Original Article

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Validity and Reliability of a Thai-Translated Malnutrition Screening Tool in an Outpatient Setting: A Comparison with the GLIM Criteria

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Abstract:

Objective: The malnutrition screening tool (MST) has been widely validated for detecting malnutrition in various countries. However, its applicability in Thai outpatient settings remains unexplored. This study aimed to translate the MST into Thai and assess its validity and reliability compared to the global leadership initiative on malnutrition (GLIM) criteria.

Material and Methods: A cross-sectional study was conducted at a tertiary care hospital, including 248 participants. Nutritional status was evaluated using the Thai-translated MST (T-MST), mini nutritional assessment-short form (MNA-SF), and GLIM criteria, which included bioelectrical impedance analysis for muscle mass assessment. Sensitivity, specificity, area under the receiver operating charateristic curve (ROC-AUC), test-retest reliability, inter-rater reliability, and internal consistency (item-total score correlation and Cronbach's alpha) were analyzed to assess the MST's performance relative to the GLIM criteria.

Results: The Thai version of the MST demonstrated excellent test-retest reliability (intraclass correlation coefficient [ICC]=0.976, p-value<0.001) and inter-rater reliability (ICC=0.917, p-value<0.001). It showed strong agreement with the GLIM criteria (Kappa=0.843), comparable to the MNA-SF (Kappa=0.834). Internal consistency was satisfactory (Cronbach's alpha=0.794). The T-MST achieved a sensitivity of 86.5% and specificity of 96.0%, while the MNA-SF showed a sensitivity of 93.2% and specificity of 93.1% against the GLIM criteria. Both tools demonstrated excellent predictive accuracy (ROC-AUC: T-MST=0.907, MNA-SF=0.929).

Conclusion: The T-MST is a reliable and efficient tool for malnutrition screening in outpatient settings. Its simplicity and ease of use make it particularly valuable in time-constrained environments. However, ongoing validation across diverse populations and settings is essential to ensure consistent performance across different clinical contexts.

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Introduction

Malnutrition remains a pervasive and critical public health issue, particularly among vulnerable populations, such as the elderly and hospitalized patients. Epidemiologically, malnutrition is more prevalent in countries with low and middle incomes; however, it is also a significant concern in high-income settings, especially among specific populations, including older adults, children, and individuals with chronic conditions[1,2]. The burden of malnutrition extends beyond individual health, impacting healthcare systems and economies. Malnutrition significantly affects the quality of life, morbidity, duration of hospital stay, mortality rates, and healthcare expenditure. Despite its impact, this condition often goes unrecognized in outpatient settings, leading to increased morbidity, extended recovery periods, and higher healthcare costs[1-4].

Nutritional screening is a simple and rapid process, typically conducted upon a patient's admission to the hospital, and serves as an essential initial step in detecting individuals who are at risk or may be at risk of malnutrition. This allows for timely referral for appropriate nutritional interventions[5]. Globally, this screening process is a standard procedure performed by nursing staff, medical professionals, and other healthcare providers during initial visits or admissions. The results from screening help in the implementation of interventions that range from basic nutritional advice to more specialized dietary support.

Early detection of malnutrition through screening is crucial in both inpatient and outpatient environments, allowing healthcare providers to initiate timely nutritional support and interventions[6]. Without proper screening mechanisms, malnutrition often goes unnoticed, leading to worse patient outcomes and a greater healthcare burden. In outpatient department (OPD) settings, where time constraints and large patient numbers are common, the use of effective and streamlined screening tools is particularly important[7]. Simple and efficient screening tests are valuable as they improve the detection of malnutrition risk while reducing time and resource requirements[8].

The global leadership initiative on malnutrition (GLIM) has developed standardized diagnostic criteria for malnutrition, incorporating phenotypic measures (e.g., weight loss, low body mass index (BMI), and decreased muscle mass) alongside aetiologic factors (e.g., reduced food intake and inflammation). These standards encourage uniformity and thoroughness in malnutrition assessments across various healthcare settings[9]. Integrating the GLIM framework into clinical practice improves diagnostic precision and facilitates evidence-based nutritional interventions. However, the effectiveness of the GLIM criteria relies on employing dependable screening methods to precisely detect individuals at risk of malnutrition. Additionally, diagnosing malnutrition may require advanced tools, such as bioelectrical impedance analysis (BIA) or dual-energy X-ray absorptiometry, to assess muscle mass. These limitations pose challenges for implementing the GLIM criteria universally, particularly in resource-limited settings. The use of straightforward screening tools is especially beneficial in busy clinical environments as they provide critical information about a patient's nutritional status without overburdening staff or processes[10]. One such tool is the malnutrition screening tool (MST), which has gained widespread acceptance because of its simplicity and effectiveness. Initially developed in English, the MST has been validated across various clinical settings, including hospitals and outpatient care[2]. The MST contains just

2 questions targeting recent weight loss and decreased appetite, making it an efficient means of identifying patients at risk of malnutrition without requiring complex clinical assessments[11].

