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VALIDITY AND RELIABILITY OF THE HELKIMO CLINICAL DYSFUNCTION INDEX FOR THE DIAGNOSIS OF TEMPOROMANDIBULAR DISORDERS

ABSTRACT

Purpose: The Helkimo Clinical Dysfunction Index (HCDI) is a brief and easy-to-use assessment tool designed to evaluate individuals with temporomandibular disorders (TMDs). The evaluation assesses muscle strength, joint function, mobility, pain, and musculature to give a rapid overall review for various levels of treatment. Because of this, the research aimed to verify the HCDI's use in a group of TMD patients.

Methods: There were 88 participants, 44 of whom had TMD. The other 44 participants were healthy. Inter-rater concordance, predictive scores, and concurrent validity were all assessed in the study.

Results: The analysis of the receiver operating characteristic curve identified an optimal cut-off point of more than 1 point in the HCDI score that manifested a sensitivity of 81.17% alongside a specificity of 72.43% for diagnosing TMDs, thus establishing the DC/TMD protocol as the benchmark.

Conclusion: This analytical process demonstrated an area under the curve of 0.90, indicative of commendable precision.

Keywords: Helkimo, Reliability, Validity, Temporomandibular dysfunction

TEMPOROMANDİBULAR BOZUKLUKLARIN TEŞHİSİNDE HELKİMO KLİNİK DİSFONKSİYON İNDEKSİNİN GEÇERLİLİĞİ VE GÜVENİRLİĞİ

ÖZ

Amaç: Helkimo Klinik Disfonksiyon İndeksi (HCDI), temporomandibular bozukluğu (TMD) olan bireyleri değerlendirmek için tasarlanmış kısa, kullanımı kolay bir değerlendirme aracıdır. Değerlendirme, çeşitli tedavi seviyeleri için hızlı bir genel değerlendirme sağlamak amacıyla kas gücü, eklem fonksiyonu, hareketlilik, ağrı ve kas sistemini değerlendirir. Bu nedenle, araştırma HCDI'nin TMD hastasında kullanımını doğrulamayı amaçlamıştır.

Yöntem: Çalışmaya 44'ünde TMD olan 88 katılımcı dahil edildi. Diğer 44 katılımcı ise sağlıklıydı. Çalışmada değerlendiriciler arası uyum, öngörücü skorlar ve eşzamanlı geçerlilik değerlendirilmiştir.

Bulgular: Alıcı işletim karakteristik eğrisinin analizi, TMD'lerin teşhisi için %72,43 özgüllüğün yanı sıra %81,17'lik bir duyarlılık gösteren HCDI skorunda 1 puandan fazla optimal bir kesme noktası belirlenerek DC/TMD protokolünü ölçüt olarak bulundu.

Sonuç: Bu analitik süreç, yüksek bir hassasiyetin göstergesi olan 0,90'lık bir eğri altındaki alanı göstermiştir.

Anahtar Kelimeler: Helkimo, Güvenirlik, Geçerlilik, Temporomandibular disfonksiyon

INTRODUCTION

Temporomandibular disorders (TMDs) affect the temporomandibular joint (TMJ), masticatory muscles, and associated structures (1). The three main symptoms of TMDs are pain in the muscles and TMJ, abnormal jaw movements, and joint sounds (2). There are three joints in the TMJ: bilateral, diarthrodial, and temporomandibular. Each joint has an associated articular eminence, glenoid fossa, and mandibular condyle. The TMJ and the surrounding tissues are crucial for controlling mandibular movement and relieving the strain of routine tasks (including eating, swallowing, and speaking). The degenerative musculoskeletal system of TMJ disorders is linked to morphological and functional abnormalities. Common TMDs include intraarticular discal position, anatomical anomalies, and dysfunction of the associated musculature (3,4).

