

Etiology of Temporomandibular Disorders Index

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Abstract

The etiology of temporomandibular disorders is complex and multifactorial. Usually, the diagnosis was done by clinical signs and symptoms. The purpose of this research is to produce an index based on etiology so early prevention and prompt treatment can be done.

This study was a quantitative study, producing a valid and reliable index to predict the etiology of temporomandibular disorders. Included in this index are stress, bad habits, gender, and the free way space which is a part of an occlusion.

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Introduction

Temporomandibular disorders (TMD) are defined as a collective term that embraces a number of clinical problems that involve the masticatory muscles, the temporomandibular joint, and the associated structures. Pain and dysfunctional symptoms or signs such as limitation in an opening, TMJ sounds, and deviation in the mandibular range of motion are the most common findings.¹ It may cause disruption of activities due to the pain sufferers that can degrade the quality of life of patients.

Cross-sectional epidemiological studies according to Turp et al., in Tabbara, showed that 40-75% of the adult population has at least one sign related to TMD. Another researchers Rugh et al. (1985), Schiffman et al. (1988), Dworkin et al. (1990), De Kanter et al. (1993), De Leeuw (2008), in McNeill and Tabbara, showed that about 33% of the population has at least one symptom of TMD. Howard, in McNeill, said that from 3.428 TMD patients, the majority of TMD patients aged ranging between 15-45 years (average 32.9 years). An increase in cases of TMD estimated as much as 2% / year. Himawan (2007) conducted a survey of students of the

faculty of dentistry in Universitas Indonesia showing as much as 96% of students have one sign related to TMD.²⁻⁴

Temporomandibular disorders are still difficult to diagnose and treated. It is caused by the etiology and pathogenesis of TMD is still difficult to understand. Determination of diagnosis is usually based on indices that mostly refers to the clinical signs and symptoms. That is why the etiology of TMD is still unclear. The therapeutic approach is given to TMD patients is mostly palliative therapy, i.e. only relieve the symptoms and do not cure the disease.⁵

Temporomandibular disorders are mostly found in women than men. Epidemiological studies suggested that the prevalence of TMD in women is twice as much compared to men. (2: 1). Some researchers said that TMD occurred at age 20-40.⁶ Etiology of TMD is complex and multifactorial because several factors may contribute to this disorder. According to Okeson, there are five major factors that related to the occurrence of TMD i.e. occlusal factors, trauma, emotional stress, deep pain inputs, bad habits and parafunctional activities.⁶ Wadhwa said that the etiology of TMD are trauma or repetitive mechanical loading, hormonal factors, and genetic factors.⁵ Several etiology factors of the TMD have been acknowledged including malocclusion, acute trauma, chronic repetitive trauma such as tooth grinding or clenching and also psychogenic.⁷

A tool that is easy, simple, and accurate to be used to look into the role of macro-trauma,

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bad habits, and parafunction as well as emotional stress, malocclusion, head and neck posture, and other factors that contributed to the occurrence of TMD is needed. The purpose of this research was to produce an index to determine the diagnosis of TMD. This index could be used as a prevention tool as well as a guideline for treatment from the point of etiology. In creating this index, several clinical data, radiography, and questionnaires were collected from epidemiological studies on Indonesian people in Jakarta.⁸

Materials and methods

The research design was a Quantitative research. 253 subjects, aged 15-88 were participated in this research. It was conducted to test the validity and reliability of the questionnaire which was collected from qualitative study i.e macro-trauma, stress, and bad habits questionnaire.⁸ Case-control design was used to develop the TMD index according to etiology, using the RDC / TMD as a gold standard.

The research was carried out in 2012-2014, in the dental hospital, faculty of dentistry, Universitas Indonesia. A sample of consecutive patients who were come to Faculty of Dentistry Universitas Indonesia aged over 15 years and be willing to follow the research by filling in the provided informed consent was asked to fill three questionnaires i.e. macro trauma, emotional stress, and bad habits. The patient does not suffer from systemic diseases such as systemic rheumatic, neurologic / neuropathic, or autoimmune disease and were not taking certain medications such as muscle relaxants, steroid therapy, antidepressants, not being in radiation therapy for head and neck, did not experience a mental disorder, and never underwent TMJ surgery. These All subjects gave informed consent to procedures approved by the proper Ethics Committee Faculty of Dentistry.

