

Validity and reliability of Bahasa Malaysia eating assessment tool (mEAT-10): A good screening tool for safe swallowing

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ABSTRACT

Objective: This study aimed to investigate the validity and reliability of the Bahasa Malaysia version of the Eating Assessment Tool-10 (mEAT-10) and determine the cutoff point for abnormal swallowing.

Methods: This prospective convenience sampling study was conducted at a tertiary center between December 2019 and May 2022. The mEAT-10 was produced following rigorous forward and backward translations. One hundred and thirty-eight participants, including 70 healthy volunteers and 68 patients with dysphagia, were recruited to complete the test–retest mEAT-10 assessment and the 3-ounce water test. The mEAT-10 was repeated within four weeks via telephone interviews or clinic visits. Patients in the dysphagia group underwent flexible endoscopic evaluation of swallowing (FEES). The FEES results were evaluated independently by four different raters to determine the reliability of the penetration-aspiration score (PAS) scoring, which categorizes them into safe and unsafe swallowing for data analysis. Internal consistency and test–retest agreement were assessed using Cronbach alpha and intraclass correlation coefficient (ICC). The mEAT-10 comparison between the normal and dysphagia groups was performed using the Mann–Whitney U test. The association between PAS and mEAT-10, gag reflex, 3-ounce water test and the other risk factors were evaluated using chi-square and Fisher exact test, with univariable and multivariable logistic regression.

Results: The mEAT-10 test–retest showed a Cronbach alpha of >0.90 and an ICC of >0.85. The mEAT-10 cutoff score indicating abnormal swallowing is seven, with sensitivity and specificity of 0.82 and 0.54, respectively. In univariable analysis, higher mEAT-10 scores (≥ 7), absence of gag reflex, and failure of the 3-ounce water test were all significantly associated with unsafe swallowing ($PAS \geq 3$). In multivariable logistic regression, however, failure of the 3-ounce water test was the only independent predictor of unsafe swallowing ($PAS \geq 3$; adjusted odds ratio 4.24, 95% confidence interval 1.53–11.77; $p=0.006$).

Conclusion: mEAT-10 is a reliable tool for screening and assessing patients with dysphagia. A cutoff score of 7 or more indicates abnormal swallowing and maybe associated with unsafe swallowing ($PAS \geq 3$).

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Abbreviations

FEES	Flexible endoscopic evaluation of swallowing
mEAT-10	Bahasa Malaysia version of Eating Assessment Tool-10
PAS	Penetration- aspiration scoring
PRO	Patient reported outcome

1. Introduction

Swallowing requires synchronized coordination of both central and peripheral neuromuscular functions. Both voluntary and involuntary reflexes involve propulsion of a food bolus into the stomach. Dysphagia is defined as difficulty swallowing, indicating impairment in different phases of swallowing, and may also be due to manifestations of other diseases. Dysphagia may originate in the oral cavity, oropharynx, hypopharynx, or esophagus.

Dysphagia is often under-diagnosed and mismanaged owing to a lack of awareness among the public and healthcare professionals. Local data have shown that 58.4 % of doctors seldom or never referred patients for dysphagia [1]. Even patients may perceive dysphagia as a normal process of aging [2,3]. The prevalence of dysphagia ranges from 15 % to 22 % [3] in the general population and from 55 % to 60 % [4,5] in patients from nursing homes as well as in those with acute illnesses.

Dysphagia can be diagnosed after a proper medical history and clinical examination. Numerous patient-reported outcome (PRO) measures for dysphagia have been used to aid the diagnosis and assessment of treatment efficacy [6]. A PRO is defined by the U.S. Food and Drug Administration (FDA) as a report of the status of a patient's health condition that comes directly from the patient, without interpretation by a clinician or anyone else [7].

A systematic review by Patel et al. revealed that 34 dysphagia-related PRO measures have been published between 1987 and 2014 [6]. PRO are gaining popularity and have recently been used as endpoints in clinical trials. Paul et al. meta-analysis of PRO used for swallowing outcomes in oropharyngeal cancer showed that 80 % of PRO between 1990 and 2016 were published after 2010 [8]. All of these enhance our understanding of patients' experiences and are beneficial for comparative studies.

The Eating Assessment Tool (EAT-10) is a PRO that was developed and validated by Belafsky in 2008 for English-speaking patients [9]. It provides clinicians with insights into symptom severity, quality of life, and treatment efficacy in dysphagia patients. The questionnaire can be readily administered in the clinic, easily scored by patients, and administered to patients with dysphagia of various etiologies. However, using such a tool requires cross-cultural adaptation, because differences in culture and language pose significant confounding factors in terms of clinical practice and research for users of different languages.