Clinical issues with the masticatory muscles, TMJ, surrounding bone, and soft tissue are all part of TMDs. Reduced mandibular range of motion, masticatory muscle discomfort, joint sound linked with function, widespread myofascial pain, and a functional restriction or deviation in jaw opening are all signs of temporomandibular dysfunction (5,6). When one or more of these symptoms are present, TMJ dysfunction can be diagnosed; however, condylar movement sounds alone cannot make the diagnosis. Diagnosing TMJ dysfunction syndrome does not need the presence of other symptoms such as subluxation/dislocation of the jaw, tinnitus, or vertigo (7).

Craniofacial pain is classified as a subset of TMDs. Masticatory muscle issues and related issues with the head and neck are linked to TMDs. Pain, restricted or asymmetrical mandibular mobility, and noise in the TMJ are the most typical symptoms experienced by patients with TMDs. Pain or discomfort typically restricts the muscles, TMJ, and jaw. Symptoms frequently present together include headache, tinnitus, dizziness, neck discomfort, and ear pain (8). Numerous studies have attempted to link specific characteristics to jaw pain-dysfunction syndrome (9).

The two main methods for diagnosing TMD are the history and physical examination. Diagnostic imaging may be helpful when malocclusion or intra-articular abnormalities are suspected (10). Imaging can diagnose TMD when the history and physical examination results are not apparent. Despite their uncommon usage, several imaging techniques are available to learn more about the causes of TMD (11). The initial evaluation should include panoramic radiography or plain radiography (transcranial and trans-axillary views). Acute fractures, dislocations, and severe articular degenerative disease are routinely seen during these tests. Computed tomography is preferred to traditional radiography for evaluating fragile bone morphology. Magnetic resonance imaging is one of the best modalities for a complete assessment of the joints in TMD patients (12). Another method used to diagnose TMD is diagnostic injections. When masticatory muscle trigger points are involved, local anesthetic injections can be used to pinpoint the site of jaw pain. Dentists and medical professionals who know how to anesthetize the auriculotemporal nerve region should only carry out this procedure (13).

Helkimo proposed one of the most popular indexes. The Anamnestic Index (AI) and the clinical Dysfunction Index (DI) are included in this index. The first focuses on the primary complaint, while the second examines factors including restricted range of motion, poor TMJ function, muscular discomfort, TMJ pain, and pain with mandibular movement. The resulting results can be used to categorize the malfunction's severity (14). The Helkimo Index is one of the most popular and commonly used indices for diagnosing various TMJ disorders. It has succeeded in the test in terms of time because it is straightforward and functional, enabling us to gauge the state of dysfunction. Compared to other clinical indices, it will make it possible to correlate the patient's symptoms with the clinical outcomes (15). Since there is a relationship for quantitative standards for rating the severity of TMDs, indices are crucial in figuring out how common the condition is in a specific population (16-18). Helkimo is credited with pioneering the development of indices that assess the severity and discomfort of TMD in patients (19). Therefore, the validity and accuracy of the Helkimo Index for the diagnosis of TMDs are evaluated. Since there is no Turkish version of Helkimo, it is intended to be culturally adapted to Turkish society.

METHOD

The study was designed as a cross-sectional validation. A total sample of 88 patients was used (44 TMD patients and 44 healthy people), and all of them were evaluated by this test, which lasted approximately 20 minimum.

The protocol of this study received the approval of the Marmara University Ethics Committee (date of approval: 29 December 2022; number: 183). This study was registered in the ClinicalTrials.gov protocol registration and results system (ClinicalTrials.gov ID: NCT05749224). The sample size and power calculation were performed using the G*Power 3.1 power analysis program. In the sample size calculated using the t-tests model "means: difference between two independent means (two groups)," the effect size was large (d=0.8), α error was 0.05, the 95% confidence interval, and the desired power was 95%. These parameters generated a sample size of at least 42 participants for each group. Accordingly, 97 participants were contacted, however the final sample was composed of 88 participant (44 TMD patients and 44 healthy controls) (20,21). Additionally, the necessary permissions were obtained from the

first author (Prof. Dr. Martti Helkimo) who developed Helkimo in order to make the Turkish validity and reliability of this scale (Appendix 1) (19). This study was developed between December 2022 and May 2023. The sample was selected from the İstanbul University, Physical Medicine and Rehabilitation Department patients, which provides Health Sciences Services. Interventions were performed through personal interviews. Written informed consent was obtained by explaining the aim and plan of the study to the participants.

