

## Re-evaluation of Malnutrition Risk Screening Tool-Hospital (MRST-H) for Geriatric Patients: A Multicentre Study in Peninsular Malaysia

(Penilaian Semula Alat Penyaringan Risiko Malpemakanan Hospital (MRST-H) untuk Pesakit Geriatrik: Kajian Pelbagai Pusat di Semenanjung Malaysia)

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### ABSTRACT

*A local Malnutrition Risk Screening Tool-Hospital (MRST-H) has been developed to identify the risk of malnutrition among hospitalized geriatric patients in Malaysia. The aims of this multicenter study were to evaluate the criterion validity of the MRST-H against the reference standard Subjective Global Assessment (SGA) and revise its scoring criteria among Malaysian geriatric patients. A cross-sectional study was conducted among 542 geriatric patients at eight general hospitals in Peninsular Malaysia from January 2011 to February 2013. The Malay version MRST-H and SGA were administered to all participants through face-to-face interviews. Sensitivity and specificity of MRST-H were established using the Receiver Operating Characteristic (ROC) curves and the optimal cut-off scores were determined. The MRST-H had area under the ROC curve (AUC) values of 0.84 and 0.88 when validated against the SGA-determined malnutrition (SGA B+C) and severe malnutrition (SGA C) status. These high AUC values indicated that the MRST-H has very good overall diagnostic accuracy. However, the original cut-off score of five points for MRST-H has undesirable sensitivity in identifying the malnutrition (sensitivity = 0.12) and severely malnutrition (sensitivity = 0.35) status. The optimal cut-off score of MRST-H in identifying malnourished and severely malnourished participants were both established at the cut-off score of two points. The sensitivity of MRST-H increased substantially at this point without compromising its specificity. Therefore, the established cut-off score of two points with optimal sensitivity and specificity was selected to replace to original cut-off score for screening of risk of malnutrition among hospitalized geriatric patients.*

*Keywords: Geriatric patients; malnutrition; MRST-H; nutritional screening; validity*

### ABSTRAK

*Suatu alat Penyaringan Risiko Malpemakanan-Hospital (MRST-H) tempatan telah dibangunkan untuk mengenal pasti risiko malpemakanan dalam kalangan pesakit dalam wad dan pesakit luar geriatrik di beberapa hospital di Malaysia. Tujuan kajian pelbagai pusat ini adalah untuk menilai kesahihan kriteria MRST-H terhadap piawai rujukan Penilaian Subjektif Global (SGA) dan menyemak semula kriteria pemarkahannya dalam kalangan pesakit geriatrik di Malaysia. Suatu kajian keratan rentas telah dijalankan dalam kalangan 542 orang pesakit geriatrik di lapan buah hospital Semenanjung Malaysia dari Januari 2011 hingga Februari 2013. Soal selidik MRST-H dan SGA versi Bahasa Melayu telah dijawab oleh semua peserta melalui temu bual bersemuka. Kepekaan dan kekhususan MRST-H diketahui melalui lengkung Penerima Operasi Sifat (ROC) dan markah titik optimum juga ditentukan melaluinya. MRST-H mempunyai kawasan di bawah lengkung ROC (AUC) sebanyak 0.84 dan 0.88 apabila disahkan terhadap status malpemakanan (SGA B+C) dan malpemakanan teruk (SGA C). Nilai AUC yang tinggi ini menunjukkan bahawa MRST-H mempunyai ketepatan diagnostik keseluruhan yang sangat baik. Walau bagaimanapun, markah titik asal MRST-H (skor lima) mempunyai kepekaan yang tidak diinginkan dalam mengenal pasti status malpemakanan (kepekaan = 0.12) dan malpemakanan teruk (kepekaan = 0.35). Kedua-dua markah titik optimum MRST-H dalam mengenal pasti peserta yang mengalami malpemakanan dan malpemakanan teruk adalah pada skor dua. Kepekaan MRST-H meningkat dengan ketara tanpa menjejaskan kekhususannya pada markah ini. Oleh itu, markah titik skor dua yang mempunyai kepekaan dan spesifikasi optimum telah dipilih untuk menggantikan markah titik asal untuk penyaringan risiko malpemakanan dalam kalangan pesakit geriatrik di hospital.*