The MST is widely utilized to detect individuals at risk of malnutrition in different healthcare environments, and its validity and reliability are well documented. The MST has shown moderate validity and strong inter-rater reliability in acute care, making it effective in detecting nutritional risk[12]. Its reliability is similar in rehabilitation and ambulatory care settings, with consistent results across diverse patient populations[13]. Additionally, the MST has been validated in oncology clinics, where it has been shown to be an effective and practical screening tool for cancer patients[14]. However, its sensitivity may be lower in specialized populations, such as inpatients with renal disorders, where one study found a sensitivity of 48.7% and a specificity of 85.5% in comparison to the subjective global assessment (SGA)[15]. These results indicate that while the MST is typically dependable, its effectiveness may differ across patient populations, potentially under-detecting malnutrition in certain groups. Overall, however, the MST remains an effective instrument for the early identification of malnutrition across various clinical settings.

This study aimed to translate, validate, and evaluate the reliability of the MST for use in Thai-speaking populations within an OPD setting. Through this, we aimed to enhance the accuracy and consistency of malnutrition screening in Thailand's healthcare system, highlight the importance of using simple and efficient screening methods, and demonstrate how the MST can serve as a reliable and effective tool for the early detection and management of malnutrition in routine clinical practice.

Material and Methods

This cross-sectional study was conducted at the OPD of a tertiary care hospital located in Bangkok, Thailand, between January 2023 and June 2024. The cross-sectional study design was selected for this validation study as it is well-suited for assessing the validity and reliability of the Thai-translated malnutrition screening tool (T-MST), enabling a direct comparison between the MST and the reference standard, the GLIM criteria, under identical conditions.

Participants

Participants were recruited from 2 outpatient clinics: the internal medicine and the family medicine OPDs, which primarily cater to patients with chronic conditions such as non-communicable diseases, infections, cancers, and systemic diseases. The study included participants who met the following eligibility criteria: individuals aged 18 years or older, fluent in Thai, and attending the outpatient clinics of internal medicine or family medicine for chronic conditions. Excluded were those unable to understand the study's purpose or provide informed consent, individuals with a confirmed diagnosis of dementia, and those who were not proficient in Thai. These criteria were designed to ensure that the participants accurately reflected the target population and could effectively complete the study assessments.

Demographic comparisons and sampling bias

Demographic and clinical characteristics, including age, sex, and primary diagnosis, were analyzed. Participants were recruited using convenience sampling from 2 outpatient clinics, which may limit the generalizability of the findings to broader populations, particularly individuals who do not

frequently attend outpatient services or are managed in other healthcare settings. To address the potential biases associated with the convenience sampling method, strict inclusion and exclusion criteria were implemented in order to minimize selection bias and ensure the sample aligned with the target population.

Smoking status was determined through patient self-reports. Individuals were classified as smokers if they were currently smoking or had smoked within the past year. Career status referred to whether participants were actively employed or engaged in any income-generating work, including part-time or freelance activities, with 'Yes' indicating active employment. Monthly household income was recorded in Thai baht and categorized into income brackets. These definitions ensured standardized and consistent data collection and analysis.

Data collection procedures

Nutritional assessment tools

The research team approached consecutive patients visiting the clinic and invited them to participate in the study. Participants who agreed to join provided their written informed consent. Each participant was assessed using the MST and mini nutritional assessment-short form (MNA-SF) as initial screening tools. Subsequently, the GLIM criteria were applied to confirm malnutrition diagnosis and validate the screening instruments. All assessments were conducted by trained doctors who received standardized instructions on the use of the MST, MNA-SF, and GLIM criteria to ensure consistency and accuracy in data collection. To minimize the risk of measurement bias, different doctors performed the assessments for each tool, ensuring that the MST, MNA-SF, and GLIM criteria were evaluated independently.

