

Diagnostic Indices for Temporomandibular Disorders (TMD): A Systematic Review

Melati Fitria Putri¹, Lindawati S Kusdhany², Ira Tanti^{2*}

1. Prosthodontics Residency Program, Faculty of Dentistry, Universitas Indonesia, Indonesia.

2. Departement of Prosthodontics, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia.

Abstract

Summarize the existing scientific literatures, investigate the diagnostic indices for temporomandibular disorder (TMD) that are used nationally and internationally, and determine the best choice in establishing the diagnosis.

Electronic search in the past 10 years by MEDLINE database, accessed through PubMed and EBSCO. The following main keywords were used: "diagnostic techniques and procedures", "questionnaires", "diagnostic index", "temporomandibular disorders". Using the inclusion and exclusion criteria 5 journals were selected for the present literature review. This review was conducted in accordance with Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines.

These studies shows that Helkimo Index (HI), Craniomandibular Index (CMI), Research Diagnostic for Temporomandibular Disorders (RDC/TMD), Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), and Temporomandibular Etiology Index have gone through validity and reliability test, each of them have different sensitivity and specificity. This indices are suitable for a screening and/or diagnostic instrument for TMD.

All of the indices above are sufficiently suitable for the evaluation of TMD. From this literature, dentists are free to choose which index they want to use to help establish a diagnosis of TMD, by knowing the plus minus each of the indices, and all of them are valid. For practical reason, Temporomandibular Etiology Index is the simplest index that can be considered.

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Introduction

Temporomandibular disorder (TMD) is a common term used to describe disorders related to masticatory muscles, joints, and supporting tissues. These disorders are also related to pain and dysfunctions around masticatory-muscle and the associated soft-tissue. Etiology of temporomandibular disorders (TMD) is complex and multifactorial, due to several factors could contribute to this disorder, such as the occlusal condition of the teeth, trauma, emotional stress, deep pain input, parafunctional activity, hormones, and others. Because of this complexity, various instruments had been

created.¹ There are many tools for TMD assessment, such as questionnaires, diagnostic criteria, and indices. The index is an organized form to assess signs and symptoms of TMD severity; it allows a reliable quantification based on symptomatology and clinical examination.²

The content of diagnostic indices sometimes confusing for general dentist to apply in their daily practice such as Helkimo index, Craniomandibular index, The Research Diagnostic Criteria for TMD (RDC-TMD) index, Diagnostic Criteria for TMD (DC/TMD) index, etc. In Indonesia, an index was developed by Himawan et al. called TMD diagnostic index (TMD-DI) and an index was developed by Tanti et al. called Etiology of Temporomandibular Disorders Index.¹ This study can help to identify the simplest diagnostic index that have a good accuracy in establishing the diagnosis of TMD, and also to facilitate the screening process for TMD patients, so that they can refer to TMD experts.

*Corresponding author:

Ira Tanti
Department of Prosthodontics
Faculty of Dentistry, University of Indonesia
Salemba Raya No. 4, Jakarta Pusat 10430, Indonesia
E-mail: iratanti@ymail.com

Therefore, the aim of this study was to summarize the existing scientific literatures, to investigate the diagnostic indices for temporomandibular disorder (TMD) that are used nationally and internationally, and to determine the best choice in establishing the diagnosis.

Materials and methods

Search Strategy

The PICO structured summary was chosen as the methodological summarized the paper, P (population): Diagnostic indices for temporomandibular disorders (TMD), I (intervention): indices that are used nationally and internationally, C (Comparison): the type of assessments, the accuracy, and the differences between each diagnostic index, O (Outcome): the best choice of diagnostic indices that are suitable for a screening and/or diagnostic instrument for TMD. A systematic search was done on 15 July 2020 – 23 July 2020 using an electronic search in the past 10 years by MEDLINE database, accessed through PubMed and EBSCO. The following combinations of keywords were used: ((Diagnostic techniques and procedures)) OR ((questionnaires)) OR ((diagnostic index)) AND ((temporomandibular disorders)). A further manual search was performed as well; checking for eligible papers in the bibliographies of the initially retrieved articles and exploring the websites of the relevant journals.