*Kata kunci: Malpemakanan; MRST-H; pengesanan; penyaringan pemakanan; pesakit geriatrik*

### INTRODUCTION

Malnutrition in the elderly can be defined as ‘faulty or inadequate nutritional status; undernourishment characterized by insufficient dietary intake, poor appetite, muscle wasting, and weight loss (Chen et al. 2001)’. It is a common problem in hospitalized geriatric patients with

various diseases and conditions (Chern & Lee 2015). In Malaysia, the prevalence of malnutrition in hospitalized geriatric patients ranging from 12.0 to 61.3% depending on study population and criteria used to determine the nutritional status (Hanisah et al. 2012; Nur-Fazimah 2015; Sakinah et al. 2012, 2010; Suzana et al. 2002;

Syamimi 2012). Internationally, few nationwide studies of malnutrition prevalence among hospitalized patients had been conducted in the Western countries. One of these large-scale multicenter studies that focused on geriatric patients in Belgium ( $n=2329$ ) showed that 33.0% of the geriatric patients were suffered from malnutrition, 42.8% were at risk of malnutrition and only 24.2% were well nourished (Vanderwee et al. 2010).

ESPEN Guidelines for Nutrition Screening 2002 had emphasized that hospital and healthcare organizations should have a policy and a specific set of protocols for identifying patients at nutritional risk (Kondrup et al. 2003). Nutritional screening allows the early detection of risk of malnutrition thus enables further assessment and effective intervention and management to be initiated. Nutritional screening tools offer a quick and simple approach to ease the screening process of malnutrition in hospital. The administration of a well-validated nutritional screening tool can also ensure an accurate evaluation of the nutritional status thus reflect the true prevalence of malnutrition in a specific population. A local Malnutrition Risk Screening Tool-Hospital (MRST-H) has been developed by Sakinah et al. (2012) to screen the risk of malnutrition among geriatric population. It is a five-item screening tool consisting of questions that are highly associated with malnutrition, i.e. weight loss, muscle wasting, functional and socioeconomic status. It has been proved as a valid screening tool in detecting risk of malnutrition among hospitalized geriatric patients (Sakinah et al. 2012). However, the limitation is that its validity was tested only in 100 geriatric patients at a single center. Therefore, the aims of this multicenter study were to evaluate the criterion validity of the Malay version MRST-H against the reference standard Subjective Global Assessment (SGA) and revise its scoring criteria among Malaysian geriatric patients from different hospitals.

#### MATERIALS AND METHODS

This cross-sectional study was conducted at eight state general hospitals in Peninsular Malaysia (two hospitals from each of the four regions): Hospital Raja Perempuan Zainab II, Kota Bharu (East coast region), Hospital Sultanah Nur Zahirah, Kuala Terengganu (East coast region), Hospital Sultanah Aminah, Johor Bahru (Southern region), Hospital Melaka, Malacca City (Southern region), Hospital Kuala Lumpur, Kuala Lumpur (Central region), Hospital Tengku Ampuan Rahimah, Klang (Central region), Hospital Pulau Pinang, Georgetown (Northern region) and Hospital Raja Permaisuri Bainun, Ipoh (Northern region). Study participants were recruited from the medical wards and medical outpatient clinics of the participating hospitals using purposive sampling method over a period of two years (January 2011 to February 2013).

The minimum sample size required was 501 participants, calculated using the 'Sample size calculator

for Sensitivity & Specificity Studies' program (Naing 2004). The expected sensitivity (0.67), specificity (0.96) and prevalence (0.17) of MRST-H were obtained from the literature (Sakinah et al. 2012) and entered into the program with the desired precision level of 0.10 and confidence level at 95%, respectively.

All Malaysian geriatric patients (aged 65 years and above) who were able to understand and communicate in Malay language were eligible for inclusion in the study based on purposive sampling method. Patients acquiring intensive care or under palliative treatment, physically unfit to complete the study protocols and those with communication difficulties were excluded. For inpatients at medical wards, the patients were screened according to the selection criteria by referring to the patient admission book at the admission counter of medical wards. As for outpatients at medical outpatient clinics, potentially eligible patients were approached and screened during their waiting time at the clinics. Written informed consent was obtained from each geriatric patient who agreed to participate in the study. For illiterate geriatric patients, the informed consent form was signed or thumb printed in the presence of an impartial witness (i.e. caregiver/family member).

