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CLINICAL RESEARCH

Diagnostic accuracy of the short-form Fonseca Anamnestic Index in relation to the Diagnostic Criteria for Temporomandibular Disorders

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ABSTRACT

Statement of problem. Screening for temporomandibular disorders (TMDs) is important in research and clinical practice. The short-form Fonseca Anamnestic Index (SFAI) was recently introduced but had only been validated for muscle disorders.

Purpose. The purpose of this clinical study was to determine the diagnostic accuracy of the SFAI and its discrete and pooled items in relation to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) benchmark.

Material and methods. A total of 866 consecutive participants with TMDs and 57 TMD-free controls (aged ≥18 years) were recruited. The participants (n=923; mean age 32.8 ±13.3 years; women 79.2%) answered the FAI, and TMD diagnoses were derived based on the DC/TMD protocol and algorithms. The 5-item SFAI, which comprised 2 pain-related and 3 function-related TMD questions, was subsequently acquired and assessed with reference to the DC/TMD diagnoses. The receiver operating characteristics (ROC) was used to verify accuracy (area under the curve [AUC]) and the best cutoff points. Sensitivity, specificity, predictive values, and likelihood ratios were also examined.

Results. Pain-related (PT) and intra-articular (IT) TMDs were present in 48.3% (446/923) and 82.7% (763/923) of the participants, respectively. The SFAI demonstrated high accuracy for identifying all TMDs, PT, and IT (AUC of 0.97, 0.99, and 0.97, respectively). The best cutoff points were 12.5 for all TMDs/IT and 17.5 for PT. Sensitivity of the SFAI ranged from 90.7% to 97.5% while specificity varied from 93.0% to 96.5%, with the highest values for PT. As positive predictive values (99.4% to 99.5%) were greater than negative ones (41.7% to 83.3%), the SFAI was better at detecting the presence than the absence of TMDs. With reference to PT, the sensitivity, and specificity of the 2 discrete and pooled pain-related questions (questions 3 and 4), extended from 82.3% to 99.3% and 77.2% to 96.5% respectively. With regard to IT diagnoses, sensitivity and specificity ranged from 56.0% to 98.3% and 86.0% to 98.3% for the 3 discrete and pooled function-related items (questions 1, 2, and 5).

Conclusions. The SFAI presented high degrees of diagnostic accuracy in relation to the DC/TMD and can be used for screening TMDs. SFAI scores between 15 and 50 points should be used to identify the presence of TMDs, with scores ≥20 points specifying possible pain-related TMDs. (J Prosthet Dent 2022;128:977-83)

Temporomandibular disorders (TMDs) are a cluster of medical and dental problems relating to pain and dysfunction of the masticatory muscles and temporomandibular joints (TMJs). Signs and symptoms of TMDs include regional pain in the face and peri-auricular area, TMJ sounds, as well as jaw movement difficulties and limitations.[1] TMDs affect up to 15% of adults with women presenting a 2 times greater risk.[1,2] TMD symptoms usually peak in middle age when prosthetic treatment and rehabilitation are often sought.[3] The multifactorial etiology of TMDs is consistent with a biopsychosocial model of illness and up to 76.6% of persons with TMDs have moderate-to-severe somatization and 60.1% have depression.[4,5] Considering

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Clinical Implications

The SFAI is a straightforward and accurate instrument for screening TMDs in research and clinical settings. When SFAI scores are ≥15, further diagnostic procedures for pain-related and/or intra-articular TMDs should be performed.

their "delicate psychophysiological equilibrium," patients with TMDs may be more hypervigilant and less adaptive to irreversible esthetic and occlusal changes.[6] As TMDs are frequently involved in dental malpractice cases and as medico-legal claims for TMD damage have escalated in recent years,[7] it is prudent that all individuals be screened for TMDs before initiating prosthetic therapy.[7,8]

