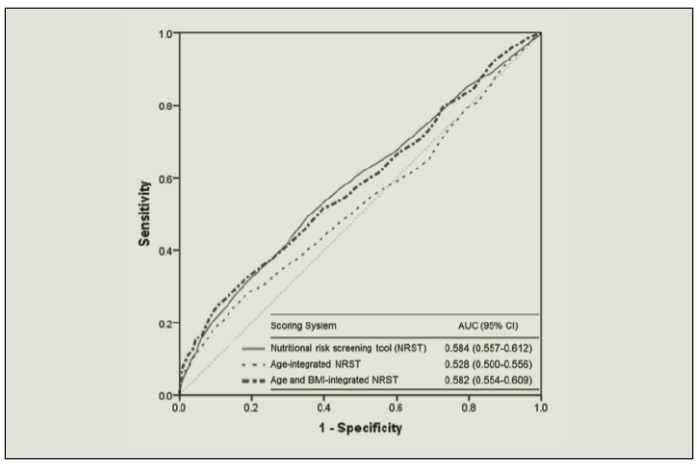
As shown in Figure 3, the AUC analysis for the prediction of sarcopenia using the NRST only was 0.602 (0.563–0.641), while when using the age-integrated NRST the AUC was 0.655 (0.615–0.694) and the AUC for age and BMI-integrated NRST was 0.676 (0.638–0.715).

Figure 2
ROC Curve analysis for the performance of the Nutritional Risk Screening Tool (NRST) in the prediction of individuals affected by or at-risk for malnutrition

(a) At-risk for malnutrition and malnourished as determined by GNRI score ≤ 98



(b) At-risk for malnutrition and malnourished as determined by MNA-SF score ≤ 11



Discussion

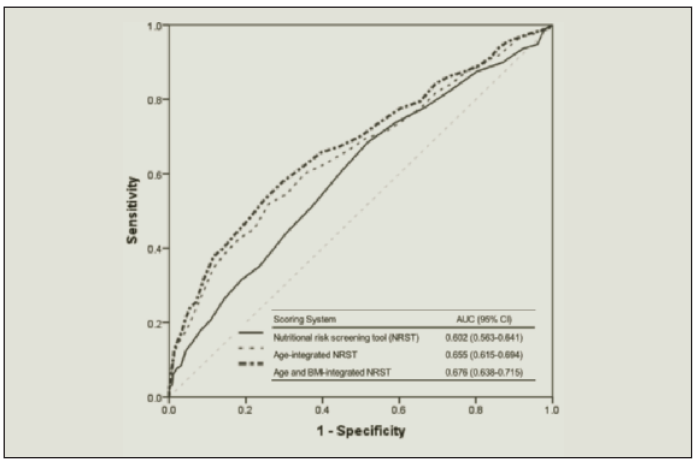
This preliminary study is the first to validate the adaptation of the original SCREEN II (as the NRST) in a population of Japanese community-dwelling older people. Our findings demonstrate that the NRST can predict malnutrition or at-risk for malnutrition status (assessed by GNRI or MNA-SF) and sarcopenia, which suggests that the NRST might be suitable for use in Japan.

According to the MNA-SF classification, our study showed a lower prevalence of malnutrition and at-risk of malnutrition (34.7%) than that reported by Hirose et al. (66.7%) in a community-dwelling older Japanese population (mean age = 81.2 years) (9). The lower prevalence of malnutrition in

our study may be owing to the younger age of our study population (mean age = 73.0 years). However, the prevalence of sarcopenia in our study was similar to that reported by other studies in Japan, in which the prevalence of sarcopenia ranged from 13.4–21.8% in men and 12.4–22.1% in women (13, 35, 36). Thus, our study cohort may be representative of the general, community-dwelling, older Japanese population.