Cross-cultural adaptation is important as it helps respondents understand the questions better, thus increasing the reliability of the final scoring. This will also reduce the risk of introducing bias into the study and prevent incorrect interpretation of results. It also enables researchers from different continents to conduct reliable future research by using scoring systems. To date, there has been no publication of the Bahasa Malaysia (local language) translated EAT-10. The translation process ensured that the questionnaire was suitable for use in the Malaysian population and facilitated accurate assessment of patients with dysphagia. The final version of the questionnaire required a formal study to determine its consistency, reliability, and clinical validity in the assessment of patients with dysphagia.

This study aimed to comprehensively evaluate the reliability and validity of the mEAT-10 as a screening and assessment tool for patients with dysphagia. This study included both healthy participants and those with dysphagia from the Malaysian population, allowing for a diverse range of insights. The study findings were derived by performing test-retest reliability of the mEAT-10 and subsequently correlating the mEAT-10 scores with 1) the 3-ounce water test, 2) penetration-aspiration score (PAS) score of flexible endoscopic evaluation of

swallowing (FEES) results, and 3) the presence or absence of gag reflex. The cutoff score of the mEAT-10 to predict safe swallowing was determined, and the PAS results were then classified into two groups based on safe and unsafe swallowing. This provides a comprehensive and valuable diagnostic tool for clinicians to accurately evaluate and treat patients with dysphagia.

2. Materials and methods

This is a prospective convenience sampling study for validation of the Bahasa Malaysia translated EAT-10 (mEAT-10), as well as determining its cutoff score for safe swallowing. This study was performed from December 2019 to May 2022 at a tertiary center, and ethics approval was obtained from the institution (FF-2020–193).

2.1. Translation and cultural adaptation

The fourth author translated the EAT-10 questionnaire into Malay language with the support of a multidisciplinary team comprising professionals from the literacy and language department, speech therapists, and otorhinolaryngologists. The translation process used forward and backward translation methods and involved three different panels of experts to ensure accuracy and consistency. After undergoing a comprehensive translation and stringent cross-cultural adaptation process, the final version of the EAT-10 questionnaire in Bahasa Malaysia (mEAT-10) was produced through consensus among all teams involved.

During pilot testing, all participants reported that the Bahasa Malaysia version of the questionnaire was clear and easy to understand. No participant required assistance or reported difficulty interpreting any item, and all responses were complete without missing any question stem. This shows good comprehensibility and face validity of the translated questionnaire.

2.2. Study recruitment

The participants in this study were divided into two groups: a normal group of healthy volunteers and a dysphagia group. Participants were recruited based on specific inclusion and exclusion criteria, as outlined in Table 1. To be included in the normal group, participants had to have normal swallowing function, be 18 years of age or older, and be literate in Bahasa Malaysia. Individuals who were receiving treatment for gastroesophageal reflux disease (GERD) and/or laryngopharyngeal reflux (LPR), as well as those who had undergone radiotherapy of the neck or recent oropharyngeal surgery were excluded from this group.

Table 1
Inclusion and exclusion criteria.

	Normal Group	Dysphagia Group
Inclusion Criteria	1. Normal swallowing function 2. Aged 18 years and older 3. Literate in Bahasa Malaysia	1. Aged 18 years and older 2. Complaint of dysphagia 3. Cooperative for flexible endoscopic examination 4. Literate in Bahasa Malaysia 5. Mentally capable of answering the questionnaire
Exclusion Criteria	1. Diagnosed gastroesophageal reflux disease (GERD), and/or laryngopharyngeal reflux (LPR) on treatment 2. History of radiotherapy and recent oropharyngeal surgery, e.g., tonsillectomy, endoscopic laryngeal microsurgery (ELMS)	1. Pregnant women

For the dysphagia group, patients who were 18 years of age or older, had complaints of dysphagia, were cooperative for flexible endoscopic examination, were literate in Bahasa Malaysia, and had normal cognitive function were included. Pregnant women were excluded from this study. All participants provided written informed consent, and a follow-up questionnaire was completed within a four-week interval before treatment execution.

2.3. Study procedure

In the normal group, the mEAT-10 was scored at the initial meeting, and a 3-ounce water test was performed to exclude swallowing problems. Another mEAT-10 was completed within four weeks for retest reliability, either through a re-interview or telephone call. The time taken for each participant to complete the questionnaire was recorded.