Inclusion Criteria

The present review sought only for articles where diagnostic indices are used world wide as a standard instrument for temporomandibular patient, and also for articles where diagnostic indices are used in Indonesia. Articles with a research design diagnostic test that have tested their validity and reliability. The search was limited to the articles published in English language.

Exclusion Criteria

Diagnostic indices for TMD that is not familiar in Indonesia. Articles with a research design other than diagnostic test, and articles in any language other than English were left out.

Results

Using the search strategy, 55 journals come from PubMed, and 31 journals come from

EBSCO. The search and the selection process carried out after the screening of the titles and the abstracts, full texts of all reviewed articles were obtained and carefully read. There were 29 journals were excluded because of the duplication, 48 journals were not in line with the purpose of this review, and 4 journals were excluded after full text evaluation. Using the inclusion and exclusion criteria 5 literatures were selected for the present systematic review, all of the articles have diagnostic study design (Table 1). Search flow summarized in Figure 1.

Helkimo Index (HI)

In 1974, Helkimo developed an index to measure severity of TMJ pain and dysfunction; it is called Helkimo Index (HI). This index consists of Anamnestic Index (Ai), Clinical Dysfunction Index (Di), and Occlusal Index (Oi). Helkimo Index was designed for studies of a general population and not for clinical outcome studies to predict treatment outcome. This index do not separate TMJ problems from muscle problems, not sensitive enough to measure small changes in severity, place unequal weight on different signs, pose some problems in palpation reliability, and difficult to score.³

Helkimo Anamnestic Index (Ai), consisting of (Ai0) there is no subjective symptom of dysfunction; (Ai1) mild symptoms, such as TMJ sounds and muscle stiffness; (Ai2) severe symptoms, such as limitation of mandibular movement and facial or jaw pain. Clinical Dysfunction Index (Di), based on the clinical examination of the masticatory muscle and TMJ, consisting of (Di0) 0 points, there is no objective symptom; (Di1) 1–4 points, mild dysfunction; (Di2): 5–9 points, moderate dysfunction; (Di3): 10–25 points, severe dysfunction. Occlusal Index (Oi), based on dental examination, consisting of (Oi0) 0 points, there is no occlusal and articulation disturbance; (Oi1) 1–4 points, mild occlusal dysfunction; (Oi2) 5–20 points, severe occlusal dysfunction.²

Cranio-mandibular Index (CMI)

In 1986, Friction and Schiffman developed the Cranio-mandibular Index (CMI) for both epidemiologic and clinical outcome studies of TMD. Cranio-mandibular Index can measures severity of disorders in TMJ and muscles by using defined criteria, simple clinical methods and scoring. This index consists of Dysfunction Index (DI) and Palpation Index (PI).²

The Dysfunction Index includes items

related to mandibular restriction, deviation, pain, and TMJ sound during movement. There are items description for mandibular movement and TMJ sound. The Palpation Index includes items related to tenderness at masticatory muscles during intra-oral and extra-oral palpation. Scoring method of the Craniomandibular Index is $CMI = (DI + PI)/2$.³ Validity and reliability test have been conducted in 1987.^{2,3}

Research Diagnostic for Temporomandibular Disorders (RDC/TMD)

In 1992, Dworkin and LeResche developed Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) that becomes the most widely used diagnostic protocol for TMD. This index consists of dual-axis assessment; Axis I based on clinical signs and symptoms, and Axis II based on psychosocial and behavioral factors.⁶

