Evaluating the accuracy and reliability of fonseca anamnestic index (FAI) in screening temporomandibular disorders

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Abstract

Background*:* Temporomandibular disorders (TMD) are a common medical condition in Vietnam and around the world. Fonseca Anamnestic Index (FAI) is a quick and simple questionnaire to diagnose TMD. **Objectives***:* (1) To evaluate the accuracy and reliability of FAI in the diagnosis of TMD and (2) to suggest adjustments to enhance the clinical value of FAI. ***Material and method:*** This study included 198 students (69 males, 129 females) from the Faculty of Odonto-Stomatology, Hue University of Medicine and Pharmacy. This study is conducted from 06/2022 to 12/2022. Participants initially filled out FAI questionnaire, then followed by questionnaire and clinical examination using Diagnostic Criteria for Temporomandibular Disorder (DC/TMD) as a gold standard. **Results***:* According to DC/TMD, the prevalence of TMD among students was 34.8%. FAI had high sensitivity (97.1%) but low specificity (40.46%) (cutoff point = 17.5), Cronbach Alpha value was 0.684. The suggested cutoff point was calculated at 22.5. Only Question 8 from FAI questionnaire showed insignificant difference between TMD and non-TMD group. By extracting the 8th question with the cutoff point at 22.5, the sensitivity and specificity of the modified questionnaire was 82.1% and 64.9% respectively and the Cronbach Alpha value mildly increased to 0.692. **Conclusion***:* The FAI is suited for screening patients with TMD because of its high sensitivity. However, FAI low specificity makes it not optimal for efficiently diagnosing TMD. It is suggested to modify the FAI by eliminating the 8th question in the questionnaire and have a higher cutoff point (23).

Keywords: accuracy, reliability, Fonseca Anamnestic Index, Temporomandibular disorders, adjustments.

1. INTRODUCTION

Temporomandibular disorders (TMD) are a medical condition that affect the masticatory muscle, temporomandibular joints (TMJs), and other related structures [1]. The three main symptoms of TMD includes orofacial pain, movement reduction of the jawbone (mandibular movement dysfunction), and abnormal temporomandibular joint sound [2]. The most common group age of TMD is between 20 - 40 years old. The incidence rate of TMD in women is higher than men [3, 4]. A number of epidemiological studies have indicated that TMD is the most prevalent non-dental cause of orofacial pain. Approximately 40-60% of the general population exhibit signs and symptoms of TMD; 41% of this group report experiencing at least one symptom related to TMD, while 56% show at least one clinical sign [1]. The results of various studies, both in the world and in Vietnam show that TMD is a common issue. A study by Bertoli F. (2018) on Brazilian adolescents found that 34.9% had symptomatic TMD [5]. Wieckiewicz M.'s research (2014) on university students in Poland reported a TMD prevalence of 54% [6]. In Vietnam,

Hoang A. carried out a research in 2015 that examined 201 Dental students at Hue University of Medicine and Pharmacy, uncovering that 72.6% of the students demonstrated the presence of at least once indications or symptoms of TMD [7].

As TMD are a multifactorial disorders [4], a comprehensive tool is required to assess TMD in all perspectives. There are several instruments currently used around the world, but the current accepted golden standard for diagnosing TMD is the Diagnostic Criteria of Temporomandibular Disorder (DC/TMD). DC/TMD is a comprehensive tool with 2 axes: Axis I is for clinical examination and Axis II provides assessment for pain behavior, psychological status and psychosocial functioning. However, it is not suitable to apply DC/TMD in epidemiological studies and clinical classification, due to its prolonged procedure, requirement for training and complex diagnosing process. Therefore, to facilitate the need of a quick and simple assessment tool, Fonseca Anamnestic Index (FAI) was proposed to examine the prevalence of TMD in clinical and community samples [8, 9].