The dual-axis Research Diagnostic Criteria for TMDs (RDC/TMD) was considered the diagnostic standard for TMDs for more than 2 decades.[9] The current benchmark for TMD assessment and diagnoses is the Diagnostic Criteria for TMDs (DC/TMD).[10] Based on the DC/TMD, common types of TMD conditions can be categorized into pain-related and intra-articular joint disorders. Although the DC/TMD is reliable and valid,[11] its routine use for clinical TMD triage is not practical given its time-consuming assessment protocol and complex algorithms. TMD screening tools must be economical, straightforward, efficient, and accurate. Contemporary TMD screening tools that offer a definite identification of TMDs include the TMD pain screener (TPS), the 3Q/TMD (3QT), and the Fonseca Anamnestic Index (FAI).[12,13] The TPS comprises 6 items focused on painful TMDs and is part of the DC/TMD repertoire. The 3QT consists of 3 items specifying the presence of pain-related and intra-articular TMDs. When related to the DC/TMD, only 74% of 3Q-positives and 16% of 3Q-negatives fulfilled the criteria for pain-related and intra-articular TMDs.[13] The FAI is probably the most popular among the 3 TMD screening tools and describes both the presence and severity of TMDs. It is based on the Helkimo index[14] and involves 10 items (Table 1) assessing pain-related (headaches, jaw joint, muscle, and neck pain) and function-related (jaw joint sounds, jaw opening, and side-movement difficulties) TMD symptoms, as well as TMD risk factors (teeth clenching or grinding, malocclusion, and emotional stress).

The FAI presented results consistent with those of other instruments for detecting TMDs, including the American Association of Orofacial Pain (AAOP) questionnaire, and had been evaluated against both the RDC/TMD and DC/TMD.[15-17] The reliability and validity of the FAI are well established,[16-18] and it has been widely used in both population and patient samples.[19-24] The dimensionality and psychometric properties of the FAI were recently investigated.[25] Multidimensionality was observed with a primary dimension consisting of 5 reliable items, specifically questions 1, 2, 3, 6, and 7, with adequate fit to the Rasch model for RDC/TMD defined muscle disorders (Table 1).[25] The short-form FAI (SFAI) originated from this work and offered excellent reliability for all 5 TMD-specific items, as well as the entire instrument. Moreover, it also exhibited a high level of accuracy for diagnosing muscle disorders in women, with a cutoff score of 17.5 points.[26] Considering the fluctuating nature of TMD symptoms,[27] the SFAI presents several advantages over the FAI for epidemiological studies and clinical triage. Besides being shorter and faster to administer, it may also limit overestimation of the prevalence or presence of TMDs by excluding non-TMD specific items and risk factors.[28]

To date, the accuracy of the SFAI has not been examined in relation to the DC/TMD standard or validated for intra-articular joint disorders or in men. The objectives of this study were to determine the diagnostic accuracy and best cutoff points of the SFAI for detecting pain-related and/or intra-articular TMDs based on the DC/TMD. More specifically, the sensitivity, specificity, predictive values, and likelihood ratios of the SFAI were established. Furthermore, the discrete and pooled items accuracy of the SFAI was also ascertained for TMD pain and dysfunction. The null hypotheses were that the SFAI is not accurate when compared with the DC/TMD standard and that the SFAI discrete and pooled items are unable to identify participants with and without pain-related or intra-articular joint disorders.

MATERIAL AND METHODS

This study was authorized by the Biomedical Institution Review Committee of Peking University School of Stomatology (PKUSSIRB-201732009). The minimum sample size (n=280) was determined a priori by using a software program (G*Power v3.1.9.3; Heinrich-Heine-Universität Düsseldorf)[29] based on an ANOVA test with a medium effect size of 0.25, alpha error 0.05, and power of 95% for 4 TMD groups. Consecutive adults (≥18 years) with TMD and TMD-free controls attending the Peking University Hospital of Stomatology were recruited over 18 months. Study information was provided and informed consent was obtained from all study participants. Participants with previous TMJ trauma and surgical interventions, major psychiatric disorders, uncontrolled autoimmune or metabolic diseases, other masticatory system diseases, and cognitive impairment and illiteracy were excluded. Demographic data were gathered, and the Chinese language version of the FAI[17] was administered to all participants before their clinical interviews. The items were scored on a 3-point response scale (with no=0 point, sometimes=5 points, and yes=10 points) and questions 4,

Table 1. Fonseca Anamnestic Index (FAI) and short-form FAI (SFAI) items

FAI	SFAI	Questions
Q1	Q1	Do you have difficulty opening your mouth wide?
Q2	Q2	Do you have difficulty moving your jaw to the sides?
Q3	Q3	Do you feel fatigue or muscle pain when you chew?
Q4*	–	Do you have frequent headaches?
Q5*	–	Do you have neck pain or stiffness?
Q6	Q4	Do you have ear aches or pain in that area (temporomandibular joint)?
Q7	Q5	Have you ever noticed any noise in your temporomandibular joint while chewing or opening your mouth?
Q8*	–	Do you have any habits such as clenching or grinding your teeth?
Q9*	–	Do you feel that your teeth do not come together?
Q10*	–	Do you consider yourself a tense (nervous) person?