Inclusion criteria were determined as being over 18 years old and having a diagnosis of TMJ dysfunction. Exclusion criteria include having had previous TMJ surgery, having neuromuscular diseases, and having vestibular symptoms that impair balance.

The research consists of three stages.

The first stage was making a cultural adaptation of Helkimo whose Turkish translation had been approved by Turkish society. Three separate translators independently translated the Helkimo Index from English into Turkish. One of the translators was a native English speaker. The final Helkimo Index translation into Turkish was achieved from several translations (Appendix 2). The Helkimo Index was then translated from Turkish to English by a separate translator, and any discrepancies were examined.

Participants were given a thorough explanation of each question on the scale by a physiotherapist with a doctorate degree (E.T.Ç.) before pilot research was done on the patients to gauge the scale's readability.

In the second stage, Helkimo Index was applied to the patient and control groups. This index consists of 2 components. These are Helkimo Anamnestic Component Questionnaire and Helkimo Clinical Dysfunction Component (HCDI) (15). The study aimed to demonstrate the validity and reliability features of the Turkish version of the Helkimo Index.

The patients were asked to fill in the Helkimo Anamnestic Component Questionnaire consisting of 8 questions by one physiotherapist with over 2 years of clinical experience (C.S.). The questions have two answer options: "yes" and "no." The questionnaire includes three options for the patients' answers: "0: no symptoms", "1: mild symptom" and "2: severe symptom." The questionnaire includes the following questions; "1. Do you have a sound (clicking or crepitation) in the TMJ area?", "2. Do you experience stiffness during slow jaw movement or when you wake up in the morning?", "3. Do you feel tired in your chin area?", "4. Do you have difficulty opening your mouth?", "5. Do you experience jaw-locking when opening your mouth?", "6. Do you feel pain in the TMJ located in the area where the jaw muscles are located?", "7. Do you have pain when moving your jaw?", "8. Do you have a luxation (dislocation) in your jaw?". If all questions are answered "no", the result is noted as "no symptoms." If one or more of the first three questions are answered yes, the result is "mild symptom". In patients who mark one or more yes answers from questions 4 to 8, "severe symptom" is put out as a result. A "no symptoms" result indicates the absence of TMJ disorder. Jaw fatigue sensation, jaw stiffness, and TMJ sounds (clicking or crepitus) are signs of "mild symptoms." Suppose it includes one or more symptoms of difficulty in mouth opening, jaw locking, jaw dislocation and painful movement, and painful TMJ area and/or masticatory muscles. In that case, it results in a "severe symptom."

The Temporomandibular Joint Dysfunction Protocol is used to scale the Clinical Dysfunction Components and done by senior doctor (D.D.). The protocol's content includes muscular soreness in the joint, pain with jaw movement, headache, the capacity to clench one's jaw, cryptic sounds coming from the jaw, and tenderness to probing in the temporomandibular muscles. There are five items in the Clinical Dysfunction Component. These include painful jaw motions, TMJ discomfort, alterations in joint function, and jaw mobility (21).

Jaw Mobility

The right-to-left laterotrusion and protrusion of the jaw were measured to determine jaw openness. If the measurement was 7 mm or more in protrusion and the lateral mouth displacement was 0 points, the range of motion between 4-6 mm was 1 point, and if it was less than 4 mm was 5 points. Mouth opening beyond 40 mm was given 0 points, 30-39 mm was given 1 point, and less than 30 mm was given 5 points. According to the constraint, three separate classes were created using the results from these areas. If the total score was 0, the result was 0 points (no temporomandibular dysfunction); if the score was between 1 and 4 points, the result was 1 point (mild TMJ dysfunction); if the score was more significant than 4 points, the result was 5 points (severe TMJ dysfunction).