Axis I physical assessment divided by 3 groups: first, examination of myofascial pain and myofascial pain with limited opening; second, examination of disc displacement with reduction, disc displacement without reduction with limited opening, and disc displacement without reduction without limited opening; third, examination of other joint condition. Axis II assessment of psychosocial status and pain-related disability has 5 screeners with 5 self-report screening instruments: Patient Health Questionnaire-4 (PHQ-4), Graded Chronic Pain Scale (GCPS), pain drawing, Jaw Functional Limitation Scale (JFLS), and Oral Behaviors Checklist (OBC).⁵

Validity of Axis I was still below the target sensitivity of $\geq 70\%$ and specificity of $\geq 95\%$. This supported the development of revised Axis I diagnostic algorithms that were subsequently demonstrated to be valid for the most common pain-related TMD and for one intra-articular disorder. The Axis II has been tested for its reliability and validity.⁵

Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)

In 2014, Schiffman et al. modified and refined RDC/TMD to DC/TMD. The new diagnostic criteria recommended for temporomandibular disorder Axis I protocol include valid screening to detect pain-related TMD and valid diagnostic criteria for distinguishing the most common pain-related TMD with sensitivity $\geq 86\%$, specificity $\geq 98\%$ and for intra-articular disorder with sensitivity 80% and specificity 97% .⁵

Axis I DC/TMD consists of Symptom Questionnaire and clinical examination data collection form. Clinical examination specifications and decision trees for TMD pain diagnoses and intra-articular diagnoses are also available. Axis II DC/TMD consists of five questionnaires of psychosocial and behavioral factors, there are the Pain Drawing, Graded Chronic Pain Scale, Patient Health Questionnaire, Jaw Functional Limitation Scale, and Oral Behaviors Checklist.^{5,6}

DC/TMD consists of 81 questions, assessing in more detail the functional limitations of the jaw, psychological distress, anxiety and the presence of comorbid pain conditions. This more comprehensive index adds screening instruments for Axis I and Axis II. Axis I include three main disorders, namely pain associated with temporomandibular joint disorders and headaches, intra-articular joint disorders, and degenerative joint disorders. For Axis II, an examination instrument is added to evaluate the incidence of pain, psychosocial status, and parafunctional habits. After completing the questionnaire and checking DC/TMD, the diagnosis can be determined by following the algorithm flow.^{5,6}

Temporomandibular Etiology Index

In Indonesia, Tanti et al (2015), developed an index for temporomandibular disorders called the Temporomandibular Etiology Index. The purpose of making this index is to produce an index based on the etiology in determining the diagnosis. This index can be used as a screening tool for TMD, which can be used to take precautionary measures for patients who have risk factors but have not yet experienced TMD, and as a reference for appropriate etiological treatments for patients who already have TMD.⁸

Temporomandibular Etiology Index consists of several components of the examination, which are gender, bad habits and stress questionnaires, and measurement of free way space.⁷ Gender with indicators of women and men, bad habits questionnaire consisting of 21 questions, stress questionnaire consisting of 18 questions, and free way space consists of 2 indicators namely 2-4 mm and <2 mm or >4 mm. This index obtained based on quantitative research with a case control design has a sensitivity of 47.8% , specificity of 88.2% , and an area under curve of 79.2 . This means that the

measuring instrument is good enough for a screening tool.^{7,8}

Discussion

The Helkimo Index (HI) is the most used indices in the epidemiological studies of TMD. They are also used in the literature to demand TMD treatment and to determine the correlations between TMD and factors such as age, malocclusion and muscle activity.¹⁴ The advantages and disadvantages of using Helkimo index are simple and easy to use specially by general practitioner, but this index do not separate TMJ problems from muscle problems, not sensitive enough to measure small changes in severity, place unequal weight on different signs, and pose some problems in palpation reliability.³ The Craniomandibular Index (CMI) has been used in other studies to determine correlations between mandibular movements and TMD, and it measures severity of problems in mandibular movements, TMJ noise, muscle and joint tenderness. The advantages of using CMI are appears to be valid for clinical studies, using defined criteria, simple clinical methods, and this index has separate TMJ problems from muscle problems, but users must be aware of its numerous potential errors and its associated strict methodologic guidelines to ensure accuracy and reproducibility of results.³

