Original Article

Efficacy of malnutrition screening tools in China for elderly outpatients

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Background and Objectives: Malnutrition in elderly individuals is extremely common. In China, Nutritional Risk Screening 2002 (NRS-2002) is often used to assess malnutrition in hospitalized elderly patients, although a gold standard for elderly outpatients is lacking. The Nutrition Screening Initiative Checklist (NSI) and Malnutrition Screening Tool (MST) have seldom been validated in elderly outpatients. This open, parallel, multi-center, cross-sectional study evaluated the performance of NRS-2002, the NSI, and the MST in estimating malnutrition risk in elderly outpatients. **Methods and Study Design:** This study included 986 elderly outpatients, with 53.2% being women, from five clinical teaching hospitals in Beijing. The sensitivity, specificity, and area under the receiver operating characteristic curve (AUC) of the tools were estimated using a body mass index (BMI) of <18.5 kg/m^2 as a reference. **Results:** The mean (range) age of the patients was 69.6±6.8 (60–100) years. Overall, 4.3% had BMI <18.5 kg/m^2, 16.8% scored ≥3 points in NRS-2002, 9.8% scored ≥2 points in the MST, and 37.0% scored ≥3 points in the NSI. NRS-2002 had the highest sensitivity and the best AUC (0.934 vs. 0.642 for the NSI and 0.660 for the MST, p<0.05), and the MST had the highest specificity. The sensitivity and specificity of the NSI were 0.64 and 0.64, respectively. **Conclusions:** NRS-2002 had the highest validity, and the MST had the highest specificity in estimating the risk of malnutrition in elderly outpatients. However, the accuracy of the NSI should be further verified with large samples.

Key Words: Elderly outpatients, malnutrition, Nutritional Risk Screening 2002 (NRS2002), Nutrition Screening Initiative Checklist (NSI), Malnutrition Screening Tool (MST)

INTRODUCTION

China is considered an aging society, and malnutrition among elderly individuals is common. Nearly 15.1% of elderly inpatients had malnutrition in a large-sample study conducted by the Chinese Medical Association Nutrition Support Group for Geriatric Patients in 2012.[1] Early diagnosis of malnutrition in the elderly population is highly important to improve life quality and avoid complications from this condition. Despite the availability of several nutritional screening and assessment tools, no diagnostic gold standard has been defined for different groups, such as community-dwelling individuals, individuals living in pension institutions, inpatients, or outpatients.[2] In China, Nutritional Risk Screening 2002 (NRS-2002) and Mini Nutritional Assessment Short Form (MNA-SF) are the commonly used nutritional assessment tools in hospitalized elderly patients, but a uniform tool for elderly outpatients is lacking. The Nutrition Screening Initiative Checklist (NSI) for elderly individuals in a community[3-5] and Malnutrition Screening Tool (MST) for hospitalized elderly patients[6-8] have been extensively validated in elderly patients. Nevertheless, few large-scale investigations have been conducted on the efficiency of these tools in elderly outpatients in China.

To address the aforementioned gap in the literature, we conducted this cross-sectional study to evaluate the performance efficiency of NRS-2002, the NSI, and the MST in estimating the risk of malnutrition in elderly outpatients.

METHODS

Study design

This open, parallel, multicenter, cross-sectional investigation included elderly outpatients from five clinical teaching hospitals in Beijing, China, for the period from October 1, 2014, to December 30, 2014. Patients were enrolled from the general surgery, thoracic surgery, gastroenterology, respiratory, neurology, geriatrics, and oncology departments of these hospitals. The study was approved by the Ethics Committee of Peking Union Medical College Hospital (approval number: S-K 012). Furthermore, the

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sensitivity, specificity, positive predictive values, negative predictive values, positive likelihood ratios, negative likelihood ratios, and areas under the receiver operating characteristic (ROC) curves (AUCs) were estimated for NRS-2002, the NSI, and the MST, with BMI <18.5 kg/m^2 serving as a reference.

Patients who were outpatients, were aged >60 years, were willing to provide informed consent, and could complete the questionnaires consciously were included. Inpatients and those in a confused state of mind were excluded.