Joint function

When evaluating changes in joint function, if the unilateral or bilateral click and laterotrusion movement was more significant than 2 mm, the process was considered less affected. If luxation/locking was observed during movement and laterotrusion movement was less than 2 mm, it was considered a severely affected function.

Painful Jaw Movements

The presence of pain while performing the movements was checked in the evaluation of painful jaw movements. Pain associated with a single movement, minor impairment, and pain occurring with more than one movement was noted as major disorder.

Muscle Pain Assessment

The pain in the chewing muscles was tested during the muscle pain assessment. It was considered a minor disorder if there was pressure sensitivity in 1 to 3 places. If there was pressure sensitivity in 4 or more places, it was considered a severe disorder. If there was no pressure sensitivity, there was no irregularity.

Temporomandibular Joint Pain

In evaluating TMJ pain, discomfort and pain on palpation in the prearticular region of the joint were investigated. Discomfort in the lateral (side) was classified as a minor disorder, and discomfort in the posterior (back) was classified as a significant disorder (21).

In the third stage, Visual Analog Scale (VAS), Neck Disability Index (NDI), dizziness Handicap inventory (DHI), headache impact scale and short form-12 health questionnaire were used and patients were asked to complete these questionnaires under the control of a physiotherapist (D.Ö.) (21).

VAS, participants were asked to indicate their perceived pain as 0 (no pain) and 10 (worst). This scale was used to measure the neck and the temporomandibular region (22).

NDI; it is a questionnaire with ten questions. The answers were reported by taking a number between 0 and 5. For each question, 0 points mean no disability, and 5 points mean total disability. A score of 0 to 5 indicates no disability, 5-14 points for low disability, 15-24 points for moderate disability, and 35-50 points for significant disability. In the study, Turkish version of NDI were used (23).

The DHI consists of 25 questions. Participants' answers were yes, no, or sometimes. This questionnaire assessed physical, emotional, and functional components. These three components had significant effects on Dizziness Properties and Quality and in 2016 the Turkish version was conducted (24).

The Headache Impact Scale is an evaluation questionnaire comprising six questions, with a total score between 36 and 78. Answers were always, almost always, sometimes, rarely, and never. This scale is valid in Turkish version (25).

Finally, quality of life was assessed using the SF-12 Brief Health Questionnaire, the short version of SF-36. It includes two components of quality of life. These are mental component and physical components and also, Turkish validity and reliability study is available (26).

Statistical Analysis

The Social Sciences Statistics Package (SPSS 23; Software version:23.0; Operating system(s): AIX, HP-UX, Linux, iOS, Solaris, Windows; document number: 256859) statistical procedures were used. For continuous data, means and standard deviations were calculated, and frequencies and percentages were calculated for categorical variables. The normality distribution of the constant variables was confirmed using the Kolmogorov-Smirnov test. The 95% confidence level ($p<0.05$) was used. The intraclass correlation coefficient (ICC) of Shrout and Fleiss, which calculates the dependability of single ratings, was employed in a one-way random effects model of the absolute agreement type to determine the agreement between the two raters for the overall HCDI score (27). Reliability was deemed inadequate when the ICC was below 0.40, moderate between 0.40 and 0.75, considerable between 0.75 and 0.90, and outstanding when the ICC was over 0.90. Pearson's correlation coefficient r was utilized to examine the concurrent validity of the HCDI with the VAS HIT-6, NDI, SF-12, and DHI. If the correlation coefficient was more significant than 0.50, it was deemed high; if it was between 0.30 and 0.50, it was considered moderate (28). The receiver operating characteristics (ROC) curves were used to assess the HCDI's capacity to distinguish between TMD sufferers and healthy individuals.

RESULTS

Characteristics of the Sample

Ninety-seven participants were contacted; however, the final sample was composed of 88 participants (44 TMD patients and 44 healthy controls). 69.3% of the participants were female with a mean age of 33.68±11.94 (range 18-64) and mean body mass index (BMI) of 24.73±4.68 (range 16.26-33.95). No significant differences were found between TMD patients and healthy controls in terms of gender distribution, age and BMI values ($p>0.05$) (Table 1).