FAI was created based on the Helkimo Anamnestic Index [10], including 10 questions that categorize patients into 4 groups according to the severity of TMD: TMD-free, mild TMD, moderate TMD and severe TMD. FAI was originally in Portuguese [10] and then translated into English [11] and Chinese [12]. For FAI to be used in Vietnam, it must be validated and assessed. Therefore, this research was conducted to achieve the following purposes:

1. To evaluate the accuracy and reliability of the FAI in diagnosing Odonto-Stomatology students with TMD at Hue University of Medicine and Pharmacy;

2. To suggest adjustments to enhance the clinical value of FAI.

2. MATERIALS AND METHODS.

2.1. Subjects

The study was conducted with 198 students from year 1 to year 6, majoring in Odonto-Stomatology at Hue University of Medicine and Pharmacy. The data was collected from August 2022 to December 2022. The exclusion criteria include students who were experienced orofacial swelling or pain caused by infection or trauma of the head and face, systemic diseases such as rheumatoid arthritis and polyarthritis, a history of joint trauma or mandibular condyle fracture or students who were undergoing orthodontics treatment.

2.2. Study method:

This was a cross-sectional study on total 198 students.

$$(n = Z^2_{1-\alpha/2} \frac{ese(1-ese)}{d^2 p})$$

In which:

ese: Expected sensitivity. Since this study examined the screening value of two diagnostic questionnaires and was based on the study of Min-juan Zhang and colleagues on the sensitivity of the Fonseca questionnaire [12], pse = 0.96 should be chosen.

p: Prevalence of TMD in previous studies. In the study on subjects and the same evaluation criteria, the rate of dental students with TMD was 30%, p = 0.3 [13])

Each patient initially filled out the Fonseca Questionnaire (FAI), then underwent a complete DC/TMD diagnosing procedure by filling in the Symptom Questionnaire (SQ), getting clinically examined by doctors with the Examine Form (EF) of DC/TMD. Signs and symptoms were analyzed based on the DC/TMD Decision Trees to classify patients into subtypes of TMD [2]. Results from FAI were accordingly compared with the diagnosis of DC/TMD as a golden standard to assess the sensitivity, specificity of the FAI, and calculated the degree of agreement between FQ and DC/TMD using Cohen's Kappa. Additionally, receiver operating characteristics (ROC) curve would be analyzed to determine the optimal cutoff point and calculate the Area under curve (AUC).

SQ, EF and FAI were translated into Vietnamese by a TMJ specialist with an eligible English level. Only one doctor, who got the certificate of DC/TMD Clinical Training and Calibration, performed the translating DC/TMD documents and assessing all the patients in this study. The FAI answers were scored as follows: "yes = 10"; "sometimes = 5"; "no = 0". All participants were then classified into 4 groups accordingly: TMD-free (0 - 15), having mild TMD (20 - 40), moderate TMD (45 - 65) and severe TMD (70 - 100) [10].

Investigated variables consists of:

- (1) Gender: male or female

- (2) Schoolyear: 6 groups - from 1st to 6th year.

- (3) Diagnosis of TMD based on DC/TMD: TMD and TMD-free

- (4)-(13) Answers of Question 1-10 of the FAI: "Yes", "Sometimes", "No" was equivalent to the score 10, 5, 0 respectively.

- (14) Classification of TMD into 4 groups based on total point of FAI: TMD-free (0 - 15), mild TMD (20 - 40), moderate TMD (45 - 65) and severe TMD (70 - 100).

- (15) Diagnosis of TMD based on FAI: TMD (including 3 group from mild to severe TMD) and TMD-free

- (16) The agreement between DC/TMD and FAI was calculated with Cohen's Kappa. Kappa coefficient (k) values of ≤ 0.40, 0.41 - 0.60, 0.61 - 0.80 and > 0.80 indicated poor, moderate, good and excellent agreement, respectively.

- (17) Receiver operating characteristics (ROC) curves were implemented to calculate the accuracy (area under the curve - AUC) of the FAI for the TMD group. The following AUC classification was applied: attributable to chance (≤ 0.5), low (> 0.5 - 0.7), moderate (> 0.7 - 0.9), and high (> 0.9 - 1.0) levels of accuracy.