Data analysis

The questionnaire was analyzed using factors analysis, test validity and reliability tests (the Cronbach's alpha). The head and neck posture anthropometry were analyzed using a Technical Error Measurement (TEM) by Dahlberg to assess the validity and reliability of the measurement.

Normality data test performed on a numeric variable. For normal distribution data, i.e.

head and neck posture (angle of NSL-OPT, NSL-CVT, CVT horizontal, OPT horizontal), bad habit, and stress variables, bivariate analysis using independent t-test were performed. For Age and macro trauma variables, distribution data were not normal, so analyzed were done by nonparametric Mann-Whitney test. Bivariate analysis using Chi-square test was done on the variable of malocclusion. This test was used to see whether there was a difference between case and control group on head and neck posture (CVA), gender, education, and employment variables. After that, multivariate analysis using a logistic regression analysis was done to built an etiology index

Results

1. Preparation Phase

Macro-trauma, emotional stress, and bad habits questionnaire conducted a factors analysis, test validity and reliability tests. These three questionnaires did not use a lot of components, but only one component of the total value. This was consistent with the results of factor analysis on each questionnaire. Based on the result of factor analysis, a validity and reliability test could be continued. From the reliability test, the value of the Cronbach's alpha was 0.76 for the "Macro-trauma" questionnaire. The correlation between each item with a total item was strong, $r=0.59 - 0.76$, and the correlation between the items in the macro trauma questionnaire was weak-strong ($0.13 - 0.65$). However, because the meaning of the question was different, it was not excluded even they had a strong correlation. (Table 1)

Macro Trauma			
No	Question	Code	Instruction
1	Have you ever experienced trauma in the facial area?		Fill the code : 0 = Never 1 = Seldom 2 = Often
2	Have you ever experienced trauma in the chin area?		
3	Have you ever experienced trauma on the left lower jaw area?		
4	Have you ever experienced trauma on the right lower jaw area?		
5	Have you ever experienced trauma in the upper jaw area?		
Macro Trauma Total score		0	

Table 1. Macro Trauma Questionnaire.

For the "bad habit" questionnaire, a similar step of the test was also done. From the reliability test, the value of the Cronbach's alpha

was 0.82. The correlation between each item with a total item was moderate-strong, $r=0.27 - 0.63$. The correlation between the items in the questionnaire was weak-strong ($0.17 - 0.65$). However, because the meaning of the question was different, it was not excluded even they had a strong correlation.(Table 2)

Bad Habit			
No	Question	Code	Instruction
1	Do you chew on one side of the jaw?		
2	Do you have the habit of nail biting?		
3	Do you have the habit of biting the hard objects e.g. sewing needles, pencil, etc.?		
4	Do you like to chew gum?		
5	Do you like to lean the chin?		
6	Do you like sucking the cheeks?		
7	Do you have a habit of sleeping on one side?		
8	Do you like to play the jaw?		
9	Do you like to bite the upper lip?		
10	Do you like to bite the lower lip?		
11	Do you like to suck the tongue?		
12	Do you like to suck your tongue and cheeks at the same time?		
13	Do you have a habit of playing the appliance (dental appliance) or prosthesis in your mouth?		
14	Do you breathe through your mouth?		
15	Do you snore while sleeping?		
16	Do you have daytime sleepiness?		
17	Do you clench your teeth during the day?		
18	Do you clench your teeth at night?		
19	Do you grind your teeth during the day?		
20	Do you grind your teeth at night?		
21	Has any one heard you grinding your teeth frequently during sleep?		
Score		0	
Bad Habit Total		0	

Table 2. Bad habit questionnaire.

For "stress" questionnaire, the validity test showed that the correlation between each item with a total item was moderate - strong, $r = 0.51 - 0.79$. Pearson correlation value between the items ranged from weak-strong ($0.15 - 0.70$). Reliability test showed that the value of Cronbach alpha coefficient was 0.92.(Table 3)

After the validity and reliability test completed, Kappa test was performed on 36 subjects to test the consistency of dental malocclusion examination. The examination was carried out by two operators (dentist) that had previously been taught on how to fill the dental examination sheet. The Kappa value got was between 0.71 - 1.00. Thus, the result of this test showed a high consistency between the two researchers.