For the dysphagia group, the mEAT-10 was completed during the first visit upon referral to the ENT or speech therapy clinic, and appointments for FEES were scheduled within four weeks. During the scheduled clinic visit, the second mEAT-10 was completed, followed by a 3-ounce water test and FEES. Videos of the FEES were recorded and subsequently anonymized for blind evaluation by multiple raters using the PAS. The second mEAT-10 was completed within four weeks, and in most cases within two weeks of the initial administration. Participants did not receive swallowing therapy or major intervention between sessions.

2.4. Study instruments

2.4.1. 3-ounce test and gag reflex

This test was performed by asking the participants to drink three ounces of water without interruption. The participant was considered to have failed the test if they were unable to complete it without coughing, choking, or had wet-hoarse vocal quality within 1 min of test completion. Gag reflex was also evaluated in the dysphagia group.

2.4.2. Flexible endoscopic examination of swallowing (FEES)

During this examination, a thin fluid with blue dye was used as the testing material, and no fluid thickener data were used in our study to prevent inconsistency among the subjects. The anonymized FEES videos were independently evaluated by four otorhinolaryngologists who were blinded to the mEAT-10 score and diagnosis. Two were senior residents with more than five years of experience, one was a junior specialist with 5–10 years of experience, and the other was a senior specialist with >10 years of experience.

2.4.3. Penetration-aspiration scale (PAS)

The evaluation was done using a validated tool called the PAS [10]. PAS was used to interpret aspiration and penetration events and had an 8-point score, with the highest score being the most severe. This scale is scored based on any residual fluid after swallowing, the location of the residual fluid if it is above, at, or below the vocal cord, and the ability of the patient to eject it out of the airway if there is penetration or aspiration. $PAS \leq 2$ is categorized as a safe swallowing, and $PAS \geq 3$ is considered an unsafe swallowing [11].

2.5. Sample size

Currently, there is no sample size calculation guideline available for evaluating the reliability and validity of a questionnaire [12]. The usual rule of thumb was used instead, in which the estimated number of respondents was calculated based on the ratio of the respondent to questionnaire items, ranging from 5:1 to 20:1, with a higher ratio indicating more accurate outcomes [13]. A total of 138 participants were recruited, which translated into a ratio of 14:1. 70 were in the normal group, and 68 were in the dysphagia group.

2.6. Statistical analysis

Data analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were calculated for all variables initially, where frequency and percentage were calculated for categorical data, and mean (standard deviation) and median (interquartile ranges) for continuous data.

Test-retest reliability was assessed using intraclass correlation (ICC) based on a two-way mixed-effect, consistency, and single rating for each individual question, and the average rating for the sum of the scores. The internal consistency reliability of the translated questionnaire was assessed using Cronbach alpha. A minimum value of 0.7 was considered to indicate good internal consistency. The mEAT-10 discriminant validity was assessed by comparing the mean of the total scores between the two groups using the Mann–Whitney U test. To determine the best cutoff points of the mEAT-10 for dysphagia, receiver operating curve (ROC) analysis was used. The area under the curve (AUC) was calculated. A minimum threshold of 0.7 was regarded as acceptable.

The inter-rater reliability of the raters in evaluating the anonymized FEES videos and PAS scores was assessed using ICC. The time taken to complete the questionnaire was compared between the two groups using the Mann–Whitney U test. The association of mEAT-10 scores with other clinical findings (3-ounce water test and PAS score) was assessed using Pearson chi-square test and Fisher exact test. A log regression test was used to determine the association of $PAS \geq 3$ (unsafe swallowing) with mEAT-10 score and gag reflex. Differences were considered statistically significant at a p -value < 0.05. The inter-rater reliability of the FEES evaluation using the PAS was assessed using ICC.

To explore factors associated with unsafe swallowing ($PAS \geq 3$) in the dysphagia group, univariable logistic regression was performed for age, gender, race, etiology, 3-ounce water test result, gag reflex, and mEAT-10 score. They were then entered into a multivariable logistic regression model using the Forward LR method to adjust for potential confounding. Model fit was assessed using Nagelkerke R^2 , the Hosmer–Lemeshow goodness-of-fit test, classification accuracy, and AUC. Differences were considered statistically significant at $p < 0.05$.