- (18) Sensitivity (Sensitivity = True Positive/(True Positive + False Negative)), specificity (specificity = True Negative/(False Positive + True Negative)), PPV (positive predictive value; PPV = True Positive/(True Positive + False Positive)), NPV (negative predictive value; True Negative/(False Negative +

True Negative)).

The collected data were processed and statistically analyzed using SPSS 20.0 software.

Descriptive data were shown in numbers, percentages, mean, and standard deviation. A p-value less than 0.05 is statistically significant.

The accuracy of the FAI questionnaire was assessed using the following metrics: sensitivity, specificity, NPV, PPV, area under the curve (AUC), and Cohen's kappa value. The reliability of the FAI questionnaire was evaluated by calculating its internal consistency using the Cronbach's alpha value.

3. RESULTS

3.1. Study sample characteristicss

Students who did not meet the criteria and have incomplete data were excluded.

This study includes a total of 198 students from the Faculty of Odonto-Stomatology at Hue University of Medicine and Pharmacy, randomly selected from 1st Year to 6th Year with the male: female ratio is 1:2 (based on the actual gender ratio in the Faculty of Ondonto-Stomatology). Specifically, there are 129 females (65.2%) and 69 males (34.8%) in this study.

According to DC/TMD, the prevalence of TMD in the research sample is 33.8% (Table 1). There's no statistical difference between the percentage of patients with TMD between 2 genders ($p > 0.05$).

Table 1. The prevalence of patients with temporomandibular disorders (TMD) between genders.

Diagnosis / Gender	TMD		TMD-free		Total		p-value
	N	%	N	%	N	%	
Male	22	11.1	47	23.7	69	34.8	
Female	45	22.7	84	42.4	129	65.2	p > 0.05
Total	67	33.8	131	66.2	198	100.0	

3.2 Sensitivity and specificity of FAI Questionnaire

Based on FAI, patients diagnosed with TMD can be respectively divided into 3 subgroups: mild, moderate and severe (Table 2). Patients within the Mild TMD group are the most common, accounting for 55.6%. Followed by 27.8% classified into TMD-free group. 15.7% had moderate level while severe level consisted of 1%.

The FAI Questionnaire demonstrated high sensitivity (97.01%) and high NPV (96.36%). Conversely, it exhibited low specificity and PPV (45.46%) (Table 3). The Kappa coefficient, calculated using Cohen's Kappa, was 0.293. The internal consistency of the FAI, assessed using Cronbach's alpha, yielded a value of 0.684.

Analyzing the ROC curve, the evaluated AUC was 0.806 ($p < 0.05$). It was suggested that by increasing the cutoff point to 22.5, the FAI would maintain high sensitivity (89.6%) while improving specificity (57.3%) (Figure 1; Table 4).

Table 2. Prevalence and classification of patients with temporomandibular disorders (TMD) according to FAI

	Patients with TMD				
	TMD-free	Mild	Moderate	Severe	Total
N	55	110	31	2	198
%	27.8	55.6	15.7	1.0	100.0

Table 3. Sensitivity, specificity, positive predicted values and negative predicted values of FAI in accordance with DC/TMD.

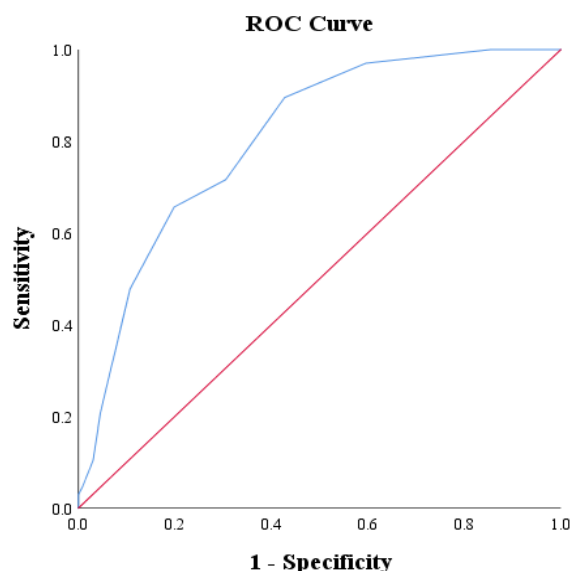| Sensitivity	Specificity	PPV	NPV	Cohen Kappa	Cronbach Alpha
97.01%	40.46%	45.46%	96.36%	0.293	0.684