To analyze the head and neck posture anthropometry, a Technical Error Measurement (TEM) by Dahlberg was used to assess the

validity and reliability of the measurement. This analysis was conducted on 36 subjects, and the measurement analysis was done by two researchers (inter rater).

EMOTIONAL STRESS			
No	QUESTION	Code	Instruction
1	Do you feel sad because of something not expected to happen?		
2	Do you feel weak or loss of balance?		
3	Do you feel excessive worry?		
4	Do you feel fatigued?		
5	Do you blame yourself?		
6	Do you feel easy to cry?		
7	Do you feel lonely?		
8	Don't you interested in any?		
9	Do you feel hopeless for the future?		
10	Do you feel unable to control something important in your life?		
11	Do you feel nervous, confused and depressed?		
12	Do you feel there is something missing from you?		
13	Do you find that you can't cope with anything to be done?		
14	Do you angry because something happens outside of your control?		
15	Do you find it very difficult to face of something that you can't fix it?		
16	Do you feel everything is difficult?		
17	Do you feel worthless?		
18	Do you feel guilty?		
Emotional Stress Total Score		0	

Table 3. Stress questionnaire.

The value of TEM was range 1.60 - 3.71 (Table 4). This big difference in value was resulted from the 3 landmarks used in this study. When using fewer landmarks, the possibility error would be fewer. No reference stated that the value was accepted or not.

Head and Neck Posture Variable	TEM
n=36	
OPT/NSL	2.14
OPT/HOR	1.93
CVA	3.71
CVT/NSL	1.86
CVT/HOR	1.60

Note: Dahlberg's Formula

Table 4. Lateral cephalometry radiograph measurement error.

2. Case Control Research

253 subjects, aged 15 - 88 were participated in this research. Among of them, 38 subjects did not complete the research, since

they did not fill the TMD questionnaire completely, and did not meet the inclusion criteria. Therefore, the analysis was done to 215 subjects.

The characteristics of the subject could be found in table 5. There was more female than male subjects. The number of subjects with and without TMD was almost balancing, i.e.1.1: 1 (113: 102). The average age was 38 years old, and most of them were educated and professional.

No	Subject Characteristic	n (215)	TMD n (%)	Non TMD n(%)	%
1	Gender				
	- Male	60	18 (15.9)	42 (41.2)	27.9
	- Women	155	95 (84.1)	60 (58.8)	72.1
2	Education				
	- < Elementary School	43	18 (15.9)	25 (24.5)	20.0
	- Junior-Senior High School	46	23 (20.4)	23(22.5)	21.4
	- University	126	72 (63.7)	54 (53)	58.6
3	Profession				
	- Professional	116	64 (56.6)	52 (51)	54
	- Non-Professional	99	49 (43.4)	50 (49)	46

Table 5. The characteristic of research subject.

Etiology	Mean ± SD		Value p	95% CI
	TMD n=69	Non TMD n=26		
NSL-OPT	75.89±7.33	76.65±7.89	0.67	-2.67 - 4.17
NSL-CVT	73.73±7.21	74.06±7.05	0.84	-2.94 - 3.61
OPT-hor	95.12±7.14	93.96±7.71	0.49	-4.50 - 2.17
CVT-hor	97.50±7.15	96.70±6.77	0.62	-4.02 - 2.42

Note: t-independent test numeric variable; p<0.05.

Table 6. Difference of Head and Neck Posture Variable between TMD and nont md.

Etiology	Mean ± SD		Value p	95% CI
	TMD n=113	Non TMD n=102		
Bad Habit	11.87±6.57	8.09±3.75	0.00	-5.20 - (-2.32)
Stress	14.8±9.92	9.81±5.40	0.00	-7.162 - (-2.80)

Note: t-independent test numeric variable; p<0.05

Table 7. Difference of Bad Habit and Stress between TMD and NonTMD.

The difference between the case and control groups were obtained from the total value of stress, bad habits, and age (p<0.05). There was no difference between the case and control groups on the macro-trauma, head and neck posture variables (Table 6, 7, 8).

Chi-square test showed that there were differences in case and control groups on the gender variable (p < 0.05). Even there was no difference in the case and control groups on malocclusion variables, transversal relationship on left molar, loss of teeth on maxilla region, overjet, free way space, and education had a value of p < 0.25 (Table 9).