Translation process

The original English version of the test was translated into Thai by authors who had medical expertise and were proficient in English. Additionally, a bilingual lecturer with no medical background from the Faculty of Arts at Chulalongkorn University participated in the translation process, resulting in 2 translated versions of the MST.

The 2 translated versions were compared by a research team consisting of family medicine physicians, geriatric specialists, and clinical nutrition experts, who discussed and revised any discrepancies between the texts. The language was reviewed for grammatical accuracy and edited to ensure clarity and correct medical terminology.

Backward translation was performed by a bilingual lecturer from the Faculty of Arts at Chulalongkorn University, who had not been involved in the forward translation and was unfamiliar with the MST. The original English and back-translated versions were compared and minor discrepancies were identified. These discrepancies were addressed and the process was repeated to resolve any remaining issues.

The key challenges in translating the MST into Thai were ensuring linguistic accuracy, cultural relevance, and consistency with the original meaning. To address these, a bilingual team with medical expertise conducted forward, and backward translations, followed by a review by a multidisciplinary team to resolve discrepancies. Pilot testing with Thai-speaking participants further ensured clarity, and cultural appropriateness, with adjustments made based on feedback.

Data collection

After obtaining informed consent, clinical information such as age, sex, weight, height, smoking and alcohol use, education level, occupation, and comorbidities was gathered through patient interviews and medical records. An investigator assessed each patient using the GLIM criteria during the interview and subsequently conducted nutritional screening using MST and MNA-SF scores. Missing data were managed by excluding incomplete cases from the analysis in order to maintain the accuracy of the results.

Reference standard (GLIM criteria)

The GLIM criteria[6] were applied as the reference standard by assessing at least one phenotypic criterion (e.g., weight loss, low BMI, or reduced muscle mass) and one etiological criterion (e.g., reduced food intake or inflammation). Muscle mass was measured using BIA with specific thresholds, while food intake and inflammation were evaluated through patient interviews and medical records. A trained doctor independently applied the GLIM criteria, blinded to MST and MNA-SF results, ensuring consistency and objectivity in malnutrition diagnosis.

Screening tools

The MST is to identify adults who may be at risk of malnutrition. It features questions on recent unintentional weight loss and appetite changes, enabling efficient preliminary screening[12,16].

The MNA-SF includes 6 questions covering areas such as food intake, recent weight loss, mobility, psychological stress or acute illness, neuropsychological conditions, and BMI or calf circumference. Based on the responses, individuals are classified as malnourished, at risk of malnutrition, or having normal nutritional status[17].

The area under the curve (AUC) for the MST was 0.62, while the MNA-SF had an AUC of 0.65. Both tools demonstrated acceptable performance when compared to the SGA[18].

In this study, the MST was initially used to screen patients for malnutrition risk, followed by the MNA-SF for a more detailed assessment, especially in older adults. Muscle mass was measured using BIA, a well-established technique used in clinical practice. The GLIM-recommended thresholds, with measurements below 7.0 kilogram per square meter (kg/m^2) for men and 5.7 kg/m^2 for women, were used to define reduced muscle mass. The aetiologic criteria were assessed based on 2 aspects: decreased food intake or absorption, along with the presence of disease burden or inflammation. Information on recent changes in appetite and food intake was obtained through patient interviews, and medical records were examined to detect acute or chronic conditions, such as infections, cancers, or systemic diseases, that could indicate inflammation.

A trained doctor independently applied the GLIM criteria, which included a BIA examination for muscle mass assessment for all participants, without access to the MST and MNA-SF results, to prevent bias and ensure an objective diagnosis. To further minimize bias, the MST and MNA-SF evaluations were carried out by a different physician who had undergone specialized training in using these tools. The validity and reliability of the MST and MNA-SF were evaluated using established cutoff values: a score of 2 or more for the MST; and scores of 11 or less and 7 or less for the MNA-SF, indicating malnutrition risk and malnourishment, respectively. These thresholds were selected based on the accuracies reported in previous studies.

The doctors responsible for administering the MST and MNA-SF underwent standardized training to ensure accuracy and consistency in data collection. This training included detailed guidance on the proper use of each tool, covering scoring methods, interpretation of responses, and techniques for conducting patient interviews. The training process involved workshops, hands-on demonstrations, and supervised practice to ensure familiarity with the tools. To maintain inter-rater consistency, periodic assessments were conducted in which multiple doctors independently evaluated the same participants, and their results were compared to identify and resolve any inconsistencies. This ensured uniformity in the use of the MST and MNA-SF across all assessors.