Table 1. Comparison of demographic informations (mean ± SD or %)

	Controls (n=44)	Patients (n=44)	Test statistics
Age	32.02±11.80	35.34±11.98	t=-1.31, p>0.05
Gender			
Male	15 (34.10%)	12 (27.30%)	x^2=0.48, p>0.05
Female	29 (65.90%)	32 (72.70%)	
BMI	24.23±3.90	25.23±5.34	t=-1.00, p>0.05

SD: Standard Deviation, BMI: Body Mass Index.

Inter-Rater Reliability

The outcomes exhibited a zenith weighted kappa coefficient of 0.894 pertinent to item C, juxtaposed with a nadir value of 0.678 pertaining to item A. With respect to these coefficients, the reliability displayed a spectrum varying from moderate to substantial. Moreover, the aggregate score of the scale attained a superior level of agreement, signified by the value of 0.955 (as can be seen in Table 2).

Correlative legitimacy of the HCDI, in association with other specific and generic tools, is presented in Table 3.

Validity and Accuracy of the TMD Diagnostic Ability

The analysis of the ROC curve identified an optimal cut-off point of more than 1 point in the HCDI score that manifested a sensitivity of 81.17% alongside a specificity of 72.43% for diagnosing TMDs, thus establishing the TMD protocol as the benchmark (Table 4). This analytical process demonstrated an area under the curve (AUC) of 0.90 (Figure 1), a value indicative of commendable precision.

Table 2. Inter-rater concordance of the Helkimo items and the total score

Measure	Value	95% confidence interval	Degree of concordance
Item A1	0.689	0.314 to 0.732	Moderate
Item A2	0.681	0.325 to 0.727	Moderate
Item A	0.678	0.470 to 0.788	Moderate
Item B	0.719	0.349 to 0.767	Moderate
Item C	0.894	0.646 to 0.921	Substantial
Item D	0.657	0.322 to 0.740	Moderate
Item E	0.742	0.393 to 0.811	Moderate
Total score	0.955	0.830 to 0.988	Excellent

Table 3. Concurrent validity of the Helkimo Clinical Dysfunction Index with other specific and generic instruments

Variable	Pearson's r	p-value	Correlation
VAS	0.607	<0.001	Strong
HIT-6	0.629	<0.001	Strong
NDI	0.497	<0.001	Moderate
SF-12 physical	-0.354	0.001	Moderate
SF-12 mental	-0.023	0.833	-
DHI physical	0.309	0.003	Moderate
DHI emotional	0.280	0.008	Poor
DHI functional	0.264	0.013	Poor
DHI total	0.296	0.005	Moderate

VAS: Visual Analog Scale, HIT-6: Headache Impact Test, SF-12: Short Form-12, DHI: Dizziness Handicap Inventory, NDI: Neck Disability Index.

DISCUSSION

This study evaluated the validity and reliability of the Helkimo anamnestic and the clinical DI. The results showed that it is a valid and reliable instrument for evaluating patients with TMD, determining the degree of severity of the condition, and discriminating between affected and unaffected patients. Helkimo's indices, which include the clinical DI and the AI, are among the most used indices. The former relies heavily on the primary complaint. In contrast, the latter examines factors including restricted range of motion, poor TMJ function, muscular discomfort, TMJ pain, and pain with mandibular movement. To categorize the malfunction according to its degree of it, utilize the data that were collected (19).

Table 4. Sensitivity, specificity, and AUC values of HCDI total score by ROC curve analysis for the diagnosis of TMDS

Statistics	Value
Sensivity	81.17%
Specificity	72.43%
Significance (p)	<0.001
Positive predicted value	0.78
Negative predictive value	0.81
AUC	0.90
AUC 95% confidence interval	0.84-0.96
Standard error of AUCs	0.03

AUC: Area Under The Curve, HCDI: The Helkimo Clinical Dysfunction Index, ROC: Receiver Operating Characteristics, TMDS: Temporomandibular Disorders.