3. Results

3.1. Demography

In total, 138 participants were recruited for this study. Seventy participants were normal, with a mean age of 39.41. In the dysphagia group, 68 patients were recruited, with a mean age of 62.50 years. The underlying medical conditions in the dysphagia group were tabulated, in which more than half suffered from cerebral vascular accidents (60 %), followed by carcinomas (18 %), which consisted of thyroid, lung, and brain carcinomas. Neurodegenerative diseases (14 %), including Parkinson disease, motor neuron disease, multiple sclerosis, myasthenia

Table 2
Demographic characteristics of participants ($n = 138$).

	Normal ($n = 70$)	Dysphagia ($n = 68$)
Age (Mean $\pm$ SD)	39.41 $\pm$ 10.76	62.50 $\pm$ 12.07
Gender n (%)		
Male	21 (30.0)	39 (57.4)
Female	49 (70.0)	29 (42.6)
Race n (%)		
Malay	39 (55.7)	37 (54.4)
Chinese	18 (25.7)	27 (39.7)
Indian	12 (17.1)	4 (5.9)
Others	1 (1.4)	0
Etiology n (%)		
CVA	41 (60 %)	
Carcinoma	12 (18 %)	
Neurodegenerative disease	9 (14 %)	
Unilateral vocal cord palsy	6 (8 %)	

gravis, and unilateral vocal cord palsy (8 %), were the other causes that patients were referred for swallowing assessment to speech therapists. (Table 2)

3.2. Descriptive data of the mEAT-10, 3-ounce water test, gag reflex, and PAS score of FEES

The mean time taken to complete the first answering of the mEAT-10 for the normal participants was 2.06 (± 0.99) minutes and 4.54 (± 2.94) minutes for the dysphagia group. The time required was significantly longer in the dysphagia group (p -value < 0.001). The mean score of the mEAT-10 questionnaire was significantly higher in the dysphagia group (22.25 ± 18.71) than in the normal group (1.16 ± 4.03), with a p -value < 0.001 . This indicates the effectiveness of the questionnaire in distinguishing between individuals with normal swallowing function and those with dysphagia. (Table 3)

In the dysphagia group, 44.1 % passed the 3-ounce water test, while 55.9 % failed, and the normal group had a 100 % passing rate. In addition, 54.4 % of patients in the dysphagia group had a gag reflex and 45.6 % failed the test. For the PAS results of FEES, scores ranging from 1 to 8 were used to evaluate the safety of swallowing, with higher scores indicating more severe impairment. Of the total sample, 26.5 % of the FEES scored PAS 1 and 17.6 % scored PAS 2. These two were considered to be safe swallowing. A PAS ≥ 3 , representing unsafe swallowing, was obtained in 55.9 % of the participants. Specifically, 7.4 % PAS 3, 11.8 % PAS 4, 5.9 % PAS 5, 7.4 % PAS of 6, 7.4 % scored a PAS 7, and 16.2 % PAS 8. (Table 3)

The inter-rater reliability of PAS on the anonymized video evaluation showed a high Cronbach alpha of 0.932 and excellent agreement with ICC of 0.925 (95 % CI: 0.881, 0.951). These results suggest a high level of consistency among multiple raters, indicating that the FEES is a reliable tool for assessing safe swallowing in patients.

3.2.1. Test-retest reliability of mEAT-10

The internal consistency reliability analysis for mEAT-10 showed excellent Cronbach alpha of 0.91 and 0.98 for the normal and dysphagia groups, respectively. Regarding the reliability of the mEAT-10 questionnaire, the ICC values for the healthy and dysphagia groups were 0.845 and 0.969, respectively, indicating excellent consistency. (Table 4)

3.2.2. Discriminative validity of mEAT-10

The present study found that the mean mEAT-10 score was significantly higher in the dysphagia group (22.25) than in the healthy group (1.16) (p -value < 0.001). The discriminative ability of the mEAT-10 was evaluated using an ROC curve, which showed an AUC of > 0.7 with a p -

Table 3
mEAT-10 mean score for both groups and 3-ounce water test, gag reflex and PAS score of FEES of the dysphagia group.

Total Score	Mean $\pm$ SD	Median (IQR)	p-value
Normal (n = 70)	1.16 $\pm$ 4.03	0.0 (1.25)	<0.001
Dysphagia (n = 68)	22.25 $\pm$ 18.71	16.5 (30.25)	
Swallowing Test			
3-ounces water test		Pass Frequency (%)	Fail Frequency (%)
Gag reflex		30 (44.1)	38 (55.9)
		37 (54.4)	31 (45.6)
PAS Score			
1		n (%)	
2		18 (26.5)	
3		12 (17.6)	
4		5 (7.4)	
5		8 (11.8)	
6		4 (5.9)	
7		5 (7.4)	
8		5 (7.4)	
		11 (16.2)	

Table 4

Internal consistency and test-retest reliability for mEAT-10.