To evaluate inter-rater reliability, multiple doctors independently administered the MST to the same participants while adhering to standardized procedures.

This approach ensured uniformity in how responses were scored and interpreted across assessors. Prior to data collection, all doctors underwent training to follow strict protocols for using the MST, minimizing potential variability. The reliability was quantified using the intraclass correlation coefficient (ICC), which measures the level of agreement between raters. Test-retest reliability was evaluated by administering the MST to the same participants twice, with a 7-day interval between assessments. This time frame was selected to minimize memory bias while maintaining stability in the participants' nutritional status. To ensure consistency, the same doctor conducted both assessments following standardized procedures. The ICC was used to assess the consistency of scores between the 2 tests, ensuring reliable measurements over time.

Statistical analysis

The sample size calculation was based on a reported prevalence of 52.6%, with a sensitivity and specificity of 75% and 94% for validating a MST in patients. Using an estimated specificity of 94% and allowing for a margin of error (d) of 0.05, the minimum required sample size was determined to be 165 patients[12]. The final recruitment of 248 participants exceeded this threshold, ensuring sufficient statistical power to perform the analyses. This larger sample size further enhanced the robustness and reliability of the study's findings, reducing the risk of Type II errors and enabling confident interpretation of the results.

Statistical analyses were performed using IBM Statistical Package for the Social Sciences version 26.0 (IBM, Armonk, NY, USA). Demographic and clinical data were summarized using descriptive statistics. Categorical variables were expressed as numbers (n) and percentages (%). For continuous variables, normally distributed data were presented as means and standard deviations (X±S.D.), while non-normally distributed data were reported as medians with interquartile ranges (25^{th}–75^{th} percentiles).

Validity was assessed by evaluating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver operating characteristic curve (ROC-AUC). These metrics were used to determine the ability of the MST and MNA-SF to accurately differentiate between patients who were well nourished and those who were malnourished or at risk of malnutrition, with the GLIM criteria serving as the reference standard for diagnosing malnutrition. The interpretation of AUC values followed standard classifications: outstanding (>0.90), excellent (0.80-<0.90), and acceptable (0.70-<0.80). Concurrent validity was assessed using Cohen's kappa statistics to evaluate the level of agreement between the MST and the MNA-SF, ensuring consistency across assessments[19].

Reliability was evaluated using multiple measures. Cohen's kappa statistic was used to calculate inter-rater reliability, with interpretations as follows: 0.01-0.20 for slight agreement, 0.21-0.40 for fair agreement, 0.41-0.60 for moderate agreement, 0.61-0.80 for substantial agreement, and 0.81-1.00 for almost perfect or perfect agreement[19]. Test-retest and inter-rater reliability were evaluated using the ICC and 95% confidence intervals (CIs). The ICC values were interpreted as excellent (0.90-1.00), good (0.75-0.90), moderate (0.50-0.75), and poor reliability (<0.50). Item-total correlation and Cronbach's alpha coefficients were used to assess internal consistency. The Cronbach's alpha coefficient was interpreted as follows: excellent (0.90-1.00), good (0.80-0.90), acceptable (0.70-0.80), questionable (0.60-0.70), poor (0.50-0.60), and unacceptable (<0.50)[20].

This study adhered to the principles outlined in the Declaration of Helsinki, as well as ethical guidelines for research involving human subjects and applicable local regulations. Approval for the study was granted by the Institutional Review Board of the Royal Thai Army Medical Department (R003h/67) before commencing the research. All participants were fully informed about the study's

objectives, procedures, potential risks, benefits, and written consent was obtained before participation. Participant confidentiality was strictly maintained by anonymizing all personal identifiers, securely storing data, and restricting access to authorized personnel. The study adhered to strict ethical guidelines, receiving IRB approval, and regular monitoring ensured compliance with ethical standards. No adverse events or major ethical concerns arose, and minor issues, such as participant discomfort, were promptly addressed through clear communication and reassurance.

Results

Of the 269 eligible patients, 248 were included in the study, while 21 were excluded for the following reasons: not meeting the inclusion criteria, which included inadequate language proficiency or inability to provide informed consent (n=10); incomplete or missing essential data required for analysis (n=4); and specific conditions, such as cognitive impairments or significant comorbidities that conflicted with the study protocol (n=7). The demographic and clinical characteristics of the 248 outpatients are shown in Table 1. Based on the GLIM criteria, 74 patients (29.8%) were categorized as malnourished and 174 (70.2%) were classified as well-nourished. The MST Thai version (Figure 1) identified 71 patients (28.6%) as malnourished and 177 (71.4%) as well-nourished. Similarly, the MNA-SF classified 81 patients (32.6%) as malnourished and 167 (67.4%) as well-nourished. Key patient characteristics were assessed during the study period.