After recruitment into the study, participants were interviewed by a trained investigator using a Malay version structured questionnaire. The SGA (nutritional assessment tool) was used as a reference standard in this study to validate the MRST-H (nutritional screening tool). SGA assess patients' nutritional status based on features of the nutrition-focused medical history (changes in weight, dietary intake and functional capacity, significant gastrointestinal symptoms and metabolic demands of the present disease) and physical examinations (loss of subcutaneous fat, muscle wasting, edema and ascites). Patients were rated as well nourished (SGA A), moderately malnourished (SGA B) or severely malnourished (SGA C) on the basis of findings from these features (Detsky et al. 1987). As for MRST-H, it screen the risk of malnutrition based on five items - socioeconomic status (financial dependency), functional status (self-feeding), clinical presentation (unintentionally weight loss) and anthropometric measurements (mid-upper arm circumference, MUAC and calf circumference, CC). A patient was identified as having risk of malnutrition with a score equal or more than five points (MRST-H  $\geq 5$  points) (Sakinah et al. 2012). Along with SGA and MRST-H, the questionnaire also integrated variables on demographic and clinical profiles (age, gender, educational level, marital status, living arrangement, occupation and primary diagnosis). The MUAC and CC measurements were taken using standard procedures (NHANES 2007).

The study protocol of this study was approved by the Medical Research Ethics Committee (MREC) of the Ministry of Health, Malaysia [(2)dlm.KKM/NIHSEC/08/0804/P10-337] and the Human Research Ethics Committee (HREC) of Universiti Sains Malaysia, Malaysia [USMKK/PPP/JEPeM (228.4[1.6])].

#### STATISTICAL ANALYSIS

Data entry and analysis was done using the IBM SPSS Statistics for Windows (Version 20.0, IBM Corporation, Armonk, New York, United States). Data exploration and cleaning were done to check for missing values and outliers and to test the data distribution. The demographic and clinical profiles of the participants were described using mean, standard deviation (SD), frequency and percentage (%). The level for statistical significance was set at  $p < 0.05$ .

The criterion validity of MRST-H in identifying malnutrition and severe malnutrition when compared against the reference standard SGA was evaluated in terms of sensitivity, specificity and area under the Receiver Operating Characteristic curve (AUC). The rating of nutritional status by SGA (well nourished, moderately malnourished and severely malnourished) was dichotomized for the purpose of analyses in this study. Two sets of dichotomized categorizations of SGA were used. For the validation of MRST-H in identifying SGA-determined malnourished participants, the SGA ratings were grouped into 'well nourished' (SGA A) and 'malnourished' (SGA B+C); while for the validation in identifying SGA-determined severely malnourished participants, the SGA ratings were combined into 'well nourished/moderately malnourished' (SGA A+B) and 'severely malnourished' (SGA C).

For the validation of MRST-H in identifying SGA-determined malnourished participants, sensitivity was defined as the probability of participants who were 'malnourished' as diagnosed by SGA (SGA B+C), correctly identified as 'at risk of malnutrition' by the MRST-H ( $\geq 5$  points). Specificity was the probability of participants who were 'well nourished' as diagnosed by SGA (SGA A), correctly identified as 'not at risk of malnutrition' by the MRST-H ( $< 5$  points). Similarly, for the validation of MRST-H in identifying SGA-determined severely malnourished participants, sensitivity was defined as the probability of participants who were 'severely malnourished' as diagnosed by SGA (SGA C), correctly identified as 'at risk of malnutrition' by the MRST-H ( $\geq 5$  points). Specificity was the probability of participants who were 'well nourished/moderately malnourished' as diagnosed by SGA (SGA A+B), correctly identified as 'not at risk of malnutrition' by the MRST-H ( $< 5$  points). A priori acceptable level of sensitivity ( $> 0.80$ ) and specificity ( $> 0.60$ ) was set to indicate the adequateness and validity of MRST-H as a nutritional screening tool (Blake et al. 2002).