	Cronbach Alpha	Intraclass Correlation Coefficient (ICC)	95 % CI
Normal	0.916	0.845	0.762, 0.901
Dysphagia	0.984	0.969	0.951, 0.981

value of 0.003. Based on this analysis, the optimal cutoff point for identifying abnormal swallowing was determined to be > 6.5 , which would be a score of 7 or more, with a sensitivity of 0.82 and a specificity of 0.54. The researchers chose to prioritize sensitivity over specificity to ensure that subjects with unsafe swallowing were not missed, and this decision was supported by the highest Youden Index observed at a score of > 6.5 [14]. (Fig. 1 and Table 5)

3.3. The association between PAS of FEES and: 1) mEAT-10 score; 2) 3-ounce water test; 3) gag reflex; and other risk factors

PAS score was divided into safe (PAS <3) and unsafe swallowing (PAS ≥ 3) and further analyzed using univariable and multivariable logistic regression. This is to look at the association between potential risk factors and the likelihood of having unsafe swallowing (PAS ≥ 3). In univariable analysis, failure of the 3-ounce water test (p -value=0.014), absence of gag reflex (p -value=0.010), and an mEAT-10 score ≥ 7 (p -value=0.005) were all positively associated with unsafe swallowing. A summary of these results is presented in Table 6.

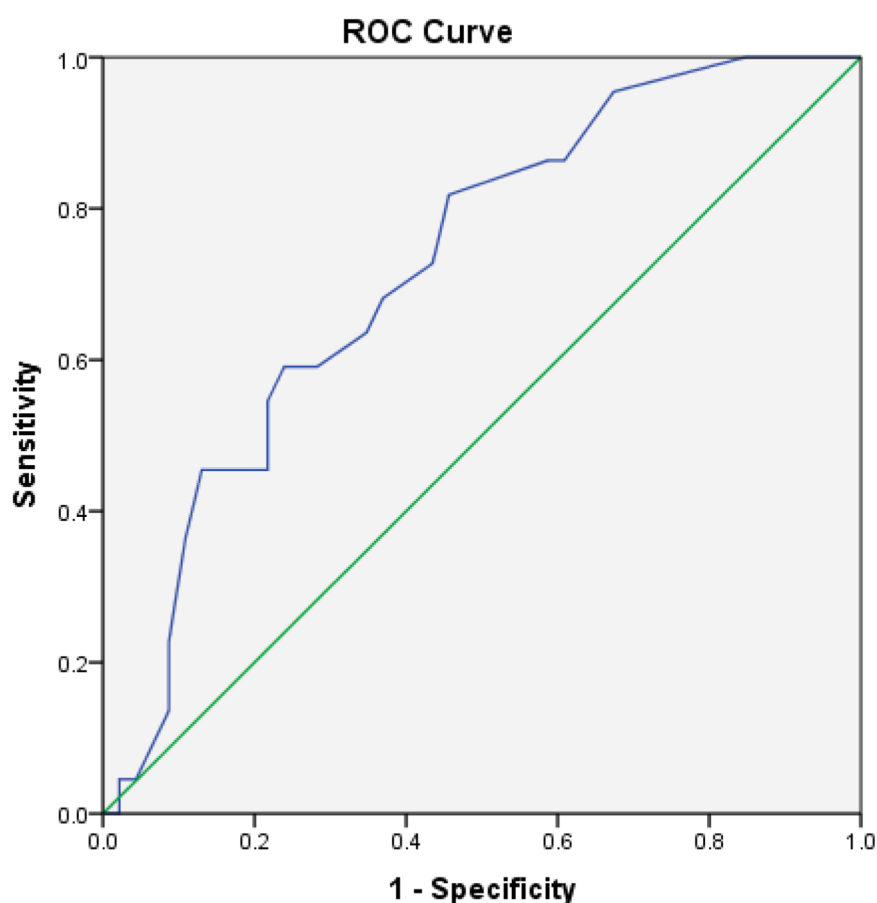
In the final multivariable adjusted model, only the 3-ounce water test remained a significant independent predictor of unsafe swallowing. Participants who failed the swallowing test had 4.24 times higher odds of unsafe swallowing compared to those who passed (adjusted OR = 4.24, 95 % CI 1.53–11.77, $p = 0.006$), after adjusting for gender, race, gag reflex, and mEAT-10 score. Other variables—including an mEAT-10 score ≥ 7 and absence of gag reflex—were positive but not statistically significant predictors after adjustment ($p > 0.05$). The model demonstrated acceptable fit, with Nagelkerke $R^2 = 0.152$, Hosmer–Lemeshow $p = 0.729$, classification accuracy of 67.6 %, and AUC of 0.735 (Table 7).