The MST Thai version, when compared with the GLIM malnutrition diagnosis criteria, demonstrated a high sensitivity of 86.5%, a specificity of 96.0%, a PPV of 90.1%, and a NPV of 94.4% (Table 2). The strength of the agreement was good (Cohen's kappa=0.843, p-value<0.001), indicating compatibility with a good screening test (Table 3). In comparison, the MNA-SF showed a sensitivity of 93.2%, a specificity of 93.1%, a PPV of 85.2%, and an NPV of 97.0%. The ROC AUC scores were 0.907 (CI: 0.847-0.966) for the MST and 0.929 (CI: 0.884-0.975) for the MNA-SF, indicating excellent performance.

The MST showed strong agreement between the assessors (Cohen's kappa=0.843, p-value<0.001), indicating its effectiveness as a screening tool (Table 3). The test-retest and inter-rater reliability analyses revealed good to excellent ICC values for all MST items (Table 4). The scale had an acceptable Cronbach's alpha of 0.794 (Table 5).

Table 1 Participants' baseline characteristics and malnutrition status categorization based on GLIM criteria

Characteristics	Well-nourished (n, %)	Malnourished[a] (n, %)	Total (n, %)	p-value
Total	174 (70.2)	74 (29.8)	248	
Age group (years)				
<65	49 (27.9)	36 (48.3)	85 (34)	0.005
≥65	125 (72.1)	38 (51.7)	163 (66)	
Sex				
Male	52 (30)	30 (40)	82 (33)	0.168
Female	122 (70)	44 (60)	166 (67)	
BMI (kg/m^2)	25.17±4.6	22.32±3.9	24.32±4.58	<0.001
ASMI (kg/m^2)	6.53±0.96	6.08±1.16	6.41±1.03	0.011
Education (years)	10.55±4.23	10.89±4.1	10.65±4.18	0.605

Table 1 (continued)

Characteristics	Well-nourished (n, %)	Malnourished[a] (n, %)	Total (n, %)	p-value
Income				
≤5000	78 (44.9)	21 (28.6)	99 (40.0)	0.035
>5000	96 (55.1)	53 (71.4)	149 (60.0)	
Living arrangement				
Alone	68 (39.1)	21 (28.6)	89 (35.9)	0.165
Not alone	106 (60.9)	53 (71.4)	159 (64.1)	
Smoking cigarettes				
Yes	1 (0.7)	2 (3.3)	3 (1.2)	0.163
No	173 (99.3)	72 (96.7)	245 (98.8)	
Drink alcohol				
Yes	7 (4.3)	2 (3.3)	9 (3.6)	0.753
No	167 (95.7)	72 (96.7)	239 (96.4)	
Career				
Yes	122 (70)	57 (76.7)	179 (72.2)	0.022
No	52 (30)	17 (23.3)	69 (27.8)	
Diagnose				
Hypertension	137 (78.6)	42 (56.7)	179 (72.2)	0.002
Dyslipidemia	169 (97.1)	54 (73.3)	223 (89.9)	<0.001
Diabetes mellitus	37 (21.4)	17 (23.3)	54 (21.8)	0.766
Respiratory disease[b]	5 (2.9)	17 (23.3)	22 (8.9)	<0.001
Gastrointestinal disease[c]	5 (2.9)	20 (26.7)	25 (10.1)	<0.001
Cardiovascular disease[d]	20 (11.4)	2 (3.3)	22 (8.9)	0.067
Neurological disease[e]	7 (4.3)	2 (3.3)	9 (3.6)	0.352
Cancer	7 (4.3)	10 (13.3)	17 (6.9)	0.022
Other	37 (21.4)	17 (23.3)	54 (21.8)	0.261
MST				
Not at risk	167 (96.0)	10 (13.5)	177 (71.4)	<0.001
At risk	7 (4.0)	64 (86.5)	71 (28.6)	
MNA-SF				
Not at risk	162 (93.1)	5 (6.8)	167 (67.4)	<0.001
At risk	12 (6.9)	60 (81.1)	72 (29.0)	
Malnutrition	0 (0)	9 (12.1)	9 (3.6)	