The RDC/TMD (Axis I and Axis II) was a model system when it was published in 1992, but the authors recognized that it was only a beginning and that further research was needed to improve its validity and clinical utility.⁵ In 2014, a panel of experts vetted and modified the Axis I and Axis II diagnostic protocols. Recommended changes were assessed for diagnostic accuracy by using the Validation Project's data set, which formed the basis for the development of the DC/TMD. The newly recommended Diagnostic Criteria for TMD (DC/TMD) Axis I protocol includes both a valid screener for detecting any pain-related TMD as well as valid diagnostic criteria for differentiating the most common pain-related TMD with sensitivity $\geq 86\%$, specificity $\geq 98\%$ and for one intra-articular disorder with sensitivity of 80% and specificity of 97%. The DC/TMD Axis I and axis II are an evidence-based assessment protocol that can be immediately implemented in the clinical and research setting.¹⁰⁻¹² Axis II assess pain intensity, pain

disability, jaw movement, psychosocial distress, parafunctional activity, and referred pain. These changes are a result of research findings from professional clinical and research groups guided by the principle to create a new DC/TMD based on the best available evidence. Full clinical implementation of the protocol in its present state would benefit the population, for consistency of diagnostic methods and clinical terms that allow standardization in reporting of measurements and criteria for diagnostic decision making.¹⁵⁻²²

The etiology of the TMD is not yet clearly known. During this time the diagnosis is usually determined based on an index that contains the direction of clinical signs and symptoms, except RDC/TMD or DC/TMD Axis II which is an instrument for screening associated with depression, somatization, and disability. RDC/TMD or DC/TMD has been widely used in the examination of TMD in several countries, but this index is still difficult to use.¹³ The Temporomandibular Etiology Index is easy to use and includes risk factors for TMD that are needed for screening, so that prevention and treatment can be done.⁸ This study resulted in a dataset of 215 participants, the number of subjects with and without TMD were almost balance. Accuracy of this index is good with sensitivity of 47.8% and specificity of 88.2%.

All of the indices can be used interchangeably for the diagnosis and grading of TMD. DC/TMD is the most accurate index to determine TMD diagnosis. However, for practical application by general dentist, Temporomandibular Etiology Index is the simplest index that has a good accuracy for TMD screening. These patients can be referred to TMD specialist. The limitation of this writing is that the author did not address all the existing TMD indices. Only the most often used indices in international and also in Indonesia. In the future, this literature can be developed and added according to the development of the indices.

Conclusions

This study help to understand the development of diagnostic indices for temporomandibular disorders. All of the indices above are sufficiently suitable for the evaluation of TMD. DC/TMD is a gold standard instrument for identification of TMD manifestations from simple to complex. For practical reason,

Temporomandibular Etiology Index is the simplest index that can be considered for screening.

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Declaration of Interest

The authors report no conflict of interest.