The Receiver Operating Characteristic (ROC) analyses were also performed using the raw score of MRST-H to evaluate its overall diagnostic performance. The ROC curves were plotted with their true positive rate (sensitivity) versus false positive rate (1-specificity) at every possible cut-off score. The AUC is a combined measure of sensitivity and specificity that summarizes the entire location of a ROC curve to represents its overall indication of diagnostic accuracy (Hajian-Tilaki 2013). As a general rule of thumb, an AUC value of at least 0.90

indicates excellent accuracy, between 0.80 and 0.90 indicates very good accuracy, between 0.70 and 0.80 indicates good accuracy, between 0.60 and 0.70 indicates sufficient accuracy and between 0.50 and 0.60 indicates poor accuracy (Okeh & Okoro 2012). The AUCs of MRST-H were used to represent its overall performance in distinguishing those SGA-determined malnourished and severely malnourished participants from those without malnutrition (i.e. discriminatory power). It should exceed 0.70 to indicate its usefulness and validity as a nutritional screening tool (Spies et al. 2009).

The total score that optimized both sensitivity and specificity was set as the optimal cut-off score for MRST-H in this study. This optimal cut-off score was determined using the Youden Index, the difference between the true positive rate (sensitivity) and the false positive rate (1-specificity): Youden Index = true positive rate - false positive rate = sensitivity + specificity - 1. The Youden Index was calculated for each possible cut-off score and the cut-off score with maximum Youden Index value was chosen as the optimal cut-off score. This optimal cut-off score for MRST-H was then compared with the original cut-off score of five points for MRST-H.

#### RESULTS

A total of 542 geriatric patients (52.0% men and 48.0% women) met the selection criteria and completed the interview using the Malay version structured questionnaire. Their mean (SD) age was 71.60 (5.17) years old (age range: 65.0-92.5 years). Majority of the participants were inpatient (73.8%), Malay (86.7%), lived with family (90.0%), married (59.6%), had formal education (70.5%) and unemployed (89.9%). The three most common primary diagnosis categories of the participants were diseases of the circulatory system (44.1%), followed by diseases of the respiratory system (14.8%) and endocrine, nutritional and metabolic diseases (14.6%). The prevalence of malnutrition was 34.7% according to the reference standard SGA (SGA B+C) (Table 1).

#### CRITERION VALIDITY OF MALAY VERSION MRST-H AGAINST SGA

Based on the original cut-off score ( $\geq 5$  points), the sensitivity and specificity of the MRST-H in identifying SGA-determined malnourished participants were 0.12 and 1.00, respectively. On the other hand, its sensitivity and specificity in identifying SGA-determined severely malnourished participants were 0.35 and 0.99, respectively. The ROC analyses identified the overall diagnostic performance of the Malay version MRST-H across every possible cut-off score using its total score (Table 2). When validated against the SGA-determined malnutrition and severe malnutrition status, the MRST-H had AUC values of 0.84 (95% CI 0.80, 0.87,  $p < 0.001$ ) and 0.88 (95% CI 0.84, 0.92,  $p < 0.001$ ), respectively.

TABLE 1. General characteristics of the participants ( $n=542$ )

Characteristics	Frequency (%)*
Type of patient	
Inpatient	400 (73.8)
Outpatient	142 (26.2)
Age	71.60 (5.17)
65-69 years	244 (45.0)
70-74 years	176 (32.5)
$\geq 75$ years	122 (22.5)
Gender	
Men	282 (52.0)
Women	260 (48.0)
Ethnicity	
Malay	470 (86.7)
Chinese	10 (1.8)
Indian	62 (11.4)
Marital status	
Married	323 (59.6)
Widowed/divorced/single	219 (40.4)
Education level	
Formal education (Primary/secondary/tertiary)	382 (70.5)
No formal education (None/others)	160 (29.5)
Living arrangement	
With family	488 (90.0)
Alone	39 (7.2)
Others	15 (2.8)
Occupation	
Unemployed	487 (89.9)
Employed	55 (10.1)
Primary diagnosis	
Diseases of the circulatory system	239 (44.1)
Diseases of the respiratory system	80 (14.8)
Endocrine, nutritional and metabolic diseases	79 (14.6)
Diseases of the genitourinary system	31 (5.7)
Factors influencing health status and contact with health services	21 (3.9)
Diseases of the digestive system	18 (3.3)
Certain infectious and parasitic diseases	18 (3.3)
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	14 (2.6)
Diseases of the musculoskeletal system and connective tissue	13 (2.4)
Others	29 (5.4)
Nutritional status	
Well nourished (SGA A)	354 (65.3)
Moderately malnourished (SGA B)	137 (25.3)
Severely malnourished (SGA C)	51 (9.4)