Q, question. Questions 4*, 5*, 8*, 9*, and 10* are excluded for SFAI.

Table 2. Distribution of DC/TMD diagnostic categories and subtypes (n=923)

Diagnostic Category	TMD Subtypes	Number (%)
No TMDs (control)	Not applicable	57 (6.2)
Pain-related TMDs	Myalgia	104 (11.3)
	Arthralgia	385 (41.7)
	Headache attributed to TMDs	10 (1.1)
	Any pain-related disorders	446 (48.3)
Intra-articular TMDs	DD with reduction	192 (20.8)
	DD with reduction with intermittent locking	64 (6.9)
	DD without reduction with limited opening	166 (18.0)
	DD without reduction without limited opening	183 (19.8)
	Degenerative joint disease	329 (35.6)
	TMJ subluxation	2 (0.2)
	Any intra-articular disorders	763 (82.7)

DC/TMD, Diagnostic Criteria for Temporomandibular Disorders; DD, disc placement; TMDs, temporomandibular disorders.

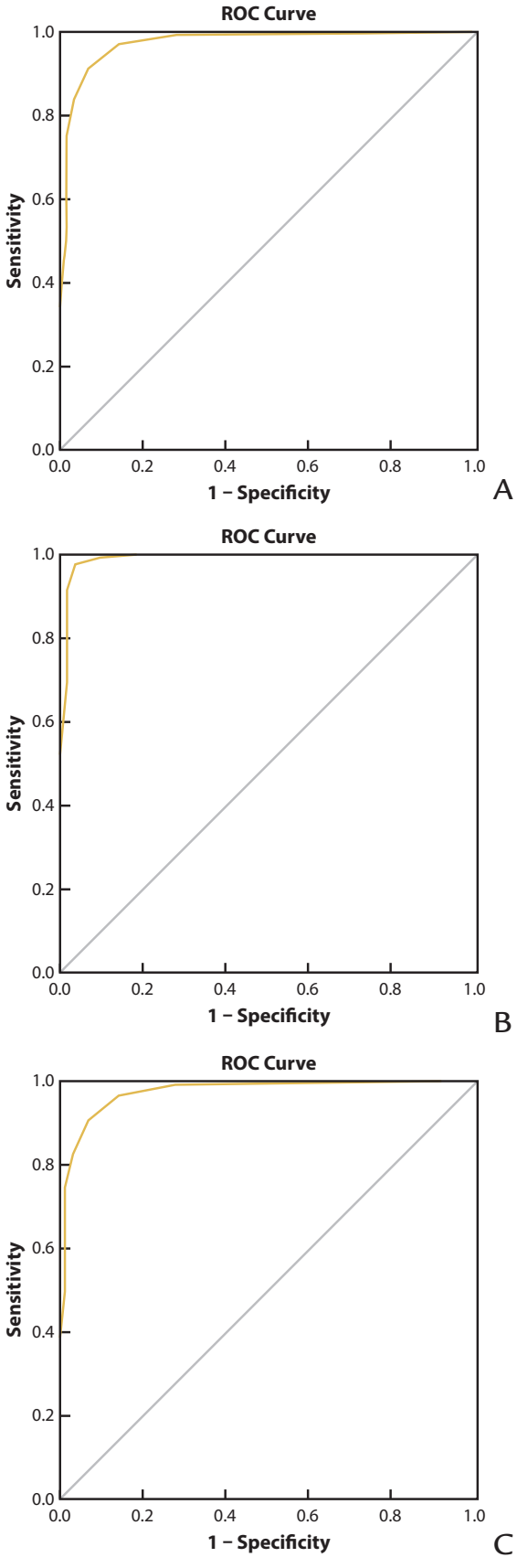
5, 8, 9, and 10 were excluded (Table 1). The SFAI scores were then determined by totaling the points for the 5 TMD-specific items.[26]

Medical, dental, and TMD histories including the Chinese DC/TMD symptom questionnaire were collected during the clinical interviews. TMD clinical examinations were performed according to the DC/TMD protocol by a single investigator (F.K.Y.) who had been trained and calibrated in the DC/TMD. TMD diagnoses were subsequently derived based on the DC/TMD diagnostic tree and algorithms.[10] The DC/TMD diagnoses were classified into pain-related (PT) and intra-articular (IT) TMDs and used as the reference to compare with the SFAI.