Nutritional screening tools

We used NRS-2002, the NSI, and the MST, three widely recognized nutritional screening methods, to screen and compare the nutritional status of elderly outpatients in order to clarify the applicability of the tools.

NRS-2002 helps assess the malnutrition risk in hospitalized patients and is recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN),[9,10] Chinese Society for Parenteral and Enteral Nutrition (CSPEN), Society of Critical Care Medicine, and American Society for Parenteral and Enteral Nutrition for use in critically ill adult patients.[11] The tool assesses disease severity, impaired nutritional status, and age, with a score of ≥3 indicating nutritional risk.

The NSI is a valid nutritional status screening tool for community-dwelling elderly individuals.3 The checklist consists of 10 self-assessment items: 1) "I have an illness or condition that made me change the kind and/or amount of food"; 2) "I eat fewer than two meals a day"; 3) "I eat few fruits or vegetables or milk products"; 4) "I have three or more drinks of beer, liquor, or wine almost every day"; 5) "I have tooth or mouth problems that make it hard for me to eat"; 6) "I do not always have enough money to buy the food I need"; 7) "I eat alone most of the time"; 8) "I take three or more different prescribed or over-the-counter drugs a day"; 9) "Without wanting to, I have lost or gained 10 lb in the past 6 months"; and 10) "I am not always physically able to shop, cook, and/or feed myself." A score of 3-5 indicates moderate nutritional risk and a score of ≥6 indicates high nutritional risk.

The MST is not designed for older adults, but it has been extensively validated in hospitalized elderly patients in both Europe and Australia.12 The tool has only two questions: "Have you lost weight recently without trying?" and "Have you been eating poorly because of a decreased appetite?" A score of ≥2 indicates the presence of nutritional risk.

Data collection

NRS-2002, the NSI, and the MST were applied to elderly outpatients, and the scores were assessed by a trained dietitian through face-to-face interviews in the clinic. In addition, baseline information, such as gender and age, of the patients was obtained. Data were abstracted and inputted independently by two trained investigators within 72 hours of the survey to ensure consistency and integrity.

Statistical analysis

Measurement data are expressed as mean ± standard deviation, and counting data are expressed as percentage. To determine the accuracy of NRS-2002, the NSI, and the MST in predicting malnutrition in elderly outpatients, the AUCs, sensitivity, specificity, positive predictive values, and negative predictive values of the tools were estimated, with BMI < 18.5 kg/m^2 serving as a reference. All statistical tests were two sided, and a p value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (Version 19, SPSS Inc., IBM, NY, USA).

RESULTS

A total of 986 elderly outpatients were enrolled in this study (Figure 1). The mean (range) age of the patients was 69.6±6.8 (60–100) years, and 53.2% (n=525) of them were women. The proportions of elderly outpatients aged 60–64, 65–69, 70–74, 75–79, 80-84 and >80 years were

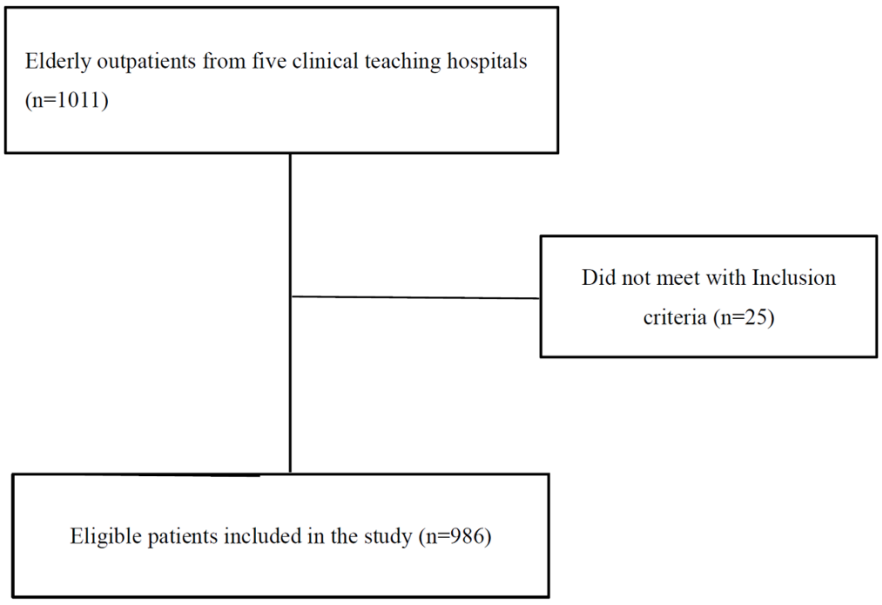

Figure 1. Study flow diagram.