\*Data were presented as frequency (percentage), except for age as mean (standard deviation); percentages might not total 100% due to rounding

The optimal cut-off scores of the Malay version MRST-H in identifying SGA-determined malnourished and severely malnourished participants were both established at the cut-off score of two points, with maximum Youden Index value of 0.57 and 0.65, respectively. The comparison of the Malay version MRST-H at original ( $\geq 5$  points) and optimal cut-off score ( $\geq 2$  points) in detecting participants with malnutrition and severe malnutrition are displayed in Table 3. When using the optimal cut-off score of two

points to detect malnutrition, the sensitivity of MRST-H was increased to 0.67; and the specificity was reduced to 0.90. The diagnostic performance of MRST-H changed in the same manner in detecting severe malnutrition.

## DISCUSSION

Validation is an important procedure to evaluate the suitability and applicability of a nutritional screening tool in

TABLE 2. Diagnostic performance of MRST-H at different cut-off scores to identify SGA-determined malnourished and severely malnourished participants

Cut-off scores of MRST-H	MRST-H to identify malnourished participants (SGA B+C)			MRST-H to identify severely malnourished participants (SGA C)		
	Sensitivity	Specificity	Youden Index <sup>a</sup>	Sensitivity	Specificity	Youden Index <sup>a</sup>
≥ 0	1.00	0	0	1.00	0	0
≥ 1	0.93	0.44	0.37	1.00	0.35	0.35
≥ 2	0.67	0.90	0.57	0.88	0.77	0.65
≥ 3	0.53	0.93	0.46	0.73	0.82	0.55
≥ 4	0.36	0.97	0.33	0.57	0.90	0.47
≥ 5	0.12	1.00	0.12	0.35	0.99	0.34
≥ 6	0.07	1.00	0.07	0.24	1.00	0.24
≥ 7	0.02	1.00	0.02	0.06	1.00	0.06
≥ 8	0	1.00	0	0	1.00	0
AUC (95% CI)	0.84 (0.80, 0.87)*			0.88 (0.84, 0.92)*		

Abbreviation: MRST-H – Malnutrition Risk Screening Tool-Hospital; SGA – Subjective Global Assessment; AUC – area under the Receiver Operating Characteristic curve; CI – confidence interval

<sup>a</sup>Youden Index = sensitivity + specificity - 1

\*AUC was significantly different from 0.50 ( $p < 0.001$ )

Bold: Optimal cut-off score = cut-off score with maximum Youden Index value

TABLE 3. The comparison for the diagnostic performance of MRST-H at original and optimal cut-off scores in detecting malnutrition (SGA B+C) and severe malnutrition (SGA C)

MRST-H cut-off score	Sensitivity	Specificity	Prevalence (%)
<i>Diagnostic performance of MRST-H in identifying malnourished participants (SGA B+C)</i>			
≥ 5 points (original)	0.12	1.00	4.2
≥ 2 points (optimal)	0.67	0.90	29.3
<i>Diagnostic performance of MRST-H in identifying severely malnourished participants (SGA C)</i>			
≥ 5 points (original)	0.35	0.99	4.2
≥ 2 points (optimal)	0.88	0.77	29.3

Abbreviations: MRST-H – Malnutrition Risk Screening Tool-Hospital; SGA – Subjective Global Assessment

identification of nutritional status in a specific population. It is essential for a nutritional screening tool to meet the criteria for validity, reliability, sensitivity and specificity prior to its use in clinical practice (Green & Watson 2006). This study demonstrates the criterion validity of a locally developed nutritional screening tool, MRST-H in identifying malnutrition risk among geriatric patients across eight state general hospitals in Peninsular Malaysia. The multicenter setting across different geographical regions in Peninsular Malaysia increased the number of available participants with different backgrounds and increased the generalizability of our findings (Sprague et al. 2009). To the best of our knowledge, this is also the first multicenter study related to nutritional status among geriatric patients in Malaysia.