Statistical analyses were performed with a statistical software program (IBM SPSS Statistics for Windows v24.0; IBM Corp) (α=.05). Probability-probability (P-P) plots were used to establish data distribution. Qualitative and quantitative data were displayed as frequencies with percentages and means with standard deviations as data were normally distributed. Independent samples *t* test and 1-way ANOVA with the Tukey post hoc test were used to examine differences in SFAI scores between the control and all TMD groups and among the 4 TMD cohorts, namely no TMDs, PT only, IT only, combined TMDs (CT) groups. The receiver operating characteristics (ROC) curve was used to verify the accuracy (area under the curve [AUC]) of the SFAI. Values used for the AUC classification were as follows: due to chance ($\leq$0.5), low (>0.5 to 0.7), moderate (>0.7 to 0.9), and high (>0.9 to 1.0) levels of accuracy.[30] The best cutoff points were determined according to the lowest value obtained with the equation: $(1 - \text{sensitivity})^2 + (1 - \text{specificity})^2$. The sensitivity (ability of the test to correctly identify participants with TMDs, calculated by true positives/[true positives + false negatives]) and the specificity (ability of the test to correctly identify participants without TMDs, calculated by true negatives/[true negatives + false positives]) of the SFAI were established.[31,32] In addition, the following measures were computed: positive predictive values (ability of the test to detect TMDs, calculated by true-positives/[true-positives + false-positives]), negative predictive values (ability of the test to detect the absence of TMDs, calculated by true-negatives/[true-negatives + false-negatives]), positive likelihood ratios (change in odds of having a diagnosis in participants with a positive test, calculated with the equation: sensitivity/[1–specificity]), and negative likelihood ratios (change in odds of having a diagnosis in participants with a negative test, calculated with the equation: [1–sensitivity]/specificity).[31-33] High positive and low negative likelihood ratio values indicate better index validity. The same measures were also examined for discrete and pooled items (at least one or more positive responses) of the SFAI.

RESULTS

Of 1015 participants with TMDs, 88 met the exclusion criteria and 61 declined to participate. The total study sample (n=923) consisted of 866 TMD and 57 TMD-free participants with a mean ±standard deviation age of 32.8 ±13.3 years. Women constituted 79.2% of the study participants. Frequency distributions of the various DC/TMD diagnostic categories and subtypes are displayed in Table 2. Overall, 48.3% qualified for "any pain-related" disorders (PT) and 82.7% qualified for "any intra-articular" disorders (IT). The most common PT and IT subtypes were arthralgia (44.5%) and TMJ disc displacements (69.9%). Table 3 shows the mean age, sex distribution, and mean SFAI scores for the control (no TMDs), all TMDs, PT only, IT only, and CT groups. Participants with TMDs were more frequently female and older. Those with painful TMDs (PT and CT groups) were significantly older than their counterparts with IT only. Significant differences in mean SFAI scores were



observed between the control and all TMD groups ($P<.001$). Ranking of mean SFAI scores was CT > PT only > IT only > no TMDs with statistically significant differences among the 4 groups ($P<.001$).

The area under the ROC curves (Fig. 1), best cutoff points, sensitivity, specificity, predictive values, and likelihood ratios of the SFAI are presented in Table 4. The SFAI demonstrated high accuracy for identifying all TMDs (AUC=0.97; 95% CI=0.95 to 1.00), PT (AUC=0.99; 95% CI=0.98 to 1.00), and IT (AUC=0.97; 95% CI=0.95 to 0.99). For all TMDs, the best SFAI cutoff point was 12.5. The sensitivity of the SFAI for all TMDs was 91.5%, while specificity was 93.0%. Positive predictive value (PPV) for the SFAI was high (99.5%), but the negative predictive value (NPV) was relatively lower (41.7%). The positive likelihood ratio (PLR) for all TMDs was 13.03 and negative likelihood ratio (NLR) was 0.09. For PT, the best cutoff point was 17.5 with sensitivity and specificity of 97.5% and 96.5%, respectively. Trends for PPV (99.5%), NPV (83.3%), PLR (27.80), and NLR (0.03) were largely similar to those for all TMDs. The best SFAI cutoff point for IT was 12.5. The sensitivity and specificity for IT were 90.7% and 93.0%. Trends for PPV (99.4%), NPV (42.7%), PLR (12.92), and NLR (0.10) were similar to those for PT, but values for most measures were about 2- to 3-fold smaller aside from PPV.