4. Discussion

Dysphagia has a huge impact on patients' psychological state and quality of life, as they are denied the pleasure of the most essential human social activity: the ability to eat. Dysphagia is also associated with high morbidity and mortality, with complications such as aspiration, resulting in frequent lung infections and malnourishment. It also increases healthcare costs and longer hospitalization [15,16] Dysphagia is the most common reason for referral to speech and language therapists (SLTs). With the shortage of SLTs in Malaysia, a good screening tool would be able to reduce the burden, and early consultation intervention can be given to those who need it [17].

Patients with swallowing disorders usually have subtle presentations and some may even perceive them as normal. A previous history of choking, coughing, and throat clearing post meals is the usual history that can be elicited [18]. Various bedside assessments are available, and generally these include medical history, cognition, communication, relevant physical examination, including cranial nerve examination, followed by evaluation of the patient to taking solid and liquids diet [19].

An easily applicable PRO would be helpful for clinicians in screening patients with dysphagia and unsafe swallowing, sending them for further investigation and early intervention. However, most dysphagia-related PRO have been developed only for specific conditions. In comparison, only a few PRO were developed for a broad range of dysphagia problems, such as EAT-10 and PROMIS-G1 [6]. As some PRO are



Diagonal segments are produced by ties.

Fig. 1. mEAT-10 ROC curve.

Table 5

Youden index of mEAT-10.

mEAT-10 Score (Positive If Greater Than or Equal To)	Sensitivity	1-Specificity	Specificity	Sensitivity + Specificity	Youden Index
0	1.00	1.00	0	1.00	0
1.5	1.00	0.848	0.152	1.152	0.152
2.5	0.955	0.674	0.326	1.281	0.281
4.0	0.864	0.609	0.391	1.255	0.255
5.5	0.864	0.587	0.413	1.277	0.277
6.5	0.818	0.457	0.543	1.361	0.361
7.5	0.727	0.435	0.565	1.292	0.292
8.5	0.682	0.370	0.63	1.312	0.312
9.5	0.636	0.348	0.652	1.288	0.288
10.5	0.591	0.283	0.717	1.308	0.308

Table 6

Association of swallowing assessment and mEAT-10 score with the PAS of FEES in the dysphagia group.

		PAS Category (n)		p-value
		1–2 (Safe)	≥ 3 (Unsafe)	
3 Oz	Pass	25	5	0.014
	Failed	21	17	
Gag Reflex	Present	30	5	0.010
	Absent	18	17	
mEAT-10 Score	<6	25	4	0.005
	≥7	21	18	

disease-specific, it may not be appropriate to use them as screening tools for the general population. The EAT-10 is widely used and is mentioned in the literature.

EAT 10 is widely accepted, as shown by its translation into various languages around the world, including Italian, European Portuguese, Japanese, Chinese, Spanish, Arabic, Swedish, Turkish, French, and Finnish (see Table 8) [9,20–28]. Translation into the respective languages helps the respondents understand the questions better, thus increasing the reliability of the final scoring.

The mEAT-10 underwent a rigorous validation and reliability process in which two groups of participants, the normal and dysphagia groups, were recruited to determine the cutoff score for abnormal swallowing. Vigorous subjective evaluations of swallowing, the 3-ounce water test, gag reflex, and FEES were also used to correlate with the mEAT-10 scores, validate it, and identify factors that contribute to

Table 7

Association between unsafe swallowing (PAS ≥ 3) to risk factors in the dysphagia group.