The p-values come from statistical tests, including chi-square tests for categorical variables and t-tests for continuous variables.
BMI=body mass index, ASMI=appendicular skeletal muscle mass index level, MST=malnutrition screening tool, MNA-SF=mini nutritional assessment short form, GLIM=global leadership initiative on malnutrition, COPD=chronic obstructive bronchitis, GERD=gastroesophageal reflux disease, [a]malnutrition by GLIM criteria, [b]respiratory disease=asthma, chronic obstructive pulmonary disease, [c]Gastrointestinal disease=dyspepsia, gastroesophageal reflux disease, [d]cardiovascular disease including cerebrovascular disease, myocardial infarction, stroke, arrhythmia, valvular heart disease, [e]neurological disease, Parkinson's disease, dementia

เครื่องมือคัดกรองภาวะทุพโภชนาการ

เครื่องมือคัดกรองภาวะทุพโภชนาการนี้ใช้สำหรับอาสาสมัครหรือเจ้าหน้าที่ที่ดูแลผู้สูงอายุ
โปรดติดต่อเราหากต้องการความช่วยเหลือในการใช้เอกสารชุดนี้

ขอคำยินยอมในการคัดกรองด้วยการถามคำถามต่อไปนี้

"ขอถามคำถามเกี่ยวกับสุขภาพทางโภชนาการของคุณได้ไหม"

ในช่วงเวลา 6 เดือนที่ผ่านมา	**1. ในช่วงไม่นานมานี้ คุณน้ำหนักลดลงโดยไม่ได้พยายามหรือไม่** ไม่ ..... 0 ไม่แน่ใจ 2	หากตอบว่าไม่แน่ใจ ให้ถามว่า สงสัยว่าน้ำหนักลดลงหรือไม่ เช่น เสื้อผ้าหลวมขึ้น
เช่น น้อยกว่า 3/4 ของปริมาณปกติ	ใช่ ลดลงกี่กิโลกรัม 1-5 (2-13 ปอนด์) 1 6-10 (14-23 ปอนด์) 2 11-15 (24-33 ปอนด์) 3 มากกว่า 15 (มากกว่า 33 ปอนด์) 4 ไม่แน่ใจ 2 **2. คุณรับประทานอาหารไม่ค่อยได้เพราะอยากอาหารลดลงหรือไม่** ไม่ ..... 0 ใช่ 1	อาจรับประทานอาหารได้น้อยลง เนื่องจากปัญหาในการเคี้ยวหรือกลืน
คะแนนรวมการตอบคำถาม เรื่องน้ำหนักที่ลดลง และความอยากอาหาร	**รวม**	

จิตรวีร์ เทพากรณ์, กษิดิศ หล้าวงษา และคณะ

Figure 1 The Thai-translated malnutrition screening tool (Adapted from: Ferguson M, Capra S, Bauer J, Banks M. 'Malnutrition-Is your patient at risk ?' Screening tool and action flowchart, Merrilyn Banks APD. Nutrition 1999;15:458-64.)

Table 2 Performance comparison between the MST and MNA-SF (n=248), using GLIM as the reference method

Diagnostic accuracy	MST	MNA-SF
Sensitivity (%)	86.5	93.2
Specificity (%)	96.0	93.1
Positive predictive value (%)	90.1	85.2
Negative predictive value (%)	94.4	97.0
Area under the ROC curve (95% CI)	0.907 (0.847-0.966)	0.929 (0.884-0.975)

MST=malnutrition screening tool, MNA-SF=mini nutritional assessment short form, ROC=receiver operating characteristic, CI=confidence interval, p-value<0.05

Table 3 Cohen's kappa indices of agreement between the different tools

Tool	MST	MNA-SF	GLIM
MST	1	0.842	0.843
MNA-SF	0.842	1	0.834
GLIM	0.843	0.834	1

MST=malnutrition screening tool, MNA-SF=mini nutritional assessment short form, GLIM=global leadership initiative on malnutrition

Table 4 Test-retest and inter-rater reliability of the MST

Item	Content	Test-retest reliability (ICC)	Inter-rater reliability (ICC)
Item 1	Weight loss	0.976	0.917
Item 2	Decreased appetite	0.94	0.861