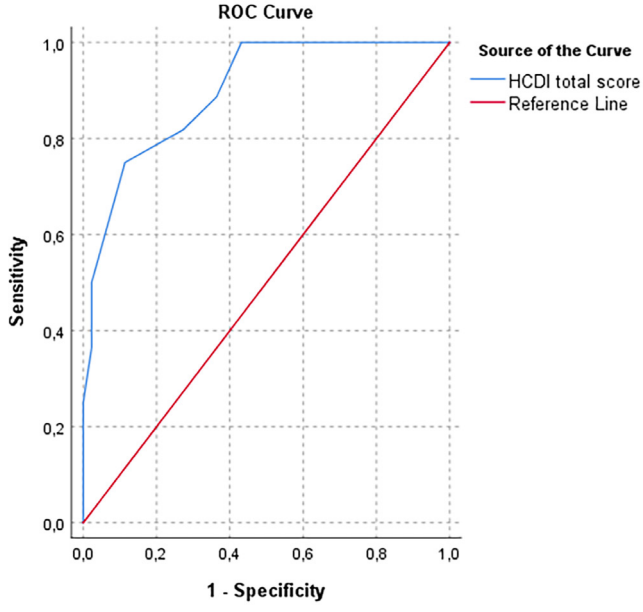

Figure 1. Receiver operating characteristic curve for HCDI.
HCDI: The Helkimo Clinical Dysfunction Index.

The most often used measure for evaluating TMD in epidemiologic research is the Helkimo index. However, this approach has come under fire for treating all symptoms equally, including those from articular to muscle problems. Additionally, the scale of 0, 1, and 5 does not provide a precise definition of the severity between score numbers and is not continuous. However, when comparing the outcomes of related investigations, the Helkimo index is helpful. Helkimo's AI gauges how well-aware the patient is of their TMD symptoms (29).

The most widely used approach in epidemiological research of TMD to assess the severity of TMD in individuals and the general population, as well as the improvement in patients' conditions following therapy, is Helkimo's DI (30). The connection between TMD, malocclusion patterns, benign joint hypermobility syndrome, and initial condylar position was examined by Barrera-Mora et al. (31) using this index. They concluded that condylar displacements in the vertical plane and anterior crossbite are risk factors for the onset of TMJ symptoms (31). Using the Helkimo index, Padala et al. (32) assessed the connection between condyle position and TMD. Vojdani et al. (33) evaluated the correlation between subjective data from a questionnaire and clinical examination. They concluded that concerning gender, women (80%) were more affected than men (62%) (33). Cone beam computed tomography (CBCT) results relevant to patients with and without the TMD were analyzed by Khojastepour et al. (34) to look into the relationship between these results and the DI. The present study's analysis of CBCT images showed distinct variations between condyles with TMD and those without. Additionally, there was a strong correlation between the total condylar bone change in TMD patients and the HCDI (34). Possible associations between clinical dysfunction indicators and the level of condylar asymmetry have been shown by research by Khojastepour et al. (35). According to the current study's results, people with a high condylar asymmetry index are more likely to develop TMD. However, the level of condylar asymmetry is not required for TMD indications and symptoms (35). These findings highlight the relevance of the HCDI in diagnosing TMD. Given the strong correlation between condylar displacements, asymmetry, and TMD symptoms, as demonstrated by previous studies, the Helkimo index serves as a valuable clinical tool for assessing dysfunction severity and identifying individuals at risk. Its applicability is further supported by CBCT analyses, which reveal distinct morphological changes in the condyles of TMD patients, reinforcing the index's role in comprehensive diagnostic assessments.

In the literature, the Helkimo index has been widely used in symptom-based TMD classification studies and its simplicity of application has made it a preferable tool in population-based studies (36-39). However, its validity, reliability and cultural adaptation have only been examined in a limited number of studies (40).