Outcome Unsafe Swallowing (PAS ≥ 3)	Crude OR (95 % CI)	p-value	Adjusted OR (95 % CI)	p-value
Age	1.01 (0.972, 1.053)	0.583		
Gender				
Male	1	0.116		
Female	0.46 (0.170, 1.214)			
Race				
Malay	1	0.058		
Chinese	0.37 (0.134, 1.035)	0.687		
Indian	1.63 (0.153, 17.239)			
Etiology n (%)				
CVA	1	0.601		
Carcinoma	0.71 (0.195, 2.576)	0.653		
Neurodegenerative disease	1.42 (0.310, 6.470)	0.260		
Unilateral vocal cord palsy	0.35 (0.058, 2.159)			
3-ounce water test				
Pass	1	0.006	1	0.006
Fail	4.24 (1.527, 11.772)		4.24 (1.527, 11.772)	
Gag Reflex				
Present	1	0.074		
Absent	2.47 (0.916, 6.666)			
mEAT-10				
<6	1	0.116		
≥7	2.20 (0.823, 5.866)			

OR=Odds ratio.

Forward LR method for Multiple Logistic Regression was applied. Those variables with p-value <0.25 (gender, race, swallowing test, gag reflex, mEAT-10) were selected into Multiple Logistic Regression in adjusting of potential confounding in the analysis. Nagelkerke R²: 0.152, Hosmer Lemeshow test p = 0.729, Classification table: 67.6 % and area under curve =73.5 % were used to check model fitness.

unsafe swallowing. It is reliable, with good internal consistency and test–retest agreement. The Cronbach's alpha values were 0.91 for the normal group and 0.98 for the dysphagia group, while the ICCs were 0.845 and 0.969, respectively. The cutoff score for abnormal swallowing was 7 or more, with a sensitivity of 0.82 and a specificity of 0.54, effectively differentiating normal and dysphagic participants. In a multivariable analysis, failure of 3-ounce water test is the only independent predictor of unsafe swallowing after adjustment for age, sex,

race, and underlying disease (adjusted OR = 4.24, 95 % CI = 1.53–11.77, p = 0.006). Other variables, including mEAT-10 score of 7 or more and absence gag reflex were positive but not statistically significant predictors after adjustment (p > 0.05). This show the benefit of integrating patient-reported assessments such as the mEAT-10 with objective bedside test to help with early recognition and early treatment of dysphagia in clinical settings.

Previous studies have proposed a cutoff score of EAT-10 in which a score of 3 or above indicates abnormality and warrants further investigation [9], while an EAT-10 score of >9 indicates higher aspiration risks [29] with sensitivity and specificity of 71 % and 53 %, respectively. There was also a large range of variations seen among the scores of different translations of EAT-10 for unsafe swallowing. The cutoff score was >4 for the Spanish version and 17 for the French version. Various studies have also shown that patients with a score of >9 will have a greater risk of aspirations [27,29–31]. This will become a useful tool in primary care settings and will help facilitate early referral to otorhinolaryngology or speech clinics for timely review and intervention.

The cutoff value of ≥7 for abnormal swallowing in the Malay version of EAT-10 was higher than that reported in many other versions, although the French version proposed a score of >17 for aspiration [9, 20–29]. This variation is likely multifactorial. First, our dysphagia population consisted mostly of elderly post-stroke and head-and-neck cancer patients, who tend to present with more advanced and persistent swallowing impairment compared to mixed outpatient cohorts in other studies. Second, linguistic and cultural factors may influence symptom self-perception; in Bahasa Malaysia, expressions for mild swallowing difficulty are typically described in softer or more neutral terms, possibly leading to lower item scores in the control group and consequently a higher ROC threshold. Third, differences in instrumental assessment may contribute: our study employed FEES, which is more sensitive to penetration and secretion pooling than VFSS. Finally, our ROC analysis prioritized sensitivity to avoid missing at-risk individuals, resulting in a higher cutoff that still demonstrated good specificity. mEAT-10 is a screening and triage tool to help stratify dysphagia risk. Scores between 3 and 6 may warrant clinical observation or periodic reassessment rather than immediate instrumental testing, ensuring efficient use of resources while maintaining patient safety.

Videofluoroscopic swallowing study (VFSS) is traditionally considered the gold standard for evaluating swallowing physiology, as it provides dynamic visualization of the oral and pharyngeal phases. Flexible endoscopic evaluation of swallowing (FEES) was selected in the current study because it is readily available in our tertiary otorhinolaryngology setting, and allows bedside assessment without radiation exposure, with more superior visualization of pharyngeal secretions, penetration, and aspiration events. VFSS slot in our center is limited, making it difficult for research activity involving many participants. FEES, on the other hand, enables repeated assessments and has comparable diagnostic

Table 8

Comparison between different versions of EAT-10.