Table 5 reflects the frequencies of positive responses, sensitivity, specificity, PPV, NPV, PLR, and NLR for discrete and pooled pain and function-related items of the SFAI. With reference to PT diagnoses, sensitivity ranged from 86.3% to 95.3% and specificity from 79.0% to 94.7% for the 2 discrete pain-related questions (questions 3 and 4). While PPV and NPV varied from 97.3% to 99.2% and 47.0% to 68.2%, PLR and NLR fluctuated from 4.53 to 16.40, and 0.06 to 0.14 respectively. When questions 3 and 4 were combined and related to PT, the sensitivity ranged from 82.3% to 99.3%, and the specificity from 77.2% to 96.5%. PPV and NPV varied from 97.2% to 99.5% and 41.0% to 93.6%, while PLR and NLR ranged from 4.36 to 23.45, and 0.01 to 0.18 respectively.

With regards to IT diagnoses, sensitivity and specificity varied from 61.7% to 92.4% and 91.2% to 96.5% for the 3 discrete function-related questions (questions 1, 2, and 5). PPV and NPV ranged from 99.3% to 99.6%, and 15.9% to 47.3%, whereas PLR and NLR varied from 10.53 to 17.59, and 0.08 to 0.40 respectively. When questions 1, 2, and 5 were pooled and related to IT, the sensitivity fluctuated from 56.0% to 98.3%, and the specificity from 86.0% to 98.3%. PPV and NPV ranged

Figure 1. Receiver operating characteristic (ROC) curves. A, For all TMDs. B, For pain-related TMDs. C, For intra-articular TMDs. TMDs, temporomandibular disorders.

Table 3. Mean ±standard deviation SFAI scores for control and TMD groups

Groups	Mean ±SD Age	*P*	Total n ±%	Women n ±%	Men n ±%	Mean ±SD SFAI Scores	*P*
Control	25.9 ±4.0^{A}	<.001*	57 ±6.2	30 ±52.6	27 ±47.4	2.9 ±6.3A	<.001*
All TMDs	33.2 ±13.6^{B}		866 ±93.8	701 ±81.0	165 ±19.1	31.4 ±12.2B	
No TMDs	25.9 ±4.0^{a}	<.001**	57 ±6.2	30 ±52.6	27 ±47.4	2.9 ±6.3a	<.001**
Pain-related TMDs only	42.4 ±15.9^{b}		103 ±11.2	73 ±70.9	30 ±29.1	33.4 ±10.7c	
Intra-articular TMDs only	29.4 ±10.7^{a}		420 ±45.5	329 ±78.3	91 ±21.7	25.3 ±11.8b	
Combined pain-related and intra-articular TMDs	35.2 ±14.3^{c}		343 ±37.2	299 ±87.2	44 ±12.8	38.3 ±8.9d	

Results of independent samples *t* test* and 1-way ANOVA with Tukey post hoc test** ($P<.05$). Different letters indicate statistically significant differences between groups ($P<.05$). SD, standard deviation; SFAI, short-form Fonseca Anamnestic Index; TMDs, temporomandibular disorders.

Table 4. Area under ROC curve, best cutoff points, sensitivity, specificity, predictive values, and likelihood ratios of SFAI

Area (95% CI)	Cutoff Point	Sensitivity	Specificity	Positive PV	Negative PV	Positive LR	Negative LR
All TMDs							
0.97 (0.95-1.00)	12.5	91.5%	93.0%	99.5%	41.7%	13.03	0.09
Pain-related TMDs							
0.99 (0.98-1.00)	17.5	97.5%	96.5%	99.5%	83.3%	27.80	0.03
Intra-articular TMDs							
0.97 (0.95-0.99)	12.5	90.7%	93.0%	99.4%	42.7%	12.92	0.10

LR, likelihood ratio; PV, predictive value; ROC, receiver operating characteristics; SFAI, short-form Fonseca Anamnestic Index; TMDs, temporomandibular disorders.