Etiology	Mean Rank		Value p
	TMD n= 113	Non TMD n=102	
Age	99.75	117.14	0.04
Macro-Trauma	112.8	102.69	0.12

Note: Mann - Whitney test; p<0.05.

Table 8. Difference of Age and Macro-trauma between TMD and non TMD.

Etiology	TMD (%) n=113	Non TMD (%) n=102	Value p
Transversal relationship on molar			0.13
- Cusp to fossa	80 (37.2)	85 (39.7)	
- Palatal crossbite	17 (7.9)	11 (5.1)	
- Cusp to cusp	10 (4.7)	4 (1.9)	
- Scissors bite	6 (2.8)	2 (0.9)	
Loss of teeth on maxilla region			0.19
- There is no loss of teeth	61 (28.4)	48 (22.3)	
- One of the posterior region	16 (7.4)	9 (4.2)	
- Both of the posterior region	25 (11.6)	27 (12.6)	
- Anterior and two posterior region	11 (5.1)	18 (8.4)	
Overjet			0.09
- 2-4mm	60 (27.9)	63 (29.3)	
- <2mm	30 (14.0)	21 (9.8)	
- >4mm	18 (8.4)	8 (3.7)	
- There was no overjet	5 (2.3)	10 (4.7)	
Free way space			0.16
- 2-4mm	86 (40)	83 (38.6)	
- 0-<2mm	19 (8.8)	9 (4.2)	
- >4mm	8 (3.7)	10 (4.7)	
Gender			0.00
- Male	18 (8.4)	42 (19.5)	
- Women	95(44.2)	60 (27.9)	
Education			0.21
- < Elementary School	18 (8.4)	25 (11.6)	
- Junior-Senior high school	23 (10.7)	23 (10.7)	
- University	72 (33.5)	54 (25.1)	

Note: Chi-square test categoric variables; p<0.05.

Table 9. Difference of Categoric Variables between TMD and non TMD.

Variable	Coefficient	Wald	p	OR	95% CI
Stress	3.20	16.56	0.00	24.46	5.24 -114.11
Bad habit	0.99	6.16	0.01	2.72	1.23 -5.97
Gender	-1.38	10.98	0.00	0.252	0.11-0.57
Free wayspace		3.35	0.19		
Free way space	0.72	1.94	0.16	2.06	0.74 - 5.69
Free way space	1.52	1.57	0.21	4.56	0.43 - 48.81
constan	-0.39	2.82	0.09	0.68	

Table 10. Model I Etiology of Temporomandibular Disorders.

Macro trauma factor had no relationship with the occurrence of TMD, but this factor had a value of p = 0.12 (p < 0.25). Thus, the multivariate analysis could be continued.

For malocclusion variables, there was no relationship between malocclusion and the occurrence of TMD, but free way space, overjet, lost of teeth on maxilla region and transversal relationship on left molar had a value of p < 0.25. Thus a logistic regression analysis could be done. The result showed that the hypothesis of

predisposing factors in profession and education was rejected, nevertheless, education has a value of $p < 0.25$, so logistic regression analysis could be performed. The result of this study also rejected the hypothesis that the head and neck posture was the etiology of TMD.

Multivariate analysis was carried out using the enter method of logistic regression which was useful to assess the simultaneous connection of an outcome with several variables that were the etiology of TMD.

The variables included in this multivariate analysis were stress, bad habits, macro-trauma, free way space, overjet, lost of teeth on maxilla region, transversal relationship on left molar, age, education, and gender. The result of this analysis could be seen in Table 10. On this model, stress and bad habit variables had not been categorized.

This model had a value of Hosmer and Lemershow $p = 0.55$ this indicated that the model was supported by the empirical data (fit model). The strength of the model could be seen from the R-square value, i.e. 39.2%.

After the cutoff point was obtained, multivariate analysis was performed again using logistic regression to obtained a final model etiology of TMD. (Table 11)

Variable	Basis	B	S.E.	Wald	p	OR	95% CI OR
Gender	Women	1.44	0.39	13.77	0.00	4.25	1.98-9.13
Stress	yes	3.22	0.78	17.05	0.00	25.04	5.43-115.53
Bad Habit	yes	0.99	0.39	6.32	0.01	2.69	1.24-5.85
free way space	<2 mm or >4mm	0.69	0.40	2.97	0.09	1.99	0.91-4.38
Constant		-1.74	0.37	21.61	0.00		

Table 11. Final Model Etiology of Temporomandibular Disorders.