MST=malnutrition screening tool, ICC=intraclass correlation coefficient

Table 5 The internal consistency of each domain and total score of the MST

No.	Total score correlations of the MST
Have you recently lost weight without trying?	0.695
Have you been eating poorly because of a decreased appetite?	0.695
Cronbach's alpha of the whole questionnaire	0.794

MST=malnutrition screening tool

Discussion

The primary objective of this study was to translate and assess the validity and reliability of the MST in an outpatient setting. The Thai version of the MST demonstrated satisfactory internal consistency, as indicated by a Cronbach's alpha of 0.794. These findings support the adaptability and utility of the MST in outpatient settings. Additionally, the tool exhibited excellent inter-rater reliability, with ICCs of 0.917 for item 1 and 0.861 for item 2, indicating consistency between raters. The kappa statistic indicated strong concordance between the MST and GLIM criteria (kappa=0.843), further supporting its utility in outpatient settings where multiple healthcare providers are involved in the assessments.

The accuracy of tools used for malnutrition screening depends largely on the reference standards adopted in the study. This study employed the GLIM criteria as the benchmark for malnutrition diagnosis. The GLIM framework integrates both phenotypic indicators and etiological factors, offering a more comprehensive and objective approach to malnutrition diagnosis[9,19]. This dual-component system enhances diagnostic accuracy compared with the single-criterion methods commonly used in earlier research.

In prior studies, the SGA or clinical judgement was often used as the reference standard for validating screening tools such as the MST and MNA-SF. Although the SGA is widely recognized and frequently used in clinical practice, it is inherently subjective and may introduce variability, thereby reducing consistency[20]. By utilizing the GLIM criteria, this study aligned with contemporary international guidelines aimed at improving the uniformity and objectivity of malnutrition diagnosis[21-22]. However, the choice of reference standards can significantly influence the sensitivity, specificity, and overall validity of screening tools. Consequently, comparing results from studies using different standards can be challenging, underscoring the need to consider the impact of reference standards when evaluating validity outcomes across diverse research settings.

Reliability is a critical attribute of any screening tool, ensuring consistent results across raters and repeated measures. Previous studies have consistently highlighted the strong reliability of the MST. For example, Ferguson et al.[12] found high inter-rater reliability with an ICC of 0.98, demonstrating that different assessors could administer the MST with minimal variability[23]. Similarly, Isenring et al.[14] validated the MST in oncology outpatients and reported excellent reliability across multiple settings[21]. These findings align with the current study, which demonstrated high reliability and agreement between raters for the MST. Furthermore, the MST has shown strong test-retest reliability, indicating its stability over time—a valuable feature in clinical environments where repeated screening is often necessary.

The findings of this study are consistent with earlier research comparing the MST with the GLIM criteria and other benchmarks. For instance, Isenring et al.[14] validated the MST in oncology outpatients and reported high sensitivity (94%) and specificity (89%)[21]. Similar findings in our study highlight the MST's ability to accurately identify individuals at risk of malnutrition. Additionally, the MST's performance was comparable to that of the MNA-SF, which demonstrated excellent sensitivity (97.8%) and specificity (94.3%) in studies conducted in Spain and New Mexico[24].

Although the MNA-SF is a well-established tool, it requires more time and effort, including the calculation of BMI and weight loss, which can be challenging in busy outpatient clinics. In contrast, the MST is quick and straightforward, taking less than 5 minutes to administer. Ferguson et al.[12] originally validated the MST in 408 hospital inpatients, showing a sensitivity and specificity of 93% in comparison to the SGA[23]. These findings, along with the results of this study, highlight the reliability and effectiveness of the MST across diverse healthcare settings, including acute care and oncology clinics.

The reliability of a screening tool is critical to ensuring the consistent and accurate identification of malnutrition risk

across various settings and raters. This study evaluated the reliability of the Thai version of the MST using multiple metrics, including Cohen's kappa for agreement, test-retest reliability, inter-rater reliability, and internal consistency. The Cohen's kappa statistic, used to measure agreement between the MST and the GLIM criteria, yielded a kappa value of 0.843, indicating substantial agreement. This result aligns with previous studies reporting kappa values ranging from 0.81 to 1.00[24], demonstrating the MST's ability to reliably classify malnutrition risk when compared with standardized diagnostic criteria[12,23]. Test-retest reliability, which evaluates the stability of a tool when applied repeatedly under similar conditions, also showed excellent results, with ICC values exceeding 0.90. These results align with previous research, further confirming the reliability of the MST for repeated use over time[14,21].