Figure 3

Comparison between the performance of the Nutritional Risk Screening Tool (NRST), age-integrated NRST, and age and BMI-integrated NRST scores in the prediction of sarcopenia



The original SCREEN II was developed as a simple and effective nutritional screening tool, superior to other conventional tools that use subjective measurements to determine nutritional risk for older adults living in the community (23, 24). Similarly, the NRST predicted nutritional risk or sarcopenia in older Japanese adults as accurately as previously validated nutrition assessment tools such as the GNRI and MNA-SF. Importantly, the NRST is easy to comprehend at home and is therefore much easier to administer than other existing screening tools, such as the GNRI and MNA-SF. The validity of the Japanese NRST was confirmed by its good correlation with anthropometric markers of malnutrition, and with biochemical markers such as serum albumin concentration. Additionally, the total NRST score was significantly correlated with the MNA-SF and GNRI scores, and with sarcopenia, indicating good predictive performance.

We also found that the proportion of the participants with NRST risk items (score < 2) was higher in the nutritional at-risk (as determined by both the GNRI and MNA-SF) and the sarcopenic groups, except for the NRST items that assessed meal frequency, fruit and vegetable servings, and meat or milk servings, which did not differ between the nutritional risk and control groups. This was likely because the majority of the community-dwelling older adults in our study showed the same tendencies to have regular meals, eat fewer servings of fruits and vegetables, and eat less meat and milk, as a consequence of the aging-associated physiological decrease in food intake (37). Thus, eating behavior and patterns, rather than the intake of specific foods and basic activities of daily livings etc. may have a great influence on the nutritional risk status of older adults (32, 38). Another possibility is that the subjective nature of the self-administered food frequency questionnaire used in the NRST may not always obtain accurate dietary intake and nutritional status information.

In ROC analysis, the NRST did not perform as well as the GNRI or sarcopenia for predicting malnutrition determined by the MNA-SF. The MNA-SF classified a higher proportion of the study population as nutritionally at-risk than did the GNRI. Previous study by Poulia et al. also reported a higher proportion of at-risk groups classified by MNA-SF than GNRI (39). Overestimation of the prevalence of malnutrition may be owing to the inclusion of false positives, which may affect the discriminative power of the NRST. This may be owing to the self-reported nutrition-related risk components such as weight loss, appetite, mobility, psychological stress contained in the MNA-SF; these components are not part of the GNRI, which is an index based on directly measured values such as serum albumin level and body weight, and is believed to offer more precise estimates of nutritional risk than other subjective scoring systems. In our study, the NRST had good discriminative power in predicting malnutrition risk as assessed by the GNRI or sarcopenia. However, the NRST achieved its best predictive performance relative to the GNRI and sarcopenia assessments with the integration of both age and BMI.

The NRST is intended to improve the self-assessment of individual nutritional status, allowing for early prediction and management of nutritional risk. Recent studies also reported that nutrition screening with the original SCREEN II would improve self-awareness of eating behaviors and nutritional status; as a result, the improvement in nutritional knowledge could anticipate the possible early preventive measures (40, 41).

This preliminary study had some limitations. The questionnaire items that corresponded to original SCREEN II items were scored using NRST scoring (total score = 19–54). Accordingly, the NRST had a Cronbach's alpha value of only 0.504, which may be insufficient to analyze its validity and reliability. The NRST is a self-reported nutritional screening tool that may not be able to accurately capture all nutritional risks; for example, reported weight changes were not based on actual measured weights. Nevertheless, the NRST is suggested to be a simple, self-administered nutrition screening tool that may be able to identify at-risk individuals living in the community.

Conclusion

The findings of this preliminary study indicate that the Japanese Nutritional Risk Screening Tool (NRST), especially

the age- and BMI- integrated NRST, may be a promising tool for the prediction of malnutrition and sarcopenia in community-dwelling older Japanese people. These results suggest that further development of a licensed, Japanese version of the SCREEN II is warranted.

Conflict of Interest: None

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Ethical Standards: This study was approved by the ethics review committee of the National Institute of Health and Nutrition and the Graduate School of Medicine, The University of Tokyo. Written informed consent was obtained from all participants.

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