Regarding the validation study of the Helkimo index conducted by Alonso-Royo et al. (21), the HCDI showed moderate to substantial inter-rater concordance among the items and excellent concordance for the total scores. The correlation with other tests was high, the correlation with dizziness disability test (total) was moderate and the correlation with NDI test, headache impact test and physical and mental component of the quality of life was poor (r=0.339, r=0.265, r=0.187, r=0.003, r=-0.171, respectively). The prediction of TMD revealed a sensitivity of 86.67%, a specificity of 68.09% and an AUC of 0.841 (18). Similarly, the present research analysis demonstrated an optimal cut-off point of more than 1 point in the HCDI score that manifested a sensitivity of 81.17% alongside a specificity of 72.43% for diagnosing TMDs. Furthermore; the correlation with VAS and HIT-6 (headache impact test) were strong (r=0.607 and r=0.629, respectively), the correlation with NDI, SF-12 (physical) and DHI (physical and total) (r=0.497, r=-0.354, r=0.309, r=0.296, respectively) were moderate and the correlation with DHI (emotional and functional) were poor (r=0.280 and r= 0.264, respectively).

A review of the literature indicates that the Helkimo index has been widely used in assessing patient-reported outcomes of TMD in conjunction with various imaging modalities. Additionally, It has been emphasized as a potential gold standard among other assessment methods. Furthermore, numerous studies reported significant correlation between cultural adaptation of other TMD-related questionnaires with the Helkimo index. However, validity, reliability, and cultural adaptation studies of this index remain insufficient at the national level. Therefore, further research is necessary to enhance its applicability and standardization across different populations. In this context, our study contributes to the validation of the Helkimo Clinical Index within the Turkish population. Nonetheless, there has been few limitations of our study. Although, our study population did not fall into the patient category, the healthy group showed signs of TMJ dysfunction. The major drawback of the study is the discovery of symptoms in patients who did not have TMJ dysfunction as determined by doctors. The fact that the patients had a short window of time to complete the questionnaires is another one of the constraints. Although the most general psychometric characteristics were examined in this study, we did not examine the sensitivity to change or the capacity to distinguish across various TMD populations. The fact that this study was conducted only on a small group of local patients in a specific geographic area also restricts the applicability of the findings.

CONCLUSION

In conclusion, the study demonstrates that the HCDI serves a purpose for TMD diagnosis. For each item, the inter-observer concordance was between moderate and considerable, which was outstanding for the test's overall score. Concerning the Fonseca's AI, the short version of Fonseca's AI and numerical pain-rating scale (NPRS) orofacial assessment instruments, the HCDI has strong concurrent validity; the NPRS neck pain assessment, emotional and physical facets, and the total DHI value have moderate validity; and the HIT-6 instruments, the mental and physical components of the SF-12, and the functional component of the DHI have poor validity. The HCDI score that manifested a sensitivity of 81.17% alongside a specificity of 72.43% for diagnosing TMDs, thus establishing the DC/TMD protocol as the benchmark.

Ethics: The protocol of this study received the approval of the Marmara University Ethics Committee (date of approval: 29 December 2022; number: 183).

Informed Consent: Written informed consent was obtained by explaining the aim and plan of the study to the participants.

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Author Contributions: Concept- ETÇ, EAK, FŞB; Design- ETÇ, CS, DÖ, HY, EAK; Supervision- ETÇ; Resources and Financial Support- ETÇ, CS, DÖ, HY, DD; Materials- ETÇ, CS, DÖ, HY, DD; Data Collection and/or Processing- ETÇ, CS, DÖ, HY; Analysis and/or Interpretation- ETÇ, CS, DÖ, HY; Literature Search- ETÇ, CS, DÖ, HY; Writing Manuscript- ETÇ, CS, DÖ, HY; Critical Review- ETÇ, CS, DÖ, HY.