	Language	Number of subjects		EAT-10 Abnormal score	EAT-10 Aspiration Score	Cronbach α	Sensitivity(%)	Specificity(%)
		Dysphagia	Control					
Belafsky et al., 2008	English	235	100	>3	>9	0.960	71	53
Schindler et al., 2013	Italian	172	269	>3	–	0.90		
Nogueira et al., 2014	European Portuguese	205	315	>3	–	0.952		
Hidetaka et al., 2014	Japanese	237	–	>3	–	0.946		
Wang et al., 2015	Chinese	130	–	>1	–	0.845		
Giraldo-cadavid et al., 2015	Spanish(Columbia)	113	55	>2	>4	0.87	94	49
Farahat et al., 2015	Arabic	138	83	>3	–	0.92		
Moller et al., 2016	Swedish	164	141	>3	–	0.88		
Demir et al., 2016	Turkish	105	–	–	–	0.9		
Lechien et al., 2019	French	52	73	>3	>17	0.95	82	57
Järvenpää et al., 2021	Finnish	117	180	≥ 3	≥ 16	0.95	70	42
Ng et al., 2025	Malaysia	68	70	≥7		0.984	82	54

accuracy in detecting aspiration. These methodological considerations may explain variations in cutoff scores among studies using different modalities.

With early detection, early intervention can be administered by a speech therapist to help patients improve swallowing function. Safe swallowing can be restored by methods such as diet modification, positioning, swallowing techniques, and mealtime strategies, or with therapies that aim to improve oropharyngeal function and prevent aspirations [18]. EAT-10 is also shown to be a reliable instrument to assess the improvement of swallowing function by reviewing the scores prior to and after treatment in other translated versions [9,20,24].

4.1. Limitations of the study

There was a mean age difference between the normal and dysphagia groups in our study; the normal group consisted of young people. This is because diseases with sequelae of swallowing issues are more common in the elderly population. The specificity of a mEAT-10 score of 7 was only 54 % for unsafe swallowing in patients with dysphagia, reflecting the focus on sensitivity for screening.

Although the test–retest interval was within four weeks, most participants were reassessed within two weeks of the initial administration. None of the participants received swallowing therapy, surgery, or major intervention during this interval. This design minimized, but did not eliminate, the possibility of natural symptom fluctuation or recovery.

Another limitation is that FEES does not evaluate the oral and esophageal phases as comprehensively as VFSS, which remains the reference standard.

4.2. Implications for current clinical practice

A validated mEAT-10 will enable it to be used in primary, secondary, and tertiary healthcare settings. It will also allow local data to be used for international comparisons in swallowing management and interventions. mEAT-10 score of ≥ 7 and/or failure of the 3-ounce water test should alert the clinician to the risk of unsafe swallowing and can be complicated with aspiration pneumonia. This would need a referral for FEES or VFSS, where available.

5. Conclusion

The mEAT-10 is a reliable translated PRO with good-to-excellent Cronbach alpha and ICC. A cutoff score of ≥ 7 indicates abnormal swallowing, with a sensitivity of 82 %. The mEAT-10 serves as a practical first-line screening and triage tool in the Malaysian population; a score ≥ 7 , particularly in combination with a failed 3-ounce water test, should prompt further evaluation for unsafe swallowing and early intervention.

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Author contributions

- **Ng Jia Ji:** Conceptualization; study design; data acquisition; coordination; FEES workflow; statistical analysis; primary manuscript drafting and revision.
- **Marina Mat Baki:** Senior supervision; methodological oversight; clinical interpretation of findings; major contributor to manuscript revision.
- **Ong Hui Yan:** Independent blinded FEES scoring; reliability assessment; statistical input; contributed to study design; critical intellectual revision..

- **Nik Fariza Husna Nik Hassan:** Led the translation and cross-cultural adaptation of mEAT-10
- **Ziyad Al Harrasi:** restructuring of manuscript; critical appraisal.
- **Sherin Sokmun:** FEES examination and data acquisition; PAS scoring; interpretation of FEES findings; manuscript review.
- **Farah Liana Lokman, Nadhirah Mohd Shakri, Mawaddah Azman, Mohd Razif Mohamad Yunus:** Contributed to study coordination, data organisation, literature review, and critical appraisal of the manuscript.

All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

Declaration of competing interest

The authors declare no conflicts of interest related to the conduct of this study, the preparation of this manuscript, or its submission for publication. No financial support or commercial relationships that could be construed as a potential conflict of interest were received beyond the institutional research grant acknowledged in this paper.

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