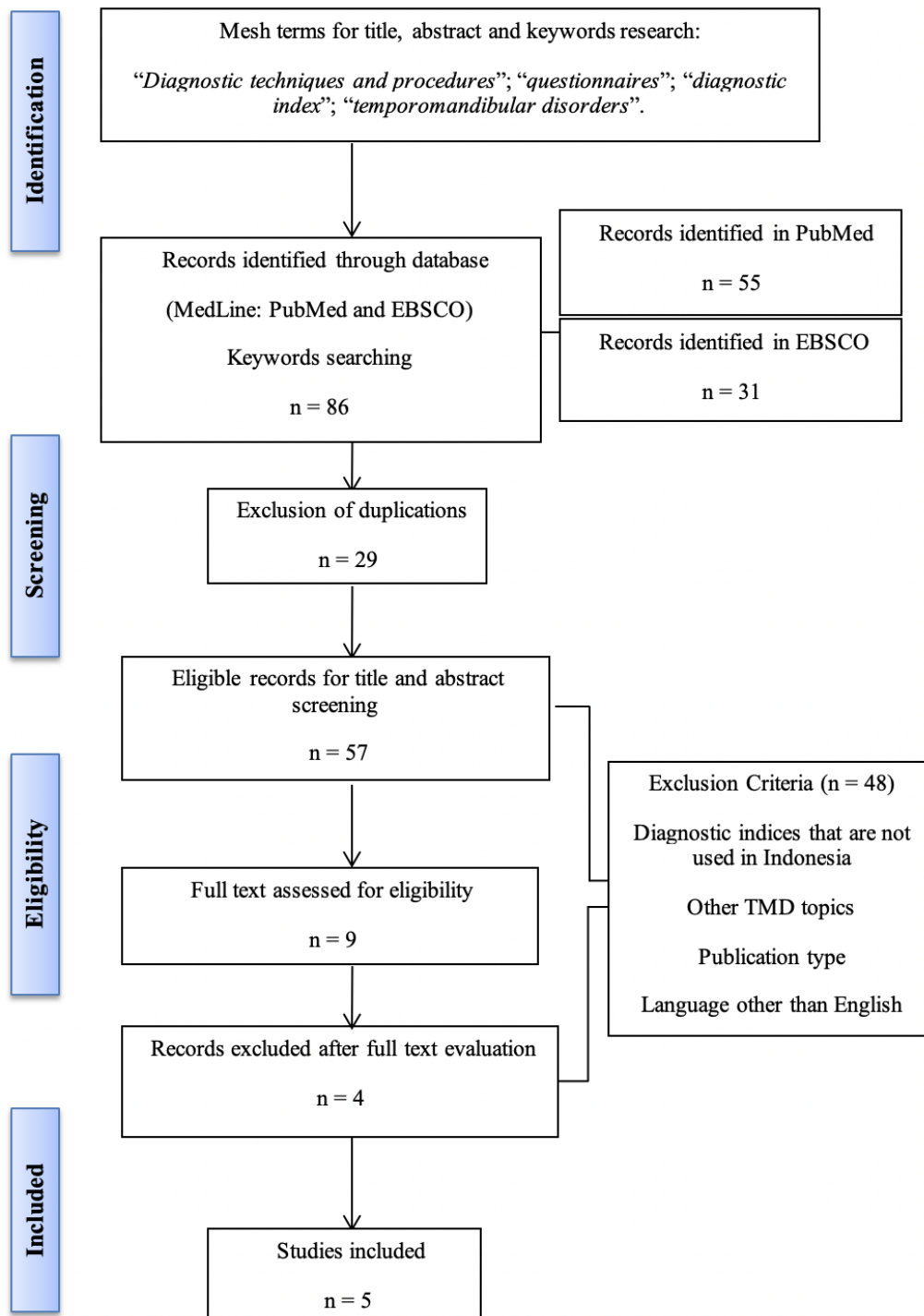


Figure 1. Flow-chart diagram for the selection of 5 papers included in the review.

Author/ Reference	Year	TMD Indices	Type of Assessment	Sensitivity Specificity	Outcome
Helkimo, M. ²	1974	Helkimo Index (HI)	Anamnestic Index (Ai) Dysfunction Index (Di) Occlusal Index (Oi)	Validity and reliability test have been conducted	<ul style="list-style-type: none"> - Type of assessment: Examination form of TMJ, muscle and occlusion. - Diagnosis: just describes the level of severity. Do not separate between muscle and joint disorders. - Not sensitive enough to measure small changes in severity. - Use in epidemiologic study of TMD. - Pioneer for TMD diagnosis - Simple clinical methods and easy to use.
Fricton, J. and Schiffman, E. ^{3,4}	1986	Craniomandibular Index (CMI)	Examination Form: Dysfunction Index (Di) → Mandibular movement, TMJ noise, TMJ palpation Palpation Index (Pi) → Extra oral, intra oral & neck muscle	Validity and reliability test have been conducted	<ul style="list-style-type: none"> - Type of assessment: Examination form of TMJ and muscle. - Diagnosis: divided into muscle disorders and joint disorders. - Use in both epidemiologic and clinical outcome studies of TMD. - Simple clinical methods and easy to use.