Table 5. Frequencies, sensitivity, specificity, predictive values, and likelihood ratios, for Q3 and Q4 in relation to pain-related TMDs as well as for Q1, Q2, and Q5 in relation to intra-articular TMDs

SFAI	Frequency n (%)	Sensitivity	Specificity	Positive PV	Negative PV	Positive LR	Negative LR
Pain-related TMDs							
Q3	437 (86.9)	95.3%	79.0%	97.3%	68.2%	4.53	0.06
Q4	388 (77.1)	86.3%	94.7%	99.2%	47.0%	16.40	0.14
Q3 or 4	456 (90.7)	99.3%	77.2%	97.2%	93.6%	4.36	0.01
Q3 and 4	369 (73.4)	82.3%	96.5%	99.5%	41.0%	23.45	0.18
Intra-articular TMDs							
Q1	647 (78.9)	84.3%	93.0%	99.4%	30.6%	12.01	0.17
Q2	473 (57.7)	61.7%	96.5%	99.6%	15.9%	17.59	0.40
Q5	710 (86.6)	92.4%	91.2%	99.3%	47.3%	10.53	0.08
Q1 or 2 or 5	758 (92.4)	98.3%	86.0%	98.9%	79.0%	7.00	0.02
Q1 and 2	461 (56.2)	60.2%	96.5%	99.6%	15.3%	17.14	0.02
Q1 and 5	599 (73.1)	78.4%	98.3%	99.8%	25.3%	44.67	0.22
Q2 and 5	440 (53.7)	57.5%	98.3%	99.8%	14.7%	32.80	0.43
Q1, 2 and 5	428 (52.2)	56.0%	98.3%	99.8%	14.3%	31.90	0.45

LR, likelihood ratio; PV, predictive value; Q, question; TMDs, temporomandibular disorders.

from 98.9% to 99.8% and 14.3% to 79.0%, while PLR and NLR stretched from 7.00 to 44.67, and 0.02 to 0.45 respectively.

DISCUSSION

The present study established the diagnostic accuracy and best cutoff points of the SFAI for identifying pain-related and intra-articular TMDs with reference to the DC/TMD. Discrete and pooled items accuracy of the SFAI was also examined. The SFAI was selected for evaluation over the 2 other screeners because of its proficiency for screening pain and function-related TMDs. Compared with earlier SFAI accuracy studies,[10,11] the present work involved both sexes, a large sample size, and was referenced to the DC/TMD. As the accuracy of the SFAI was high, the first null hypothesis was rejected. As the sensitivity of the discrete and pooled items for identifying PT and IT varied from low to high and specificity was moderate to high, the second null hypothesis was partially accepted. The age and sex distribution of the participants with TMDs were consistent with that of prior studies.[2,3] Based on the RDC/TMD, Manfredini et al[34] reported prevalences of 45.3% muscle disorders, 41.1% disc displacements, and 30.1% joint disorders among TMD patients. In the present Chinese TMD sample, muscle disorders were present in only 12%. The prevalence of disc displacements was relatively higher (69.9%) than TMJ arthralgia (44.5%) and degenerative joint

diseases (38.0%). The variance in the frequency of TMD subtypes may be contributed to by differences in referral settings, race, ethnicity, and diagnostic criteria used.

Significant differences in mean SFAI scores were observed between the control and all TMDs groups, as well as among the 4 TMD groups. The CT group had higher scores than the PT group, which in turn exhibited greater scores than the IT group. The TMD-free participants presented lower scores compared with the PT and IT groups. The higher SFAI scores for the CT and PT groups may be because of functional limitations associated with pain-related TMDs. The best cutoff points for SFAI were 12.5 for all TMDs, as well as IT, and 17.5 for PT. When considering its 5-point intervals, the recommended SFAI scores were thus 0 to 10 for no TMDs, 15 to 50 for identifying all TMDs/IT, and 20 to 50 for distinguishing PT. The latter corroborated the conclusion of Pires et al[26] that specified 20 to 50 points for detecting muscle disorders based on the RDC/TMD. Collectively, the studies indicate that SFAI scores of 15 to 50 should be used to screen for the presence of TMDs with scores $\geq$20 points stipulating the prospect of pain-related TMDs.