Figure 1. ROC (receiver operating characteristic) Curve for FAI

Table 4. Sensitivity, specificity and AUC (area under curve) of FAI at the cutoff point of 22.5

Cut-off point	Sensitivity	Specificity	AUC
22.5	89.6%	57.3%	0.806

3.3. Reliability of each items in FAI

The highest mean score difference between TMD and TMD-free group is the 7th Question in the FAI (FQ7 - Have you ever noticed any noise in your temporomandibular joint while chewing or opening your mouth?). The 8th question from FAI (FQ8 - Do you have any habits such as clenching or grinding your teeth?) is the item had the lowest mean difference and the only item with the insignificant mean score difference between TMD and TMD-free ($p > 0.05$) (Table 5).

Executing ROC analysis after eliminating the 8th question, AUC had increased to 0.811 ($p < 0.05$) (Figure 2). Suggested cutoff point for the modified questionnaire is 22.5. At that cutoff point, the sensitivity and specificity of FAI questionnaire is 82.1% and 64.9% respectively (Table 6).

Table 5. Meaning of each FAI question in diagnosing TMD and internal consistency.

Question	Mean score		Mean difference between TMD and TMD-free	Corrected item-total correlation	Internal consistency (Cronbach's alpha) if item deleted
	TMD	TMD-free			
FQ1	1.42	0.23	1.19	0.32	0.67
FQ2	1.49	0.49	1.00	0.32	0.67
FQ3	4.25	2.18	2.07	0.54	0.63
FQ4	4.70	3.24	1.46	0.43	0.64
FQ5	4.40	3.02	1.38	0.33	0.67
FQ6	2.91	1.18	1.73	0.47	0.64
FQ7	4.55	1.45	3.10	0.41	0.65
FQ8*	2.99	2.33	0.66	0.18	0.69
FQ9	4.03	2.37	1.66	0.17	0.70
FQ10	6.57	5.08	1.49	0.42	0.65

Using Mann-Whitney U Test: for FQ8: $p > 0.05$; for others: $p < 0.05$
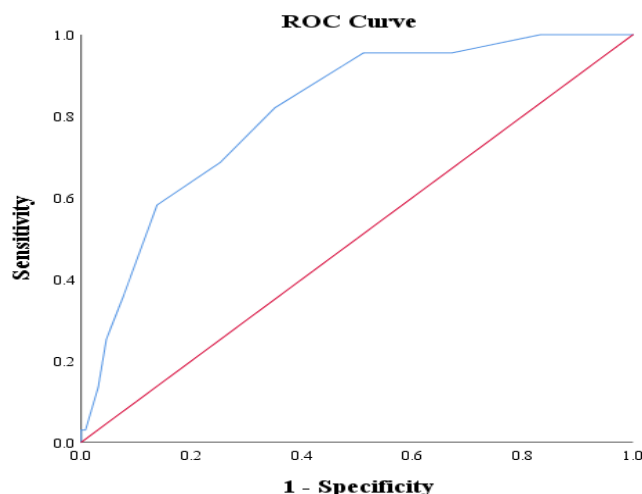
Figure 2. ROC curve after extracting the 8th question.

Table 6. Sensitivity, specificity and AUC of the modified FAI questionnaire (After extracting the 8th question) at the cutoff point of 22.5.