Table 1. Patient characteristics

Characteristics	n (%)
Age, y, mean±SD	69.6±6.8
Range	60-100
60-64	283 (28.7)
65-69	263 (26.7)
70-74	188 (19.1)
75-79	171 (17.3)
80-84	52 (5.3)
≥85	29 (2.9)
Sex	
Male	433 (43.9)
Female	525 (53.2)
Missing data	28 (2.8)
Education	
Primary school	217 (22.0)
Secondary Education	495 (50.2)
College education	249 (25.3)
Missing data	25 (2.5)
Diagnoses	
Hypertension	507 (51.4)
Diabetes Mellitus	340 (34.5)
Coronary heart disease	233 (23.6)
Cancer	128 (13.0)
Stroke	69 (7.0)
Liver cirrhosis	60 (6.1)
Chronic renal failure	42 (4.3)
Chronic obstructive pulmonary disease	30 (3.0)
Hip fracture	8 (0.8)
BMI	
Mean±SD	24.3±3.5
Range	11.3-39.3
BMI <18.5 kg/m^2	42 (4.3)
NRS2002 ≥3	166 (16.8)
MST ≥2	97 (9.8)
NSI ≥3	365 (37.0)

BMI: Body Mass Index; NRS2002: Nutritional Risk Screening 2002; MST: the Malnutrition Screening Tool; NSI: Nutrition Screening Initiative Checklist.

28.7%, 26.7%, 19.1%, 17.3%, 5.3%, and 2.9%, respectively. Furthermore, 25.2% of the elderly outpatients had college education, 50.2% had secondary education, and 22.0% had primary-school education. All diseases of these patients were officially documented in the outpatient medical records. Hypertension, type 2 diabetes, and coronary heart disease were the most common diseases, accounting for 51.4%, 34.5%, and 23.6%, respectively. Moreover, 13.0% of the elderly outpatients had a diagnosis of tumor, and 57.5% had three or more diseases (Table 1).

The average (range) BMI of the patients was 24.3±3.5 (11.3–39.3) kg/m^2. Moreover, 42 patients had a BMI of <18.5 kg/m^2, accounting for 4.3%. In addition, 166 patients (16.8%) had an NRS-2002 score of ≥3, 97 patients (9.8%) had an MST score of ≥2, and 365 patients (37.0%) had an NSI score of ≥3. Basic responses to the nutritional screening tools are presented in Table 2.

At a reference BMI of <18.5 kg/m^2, the sensitivity, specificity, positive predictive values, negative predictive values, and AUC values of NRS-2002 were 1, 0.87, 0.25, 1, and 0.934, respectively; those of the NSI were 0.64, 0.64, 0.07, 0.98, and 0.642, respectively, and those of the MST were 0.40, 0.91, 0.17, 0.97, and 0.660, respectively (Table 3). The sensitivity, negative predictive value, and AUC value of NRS-2002 were the best, and MST had the highest specificity (Figure 2).

DISCUSSION

According to our review of the relevant literature, this is the first large-scale study to explore the predictive efficiency of NRS-2002, the NSI, and the MST in elderly outpatients in China. Among 986 patients, 4.3% had a BMI of <18.5 kg/m^2, 16.8% scored ≥3 points in NRS-2002, 9.8% scored ≥2 points in the MST, and 37.0% scored ≥3 points in the NSI. The sensitivity, negative predictive value, and AUC of NRS-2002 were the best, and MST had the highest specificity at a reference BMI of <18.5 kg/m^2.