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Appendix 1. English version of Helkimo index

Table 1. Questionnaire for anamnestic component		
Name:		
Age:		
Gender:		
1. Do you have a sound (clicking or crepitation) in the area of TMJ?	Yes	No
2. Do you have jaw rigidity during awakening or slow movement of mandible?	Yes	No
3. Do you feel fatigue in the jaw area?	Yes	No
4. Do you have difficulty while opening mouth?	Yes	No
5. Do you have locked mandible during opening the mouth?	Yes	No
6. Do you have pain in the TMJ in the area of masticatory muscles?	Yes	No
7. Do you have pain during movement of mandible?	Yes	No
8. Do you have luxation of mandible?	Yes	No
TMJ: Temporomandibular Joint		

Table 2. Clinical dysfunction component	
Component	**Details**
Mandibular opening	>40 mm 30-39 mm >30 mm
Mandibular deviation during lowering	<2 mm 2-5 mm >5 mm
TMJ dysfunction	No impairment Palpable clicking Evident clicking
TMJ pain	No pain Palpable pain
Muscle pain	No pain Palpable pain Palpated reflex
TMJ: Temporomandibular Joint.	

Appendix 2. Turkish version of Helkimo index

Tablo 1. Helkimo anamnestik komponent anketi		
İsim:		
Yaş:		
Cinsiyet:		
Temporomandibular eklem bölgesinde sese (tıkırtı veya krepitasyon) sahip misiniz?	**Evet**	**Hayır**
Yavaş çene hareketi sırasında veya sabah uyandığınızda çene sertliği yaşıyor musunuz?	**Evet**	**Hayır**
Çene bölgenizde yorgunluk hissediyor musunuz?	**Evet**	**Hayır**
Ağızınızı açarken zorluk yaşıyor musunuz?	**Evet**	**Hayır**
Ağızınızı açarken çene kilitlenmesi yaşıyor musunuz?	**Evet**	**Hayır**
Çene kaslarının bulunduğu bölgede yer alan temporomandibular eklemde ağrı hissediyor musunuz?	**Evet**	**Hayır**
Çenenizi hareket ettirirken ağrınız oluyor mu?	**Evet**	**Hayır**
Çenenizde bir lüksasyon (çıkık) var mı?	**Evet**	**Hayır**

Tablo 2. Klinik disfonksiyon (fonksiyon bozukluğu) komponenti	
Çene mobilitesinde etkilenim	
Dikey;	**Yatay;**
30-39 mm: Hafif bozulmuş hareket	**4-6 mm:** Hafif bozulmuş hareket
≤29 mm: Ciddi şekilde bozulmuş hareket	**≤3 mm:** Ciddi şekilde bozulmuş hareket
≥40 mm: Normal eklem hareket açıklığı	**≥ 7 mm:** Normal eklem hareket açıklığı
Çene fonksiyonunda değişim	
1. Tek taraflı veya çift taraflı tıkırtı/sürtünme laterotrüzyon ≥2 mm=Hafif bozulmuş hareket	
2. Hareket sırasında luksasyon/kilitlenme=Ciddi şekilde bozulmuş hareket	
3. Yumuşak hareket, ses yok/laterotrüzyon <2 mm=Normal fonksiyon	
Ağrılı hareket	
1. Bir hareketle ilişkili ağrı=Minör bozukluk	Bir hareketle ilişkili ağrı=Minör bozukluk
2. İki veya daha fazla hareketle ilişkili ağrı=Şiddetli bozukluk (ağrısız hareket=Normal fonksiyon)	İki veya daha fazla hareketle ilişkili ağrı=Şiddetli bozukluk (ağrısız hareket=Normal fonksiyon)
Kas ağrısı	
1. 1-3 yerde basınca duyarlılık=Minör bozukluk	
2. 4 veya daha fazla yerde basınca duyarlılık=Şiddetli bozukluk	
3. Basınca duyarlılık yok=Bozukluk yok	
Temporomandibular eklem ağrısı	
1. Lateral basınca duyarlılık=Minör bozukluk	
2. Posterior basınca duyarlılık=Şiddetli bozukluk	
3. Basınca duyarlılık yok=Bozukluk yok	