Cut-off point	Sensitivity	Specificity	AUC	Cronbach Alpha
22.5	82.1%	64.9%	0.811	0.692

4.DISCUSSION

4.1. Clinical characteristic of TMD.

The research includes 198 students majoring in Odonto-Stomatology at Hue University of Medicine and Pharmacy, with the sample age range of 18 - 24. The prevalence of students with TMD in the study was 33.8% (Table 1). This result was consistent with the study by Wu J. (2021) and Srivastava K. (2021), which the TMD prevalence were 31.7% [14] and 36.9% [15], respectively. This similarity may be due to the use of the same sample type (university students in the medicine and dentistry field) and the use of DC/TMD as diagnostic instrument. However, the TMD prevalence in the study by Do H. (2012) on medical students at Thai Nguyen University reached 83.8%, with a 100% prevalence of joint noises, possibly due to the use of a stethoscope to detect joint noises, which may lead to false positives [16]. According to the study by author Hoang A. in 2016, also including Odonto-Stomatology students at Hue University of Medicine, the TMD prevalence was very high at 72.6%, possibly because the author's diagnostic criteria included at least one symptoms or signs of TMD, such as joint sounds, jaw fatigue, pain during movement, pain when palpating the joint muscles, and reduction in mouth opening [7].

The study also revealed no significant difference in the TMD prevalence between male and female groups. The findings align with Do H.'s study (2012) on medical students at Thai Nguyen University of Medicine, which showed no gender-related correlation with TMD [16]. Modi P.'s study in 2012 also demonstrated a similar result, concluding that there was no relationship between TMD and gender in medical and dental students in India [17].

4.2. Evaluation of the FAI Questionnaire's accuracy and reliability in diagnosing TMD

Regarding the questionnaire's accuracy, the FAI exhibited high sensitivity (97.01%) and high NPV (96.36%), making it suitable for screening TMD patients (Table 3). However, its specificity was low (40.46%), rendering it less effective in identifying patients without TMD. This finding aligns with Stasiak G.'s study (2020), which used the RDC/TMD as the diagnostic instrument and reported that sensitivity and specificity of the FAI were 97.21% and 26%, respectively [18]. Therefore, the FAI questionnaire could be utilized as an initial screening tool in the diagnostic model for TMD. Conversely, Zhang M.'s study (2019), involving 613 TMD patients diagnosed using DC/TMD and 57 patients without TMD, found that the Chinese version of the FAI questionnaire had higher accuracy, with sensitivity at 95.9% and specificity at 71.9% [12]. This discrepancy may be attributed to the characteristics of the sample, specifically the larger number of TMD patients (613) compared to the control group (57).

The Kappa's coefficient value indicated

agreement between the FAI and DC/TMD was poor (k = 0.293), likely due to its incapability to exclude individual from TMD-free group. Therefore, the FAI lacks sufficient accuracy to diagnose patients with TMD. In Zhang M.'s study in 2020, the Chinese version of the FAI had a higher agreement with DC/TMD (k = 0.633) [12]. This difference was also due to the variation in sample size.

Evaluating the internal consistency of the FAI questionnaire, the Cronbach Alpha value was 0.684, which was close to the critical value of 0.7. This result aligned with one of Zhang M's findings, reporting that the reliability of the FAI in Chinese was 0.67, and Campos's study, which found an optimal reliability of the modified FAI (Cronbach Alpha value was 0.704), after deleting the questions 4, 5, 8, 9 and 10 [12,19]. However, in a study on the validation of the Turkish version of the FAI conducted by Kaynak, the Cronbach's Alpha suggested a higher value of 0.805. [20] This difference can be explained by different sample characteristic (age, occupation) and study method, wherein the results of all the participants were taken from the second questionnaire filling.

Currently, various tools are available for screening TMD patients, but the FAI remains widely used and popular due to its high sensitivity [14,15,17]. The sensitivity of the FAI in this study (97.01%) is higher than that of the Screening Questionnaire for Temporomandibular Disorder (81.6%) in Nishiyama A.'s 2014 study [21] and the 3Q questionnaire in Lövgren A.'s 2016 study (80.6%) [22].