<p>Dworkin and LeResche. 5</p>	<p>1992</p>	<p>Research Diagnostic for Temporomandibular Disorders (RDC/TMD)</p>	<p>Axis I: Physical Assessment</p> <p>Group I: Myofascial pain, myofascial pain with limited opening</p> <p>Group II (Disc displacement): Disc displacement with reduction, disc displacement without reduction with limited opening, disc displacement without reduction without limited opening.</p> <p>Group III (Other joint condition): Arthralgia, osteoarthritis, osteoarthrosis.</p> <p>Axis II: Assessment of psychosocial status and pain-related disability.</p> <p>Axis II screeners with 5 self-report screening instruments (PHQ-4, GCPS, pain drawing, JFLS & OBC).</p>	<p>Axis I Sensitivity ≥ 0.70 Specificity ≥ 0.95</p>	<ul style="list-style-type: none"> - Type of assessment: Axis I → Examination form of TMJ and muscle. Axis II → Questionnaire of psychosocial status and pain-related disability. - Diagnosis: divided into muscle disorders and joint disorders. - Accuracy: has a good accuracy, but Axis I validity was below the target and lack of reliability for clinical use. - Golden Standard for TMD diagnosis in 1992-2014. - Advance clinical methods and difficult to use.
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<p>Schiffman, E., et al.⁵</p>	<p>2014</p>	<p>Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)</p>	<p>Axis I: Physical Assessment</p> <p>Pain related TMD (6 item): Arthralgia, Myalgia; local myalgia, myofascial pain, myofascial pain with referral, headache attribute to TMD.</p> <p>Intra-articular disorders (6 item):</p> <p>Disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction with limited opening, disc displacement without reduction without limited opening, degenerative joint disease.</p> <p>Axis II: Assessment of psychosocial, psychological status and pain behavior.</p> <p>Axis II screeners with 5 self-report screening instruments (PHQ-4, GCPS, pain drawing, JFLS & OBC).</p> <p>Comprehensive Axis II instruments (PHQ-9, GAD-7 & PHQ-15)</p>	<p>Axis I</p> <p>Pain related TMD:</p> <p>Sensitivity ≥ 0.86</p> <p>Specificity ≥ 0.98</p> <p>Intra-articular disorders:</p> <p>Sensitivity 0.80</p> <p>Specificity 0.97</p>	<ul style="list-style-type: none"> - Type of assessment: Axis I → Examination form of TMJ and muscle. Axis II → Questionnaire of psychosocial, psychological status and pain behavior. - Diagnosis: divided into 2 groups → pain related TMD and intra-articular disorders. - Accuracy: has a very good accuracy → an improved form of RDC/TMD. - Golden Standard for TMD diagnosis since 2014 until now. - Advance clinical methods and difficult to use.
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Tanti I, et al. ⁸	2016	TMD Etiology Index	Bad Habit Questionnaire Emotional stress Questionnaire Gender & free way space	Sensitivity 0.478 Specificity 0.882	<ul style="list-style-type: none"> - Type of assessment: Bad habit and emotional stress questionnaires. Examination of gender and free way space. - No diagnosis; this index is a screening tool based on etiology, to determine the risk of having TMD. - Accuracy: has a good accuracy - Simple and easy to use.
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Table 1. Collection and analysis of TMD diagnostic indices.