The SFAI exhibited high levels of accuracy with reference to the DC/TMD. Sensitivity for all TMDs, PT, and IT ranged from 90.7% to 97.5% while specificity varied from 93.0% to 96.5%. The highest sensitivity and specificity were associated with the correct classification of pain-related TMDs. These values were comparable with those of the TPS.[12] Given its high sensitivity and specificity, the SFAI is useful for both excluding and including TMDs.[32] This is uncommon for most diagnostic and screening tests, as sensitivity is usually inversely proportional to specificity.[31,32]

Positive and negative predictive values describe a participant's probability of a disease once the result of the diagnostic test is known.[32] While PPVs were high for all TMDs, PT, and IT (99.4% to 99.5%), NPVs were low to moderate (41.7% to 83.3%). The highest NPVs were noted for PT. This all indicates that the SFAI is more proficient in detecting the presence than the absence of TMDs. Unlike sensitivity and specificity, predictive values are also influenced by the prevalence of the conditions.[32] Low disease prevalence is associated with low PPV even when a test with high sensitivity and specificity is applied.[32] Similarly, the relatively lower number of controls could have contributed to the lower NPVs observed. The present work could be extended to the general population to better verify the NPVs of the SFAI. The sensitivity and specificity of the SFAI cannot be used to estimate the probability of TMDs in individual participants. However, they can be combined to derive the likelihood ratio, which summarizes how many times more (or less) likely participants with TMDs are to have a particular test result than those without TMDs.[33] Two types of likelihood ratios exist, namely PLR or NLR. When PLR is >10 or NPR is <0.1, the prospect of detecting or excluding TMD is increased considerably. PLRs of the SFAI ranged from 12.92 to 27.80 for all TMDs, PT, and IT, indicating that participants with TMDs are 13 to 28 times more likely to have a positive test than those who have no TMDs. The lowest and highest PLRs were for IT and PT respectively, alluding to the higher odds of having painful TMDs in participants with a positive test. NLRs varied from 0.03 to 0.10 for all TMDs, PT, and IT. This means that the chances of having a negative test for participants with TMDs are at most only 0.10 times or one-tenth those of participants without TMDs.

The sensitivity as well as specificity of discrete and pooled items of the SFAI fluctuated somewhat as with predictive values and likelihood ratios (Table 5). For pain-related TMDs, the highest sensitivity (99.3%) was noted with questions 3 or 4 (muscle or joint pain), and the highest specificity (96.5%) with questions 3 and 4 (muscle plus joint pain). Regarding intra-articular disorders, the highest sensitivity (98.3%) was observed with questions 1, 2, or 5, and the highest specificity (98.3%) with the groupings of questions 1 and 5, 2 and 5, and 1, 2, and 5. Considering the much higher PPVs when compared with NPVs, the discrete and pooled items of the SFAI are better at identifying the presence of PT and/or IT than their absence. Similarly, PLRs were high while NLRs were low, indicating good index validity. The poorer outcomes with questions 1, 2, and 4 may be contributed to by the association between TMJ dysfunction and pain, more specifically TMJ disc displacements without reduction and TMJ osteoarthritis.[35]

The SFAI is merely intended as a screening tool for TMDs. When testing is positive, comprehensive history taking and examination must still be performed to diagnose possible TMDs based on protocolized diagnostic standards. As the study was conducted in a tertiary dental hospital, those recruited with TMD may have been more complex and advanced than those encountered in general dental practice, heightening the sensitivity of the SFAI. The research could be extended to the general population to confirm the usefulness of the SFAI in community settings. This will also address the relatively small number of TMD-free controls in the present study.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. SFAI scores of 0 to 10 signified the absence of TMDs, while scores of 15 to 50 indicated TMD presence, with scores $\geq$20 specifying possible pain-related TMDs.
2. The SFAI presented high diagnostic accuracy, as well as high sensitivity and specificity in relation to the DC/TMD.
3. The SFAI is better at detecting TMD presence than its absence.

4. Participants with TMDs were 13 to 28 times more likely to have a positive test than the TMD-free ones.
5. Participants who test positive with SFAI require a comprehensive TMD history taking and examination based on the DC/TMD or other protocolized diagnostic standards.

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