4.3. Enhancing the Clinical Value of the FAI Questionnaire

The ROC curve analysis yielded an optimal cutoff point of 22.5 (Table 4). At this cutoff point, sensitivity remained high (89.6%), and specificity significantly increased (57.3%). Although the specificity was still relatively low, the cutoff point of 22.5 enabled the FAI to achieve the highest possible accuracy and reliability in diagnosing TMD. This suggested cutoff point is similar to the findings of Yap A. in 2021, who recommended a cutoff point of 22.5, with sensitivity and specificity of 94.5% and 87.7%, respectively [23]. The higher specificity might be due to differences in sample selection, as Yap A.'s study included patients who visited Peking University Hospital of Stomatology over an 18-month period, divided into TMD patients (with at least one DC/TMD Axis I diagnosis) and control groups (no DC/TMD diagnosis). At this cutoff, the effectiveness of the FAI in diagnosing TMD was moderate (AUC=0.806) (Table 4).

Within this specific sample, regarding the accuracy and reliability of each individual questions, FQ8 showed the least statistical significance between the TMD and TMD-free groups; FQ8 and FQ9 are the two items that had a correlation below recommended minimum of 0.2 (0.18 and 0.17, respectively) (Table 5). Therefore, FAI could be modified to both have higher accuracy and reliability by excluding FQ8 (AUC = 0.811; Cronbach Alpha value = 0.692). The optimal cutoff point remained at 22.5, the sensitivity and specificity of the modified version were 82.1% and 64.9%, respectively (Table 6). This modification aligned with studies on the short form of FAI, which also suggested that the 8th question should be excluded [19, 24].

5. CONCLUSION

Temporomandibular Disorders (TMD) are a common issue not only worldwide but also within the university environment. There is no difference in TMD prevalence between genders in this study. To diagnose TMD, the Fonseca Anamnestic Index (FAI) is a useful tool for initial screening of patients with symptoms related to TMD. However, a second diagnostic step is still necessary to confirm whether patients truly have TMD. Within this study sample, the possible adjustments to enhance the practical application of the FAI could be increasing the cutoff point to 22.5 and eliminating the 8th question.

This study chose a convenient cross-sectional sample, which has limitations in terms of sample size. To enhance the study's value, future research should be conducted on patients visiting hospitals with TMD-related issues, with a larger sample size. Ultimately, the FAI should still be encouraged for use by clinical practitioners as an initial screening tool for patients with TMD symptoms, thereby reducing the time needed for diagnosis based on the DC/TMD protocol.

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APPENDIX

Fonseca Amnestic Index (FAI) in English and Vietnamese.

Questions/Câu hỏi	Yes/Có	Sometimes/ Đôi khi	No/Không
1. Do you have difficulty opening your mouth wide? Bạn có gặp khó khăn khi há miệng không?			
2. Do you have difficulty moving your jaw to the sides? Bạn có gặp khó khăn khi đưa hàm sang hai bên không?			
3. Do you feel fatigue or muscle pain when you chew? Bạn có thấy mỏi hay đau cơ khi nhai không?			

4. Do you have frequent headaches? Bạn có thường xuyên đau đầu không?
5. Do you have neck pain or stiffness? Bạn có đau ở gáy hay cứng cổ không?
6. Do you have earaches or pain in that area (temporomandibular joint)? Bạn có đau ở tai hay ở khớp thái dương hàm (vị trí trước tai) không?
7. Have you ever noticed any noise in your temporomandibular joint while chewing or opening your mouth? Bạn có thấy tiếng kêu nào ở khớp thái dương hàm khi nhai hay khi há miệng không?
8. Do you have any habits such as clenching or grinding your teeth? Bạn có thói quen cắn chặt hay nghiến răng không?
9. Do you feel that your teeth do not come together? Bạn có cảm thấy các răng không ăn khớp tốt với nhau?
10. Do you consider yourself a tense (nervous) person? Bạn có cho rằng bản thân là một người hay lo lắng (hồi hộp) không?