Criterion validity is defined as the degree to which the scores of a target test are an adequate reflection of a gold standard test (De Vet et al. 2011). As there is no consensus on a single best tool for the assessment of nutritional status, a more established and commonly used nutritional assessment tool, SGA has been selected as the reference standard in this study. The selected SGA was considered as

a valid reference method to assess the criterion validity of other tools in a recent systematic review (Van Bokhorst-de van der Schueren et al. 2014).

Based on the SGA, 34.7% of the geriatric patients were malnourished (SGA B = 25.3% and SGA C = 9.4%). This prevalence figure is consistent with the prevalence reported in other local and Asian studies that applied SGA and similarly conducted among hospitalized geriatric patients (35.0% to 42.2%) (Lim 2010; Nur-Fazimah 2015; Tsutsumi et al. 2012). A local study by Hanisah et al. (2012) reported a malnutrition prevalence of 61.3% (SGA B = 50.3% and SGA C = 11.0%), which is much higher than in our study, however, the participants included only 145 patients from a single site.

A nutritional screening tool should be highly sensitive and specific. A high sensitivity enables further assessment to be done thus suitable intervention and management to be initiated on those who truly have the risk. A high specificity reduces the probability of giving unnecessary assessment and intervention to those who do not required it (Sakinah & Tan 2012). The Malay version MRST-H with the original cut-off score of five points has low sensitivity

(0.12 and 0.35) but high specificity (1.00 and 0.99) when validated against the SGA-determined malnutrition and severe malnutrition status. The low sensitivity and high specificity values in the present study were indeed not surprising as these findings followed the similar trend as in the original development and validation study of MRST-H (Sakinah et al. 2012). The MRST-H was developed in 181 hospitalized geriatric patients and then validated in another 100 hospitalized geriatric patients with Global Indicator of Malnutrition (GIM) as the reference standard. GIM is a combined measure of nutritional assessment methods including body mass index (BMI), SGA and three biochemical parameters [albumin, total lymphocyte count (TLC) and hemoglobin level]. A patient was considered malnourished if two or more of the GIM indicators were presented: BMI < 16.0 kg/m<sup>2</sup>, SGA rating C, low biochemical parameters (two or more conditions presented – albumin < 3.3g/dL; hemoglobin < 13.0/11.5g/L for men/women; TLC < 1200×10<sup>6</sup>/L). In its original development and validation study, the recommended cut-off score of five points for MRST-H showed low to moderate sensitivity (0.40 & 0.67) and high specificity (0.95 & 0.96) to the GIM (Sakinah et al. 2012).

The high AUC values (0.84 and 0.88) indicated that the MRST-H has very good overall accuracy in discriminating both the malnourished and severely malnourished participants. The high AUC results and the poor sensitivity of MRST-H at the original cut-off score of five points prompted the revision of cut-off score for screening of malnutrition risk among this geriatric population. The optimal cut-off score of MRST-H in identifying malnourished and severely malnourished participants were both established at the cut-off score of two points. The sensitivity of MRST-H increased substantially at this point without compromising its specificity to undesirable level. Therefore, the established cut-off score of two points with optimal sensitivity and specificity was suggested to replace to original cut-off score for screening of risk of malnutrition among Malaysian geriatric patients. Hence, early identification of patients who are nutritionally depleted is vital and achieves the most effective use of resources. This will improve quality of care (professional practice) and patient outcomes compared with usual care. A limitation of the MRST-H is that a number of questions target hospitalized geriatric patients but not independent-living elders in community.

#### CONCLUSION

The overall results showed that the Malay version MRST-H with the original cut-off score of five points did not have sufficient criterion validity as a nutritional screening tool as its sensitivity were much lower than the predefined acceptable level (sensitivity > 0.80) when validated against the SGA-determined malnutrition and severe malnutrition status. However, the AUC results demonstrated that its overall diagnostic accuracy in discriminating the

malnourished and severely malnourished patients was still very good. Therefore a new cut-off score of two points with optimal sensitivity and specificity was recommended to replace the original cut-off score for screening of risk of malnutrition among Malaysian geriatric patients. All geriatric patients should be offered annual nutrition screening to determine the presence or absence of nutrition risk factors. Elderly who screen positive for nutritional risk factors should be offered in-depth nutrition assessment and should be addressed through nutrition intervention.

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