In this study, malnutrition was common in those with increasing age, decreased appetite, reduced eating, comorbidities, depression, or economic problems, as well as in those living alone. Early diagnosis of malnutrition in elderly individuals is particularly important, implying the need for higher sensitivity and easy-to-use nutritional screening tools for improving clinical outcomes.

In particular, there are no uniform tools for assessing the risk of malnutrition in elderly outpatients. However, NRS-2002 and MNA-SF13-15 are the commonly used nutritional assessment tools for hospitalized elderly patients in China. In a previous study, MNA-SF had a high clinical sensitivity of 97.9%–100% and specificity of

Table 2. Basic responses to the NSI, MST and NRS 2002

NSI	Yes (%)
I have an illness or condition that made me change the kind and/or amount of food I eat	298 (30.2)
I eat fewer than two meals a day	25 (2.5)
I eat few fruits or vegetables or milk products	135 (13.7)
I have three or more drinks of beer, liquor, or wine almost every day	33 (3.3)
I have tooth or mouth problems that make it hard for me to eat	154 (15.6)
I don't always have enough money to buy food I need	12 (1.2)
I eat alone most of the time	128 (13.0)
I take three or more different prescribed or over-the-counter drugs a day	523 (53.0)
Without wanting to, I have lost or gained 10 Ib in the past 6 months	70 (7.1)
I am not always physically able to shop, cook, and/or feed myself	59 (6.0)
MST	
Have you lost weight recently without trying?	
How much weight have you lost?	
1-5	108 (10.9)
6-10	47 (4.8)
11-15	7 (0.7)
> 15	0
Have you been eating poorly because of a decreased appetite?	152 (15.4)
NRS2002	
Severity of disease	
0	521 (52.8)
1	416 (42.1)
2	43 (4.4)
3	0 (0)
Impaired nutritional status	
0	741 (75.1)
1	103 (10.4)
2	95 (9.6)
3	47 (4.8)
Age> 70	425 (43.1)

NRS2002: Nutritional Risk Screening 2002; MST: the Malnutrition Screening Tool; NSI: Nutrition Screening Initiative Checklist.

Table 3. Comparison of the performance

	NRS2002	MST	NSI
Sensitivity	1 (0.90-1)	0.40 (0.25-0.56)	0.64 (0.48-0.78)
Specificity	0.87 (0.85-0.89)	0.91 (0.90-0.93)	0.64 (0.61-0.67)
Positive predictive value	0.25 (0.19-0.33)	0.17 (0.11-0.26)	0.07 (0.05-0.11)
Negative predictive value	1 (0.99-1)	0.97 (0.96-0.98)	0.98 (0.96-0.99)
Area under the ROC curve*	0.934 (0.917-0.951)	0.660 (0.562-0.758)	0.642 (0.557-0.728)
Positive likelihood ratio	7.61 (6.46-8.97)	4.65 (3.04-7.10)	1.80 (1.41-2.28)
Negative likelihood ratio	0.00	0.66 (0.52-0.84)	0.56 (0.37-0.84)

NRS2002: Nutritional Risk Screening 2002; MST: the Malnutrition Screening Tool; NSI: Nutrition Screening Initiative Checklist; ROC: receiver operating characteristic.
*$p<0.05$.

69.5%–100% in hospitalized elderly patients,[16] although it was not applied to outpatients. The CSPEN recommended the use of NRS-2002 in 2008, and its applicability has been verified by large-sample studies. The tool is widely used for inpatients, including elderly patients and outpatients, in China. Considering that there is no uniform tool for assessing nutritional status in elderly outpatients, we chose the commonly used NRS-2002. We found that NRS-2002 had a high sensitivity, negative predictive value, and AUC value, in line with the findings in the literature.[17]

The NSI is used in community-dwelling elderly individuals, and the use of the MST, designed for emergency patients and validated in hospitalized older patients, is rarely reported in Chinese elderly outpatients. This study was a pilot study on the effectiveness of these tools for outpatients.