References

1. Tanti I, Himawan LS, Kusdhany L. Development of Questionnaire to Determine the Etiology of Temporomandibular Disorders. *Int J Clin Prev Dent.* 2014;10(2):103-108
2. Rodrigues AF. Helkimo and Craniomandibular Indices in the Classification of Temporomandibular Disorders: A Comparative Study. *A journal of myofascial pain and fibromyalgia.* 2016;1-6
3. Friction JR, Schiffman EL. Reliability of a craniomandibular index. *J Dent Res.* 1986;(65)11:1359-1364
4. J.R Friction ,E.L Schiffman. The craniomandibular index: Validity. *J Dent Res.* 1987;(58)2:222-228
5. Sciffman EL. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group. *Quintessence publishing.* 2014;28(1)6-27
6. Sciffman E, Ohrbach R. Executive summary of the Diagnostic Criteria for Temporomandibular Disorders for clinical and research applications. *Journal of American Dental Association.* 2016;1-8
7. Tanti I, Himawan LS, Kusdhany L, et al. Validation of Stress Screening Questionnaire in Temporomandibular Disorders Patient. *Journal of International Dental and Medical Research.* 2016;(9)272-276
8. Tanti I, Himawan LS, Kusdhany L, et al. Etiology of Temporomandibular Disorders Index. *Journal of International Dental and Medical Research.* 2016;(9)299-305
9. Nokar S. Evaluation of signs, symptoms, and occlusal factors among patients with temporomandibular disorders according to Helkimo index. *The journal of craniomandibular & sleep practice.* 2018;1-6
10. Okeson JP. Reliability and Validity of DC/TMD the Axis I; Critical commentary I. *Quintessence Publishing.* 2018:1-3
11. Schiffman EL and Ohrbach R. Reliability and Validity of DC/TMD the Axis I; Critical commentary II. *Quintessence Publishing.* 2018:1-3
12. Svensson, Bendixson. Reliability and Validity of DC/TMD the Axis I; Critical commentary III. *Quintessence Publishing.* 2018:1-2
13. Otserlund C. Diagnostic Criteria for Temporomandibular Disorders: diagnostic accuracy for general dentistry procedure without mandatory commands regarding myalgia, arthralgia and headache attributed to temporomandibular disorder. *Journal of oral rehabilitation.* 2018;45(7)497-503
14. Van Der Weele. Helkimo's index: a scale or just a set of symptoms? *Journal of oral rehabilitation.* 1987;(14)229-237
15. Von Korff M. Assessment of chronic pain in epidemiological and health services research: empirical bases and new directions. In: Turk DC, Melzack R, eds. *Handbook of Pain Assessment.* 3rd ed. New York, NY: Guilford Press; 2011:455-473.
16. Von Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain.* 1992;50(2):133-149.
17. Ohrbach R, Larsson P, List T. The Jaw Functional Limitation Scale: development, reliability, and validity of 8-item and 20-item versions. *J Orofac Pain.* 2008;22(3):219-230.
18. Ohrbach R, Dworkin SF. The evolution of TMD diagnosis: past, present, future. *Journal of Dental Research.* 2016;95(10):1093-1101.
19. Kroenke K, Spitzer RL, Williams JB, et al. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics.* 2009;50(6): 613-621.
20. Löwe B, Wahl I, Rose M, et al. A 4-item measure of depression and anxiety: validation and standardization of the Patient Health Questionnaire- 4 in the general population. *J Affect Disord.* 2010;122(1-2):86-95.
21. Markiewicz MR, Ohrbach R, McCall WD Jr. Oral behaviors checklist: reliability of performance in targeted waking-state behaviors. *J Orofac Pain.* 2006;20(4):306-316.
22. Michelotti A, Alstergren P. Next steps in development of the diagnostic criteria for temporomandibular disorders (DC/TMD): Recommendations from the International RDC/TMD Consortium Network workshop. *Journal of oral rehabilitation.* 2016;43:453-467.