Inter-rater reliability was similarly high, with ICCs of 0.917 for item 1 and 0.861 for item 2, indicating that the MST can be reliably administered by different healthcare professionals, such as physicians, nurses, and dietitians. This reinforces earlier findings highlighting the robustness of the tool in multidisciplinary settings[12,23]. In terms of internal consistency, the MST demonstrated a Cronbach's alpha of 0.794, which is within an acceptable range. This result is comparable to those of earlier studies, which reported Cronbach's alpha values between 0.75 and 0.80, indicating that the MST reliably captures the construct of malnutrition risk[12,23,25]. Together, these findings underscore the MST's strong reliability and consistency, supporting its use as a practical and effective MST in outpatient settings. Further validation across diverse populations is recommended to ensure broad applicability.

Since both the MST and the MNA-SF are designed for screening, there have been few studies directly comparing the MST with the MNA-SF. Rather than being used interchangeably, the 2 tools complement each other in practice. The MST is typically used for quick initial screenings, while the MNA-SF is employed for more detailed evaluations when a higher risk of malnutrition is suspected. Consequently, direct comparisons between the 2 are limited, and they are regarded as separate tools, each serving a distinct role in identifying malnutrition risk.

The differences in malnutrition classification between the MST, MNA-SF, and GLIM criteria likely arise from variations in their design, emphasis, and thresholds for identifying malnutrition. The MST, being a quick and simple screening tool, focuses on subjective factors like appetite loss and weight changes, which might overlook subtle clinical signs. In contrast, the MNA-SF offers a more detailed assessment, incorporating factors like mobility, psychological stress, and BMI, which may contribute to its slightly higher sensitivity. The GLIM criteria, conversely, combine both phenotypic and etiological factors, using objective measures such as reduced muscle mass and inflammation. While this makes GLIM more specific, it may be less sensitive to milder cases of malnutrition.

These differences highlight the importance of selecting the most appropriate tool based on the clinical setting. When necessary, using multiple methods can provide a more comprehensive assessment of malnutrition. The findings emphasize the need for reliable screening tools, such as the MST and MNA-SF, in outpatient settings in order to facilitate early detection of malnutrition and timely intervention. The MST's simplicity makes it suitable for initial screenings, while tools like the MNA-SF or GLIM criteria can offer more detailed evaluations when needed. Integrating these tools into routine outpatient care can improve patient outcomes and overall management.

It is important to acknowledge that the MST's performance can vary depending on the reference standard and patient population. For instance, studies conducted in inpatient settings often report slightly higher accuracy due to more controlled conditions and access to comprehensive clinical data. While this study has several strengths, it also has limitations. The cross-sectional design and focus on 2 outpatient clinics may restrict the generalizability of

the findings to other settings. Additionally, reliance on self-reported weight loss data could lead to inaccuracies, potentially underestimating the prevalence of malnutrition. Furthermore, the small sample size in certain diagnostic subgroups limited the ability to draw robust conclusions for these populations. The demographic characteristics of the sample may also affect the generalizability of the findings. Recruitment from 2 outpatient clinics likely overrepresented individuals who frequently access healthcare services, while underrepresenting those from rural areas or other healthcare settings, such as inpatient care. Variations in age, income, and disease prevalence within the sample may not fully reflect the broader population, which could impact the applicability of the results. Future research should validate the MST in diverse settings, such as inpatient care, rural clinics, and among specific groups like pediatric and geriatric patients, to ensure its reliability across populations. Integrating the MST into digital health systems and studying its impact on outcomes, such as improved nutrition and reduced hospitalizations, would further support its effectiveness and broader adoption.

Conclusion

The T-MST is a reliable and efficient tool for malnutrition screening in outpatient settings. Its simplicity and ease of use make it particularly valuable in time-constrained environments. However, ongoing validation across diverse populations and settings is essential in order to ensure consistent performance across different clinical contexts.

Statement of contribution

Jitrawee Tepakorn: Conceptualisation, Methodology, Investigation, Writing – Original Draft; Kasidid Lawongsa: Conceptualisation, Methodology, Software, Writing – Review & Editing; Patsri Srisuwan: Supervision; Sirakarn Tejavanija: Supervision; Kulachade Gesakomol: Supervision.

Data availability statement

The data underlying this study are openly available in PubMed. For further correspondence, please contact kasidid.lawongsa@gmail.com

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Conflict of interest

The authors report no conflicts of interest relevant to this research.

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