The NSI was published in 1991 and has since been used in elderly community-dwelling individuals and validated in the United States, Europe, South America, and Africa.[3-5] De Groot et al[5] found that 48% of 1,161 elderly individuals in a community in Europe were at high nutritional risk. This finding is consistent with that of our previous study, wherein 48.4% of 3,885 elderly individuals in a community had high nutritional risk. However, there are only a few reports of elderly outpatients in China. In the present study, we found that 37% of the study population had a moderate and high nutritional risk on the NSI. Among 986 elderly outpatients, the items with the highest response rates on the NSI were “I take ≥3 different medications daily,” accounting for 53.0%; “I have difficulty in eating due to oral and dental problems,” accounting for

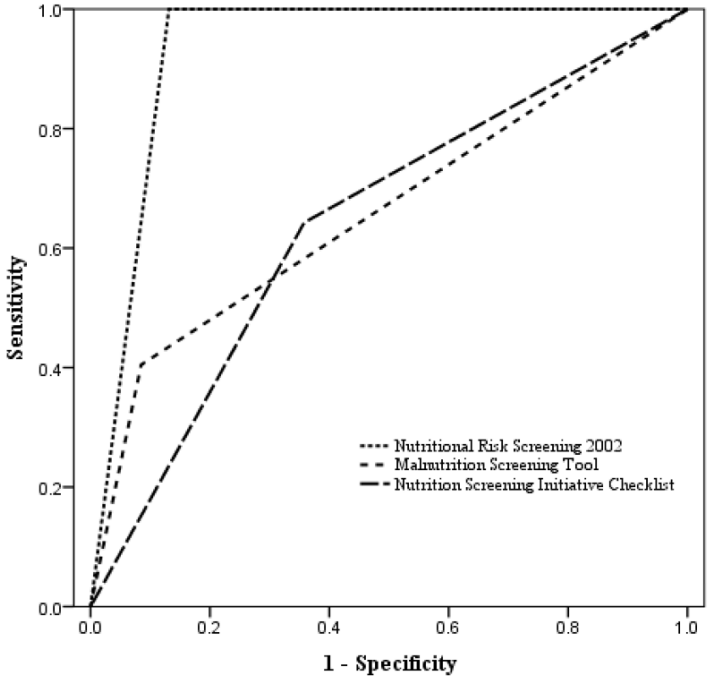

Figure 2. Receiver operating characteristic curve of the NSI, MST and NRS 2002.

15.6%; and "I'm usually alone when I eat," accounting for 13.0%. Multiple drug use,[18] tooth loss,[19-21] and living alone[22-24] may increase the nutritional risk of the elderly population, which are not directly included in the MST. This could be the reason why the NSI had a higher sensitivity than the MST. Moreover, because the NSI is designed to evaluate both overnutrition and undernutrition, it may overestimate the risk of malnutrition.[25] Although the sensitivity and negative predictive values of the NSI were higher than those of the MST, the AUC of this tool was smaller than those of the other tools. Further large-sample studies are warranted to validate the efficiency of the NSI in elderly outpatients.

The MST, originally developed for emergency inpatients and widely used in hospitals across Australia and New Zealand, has been validated in hospitalized elderly patients in both Europe and Australia.[6-8,12] The efficiency of the diagnostic tool in elderly outpatients has not been verified in China. In this study, the MST had the highest specificity at a reference BMI of <18.5 kg/m^2. In a previous study involving 171 hospitalized elderly patients, the MST had a relatively high specificity when of <18.5 kg/m^2 was used as a reference.[26] In elderly Asians, the MST had higher specificity than sensitivity.[15] Moreover, the MST has only two questions and is simple and easy to use.

This study has certain limitations. First, elderly outpatients with a moderate and high nutritional risk as per the NSI were merged into a single category in the statistical analysis. At a cutoff value of ≥6, the NSI had a higher specificity than did the other tools (data not shown). Second, this was an exploratory study for estimating the efficiency of nutritional screening tools in elderly outpatients. We recommend that future studies verify the efficiency of other tools, such as MNA-SF,[14,15] Mini Nutritional Assessment,[25] MUST,[14,27] and GLIM criteria,[28] in the elderly population.

Conclusion

NRS-2002 was the most valid and the MST had the highest specificity among the tested tools for estimating the risk of malnutrition in elderly outpatients. The accuracy of the NSI should be further verified with larger samples.

AUTHOR DISCLOSURES

The authors declare no conflict of interest. This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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