Etiology	Code	Value	Score (code x value)
Gender			
- Women	1	5	
- Male	0		
Stress			
- Yes	1	6	
- No	0		
Bad Habit			
- Yes	1	2	
- No	0		
Free way space			
- 2-4mm	0	1	
- <2mm or >4mm	1		
Jumlah skor	0-14		
Conclusion :	<input type="checkbox"/> Low risk of TMD (< 7) <input type="checkbox"/> High risk of TMD (≥ 7)		

Table 12. Temporomandibular Disorders Etiology Index.

This Model had a sensitivity of 62.8% and specificity of 81.4% with the area under curve 80.1%.The value of Hosmer and Lemershow was $p = 0.792$. This indicated that

the model was supported by the empirical data (fit model). The strength of the model could be seen from the R-square value, i.e. 37.2%.

The scoring model was build to made a TMD etiology index. Number simplification was done. The score was obtained for each variable (Table 12).The results showed that the cutoff point of TMD was ≥ 7 , the value of sensitivity was 47.8%, and specificity was 88.2%, the area under curve was 79.2%.

	RDC/TMD			Total
	No TMD	TMD		
Etiology TMD	No TMD	83	19	102
Index	TMD	43	70	113

Table 13. Result Comparison between RDC/TMD and TMD Etiology Index.

The comparison between TMD subjects and non-TMD subjects were reviewed by RDC/TMD. It could be seen in Table 13. A score of stress and score of bad habits were obtained from the total score of the stress questionnaire and bad habits questionnaire. (Table 2 and Table 3)

The table showed that the pseudo-positive value was more than the pseudo-negative value. Pseudo positive value stated that there were subjects who had no TMD, were declared as TMD subjects by etiology TMD index. The positive predictive value was 61.9% and the negative predictive value was 81.4%.From the table above, it was seen that the value of LR +4.05, while LR -0.59.

Discussion

Research questionnaire has good psychometric assessments and can be used to perform macro trauma, bad habits, and stress screening as the etiology of TMD. These instruments have a high internal consistency and prove that the questionnaire had a good of constructs validity.

Bivariate analysis demonstrated that there were a relationship between gender, age, stress, and bad habits and the occurrence of TMD. Malocclusion such as the loss of teeth, molar and canine relations, overjet, overbite, free way space showed there was noa relationship. The head and neck posture that was seen from the NSL - OPT, NSL - CVT, OPT - horizontal, CVT - horizontal, and CVA were no statistically significant relationships with TMD. Including

sociodemographic variables such as education and profession.

A systematic review of clinical research reported that the age, gender, and psychological factors associated with TMD. This research suggests that women are common in the occurrence of TMD. Age factors in this study showed that there is a relationship with TMD, in accordance with previous studies that aged 25-45 years are common in the occurrence of TMD.^{9,10}

Bonjardim et al., and Manfredini et al., in Mottaghi et al., suggested that anxiety associated with TMD. Mehdizale and Madani, in Mottaghi et al., comparing some of the initiating factors of TMD and concluded that the psychological factor was the most important factor among other factors.¹¹

Emodi-Perlman et al argued that the intensity of the bad habits play a role in the occurrence of disturbances in the system of stomatognathic. A constant load on the TMJ and the muscles of mastication can cause the onset of the sound joints and pain in the muscles. For example, there was a statistically significant relationship between chewing gum for three hours per day with the onset of signs and symptoms of TMD. Jaw Play, oral tissue biting, nail and foreign object biting, leaning of the head on the arm and clenching led to the increased severity of TMD.¹²

In some papers, interpretation the head and neck posture were based on empirical or personal experience of the researchers.¹³ Determination points of anatomy at the time of the measurement was very crucial to be done since inequality perception between the two researchers would result in error. In this research, the measurement of CVA had the greatest error i.e. 3.714. It could happen since it was difficult to determine the ANS and PNS point. Many variations of anatomy landmark could be found at that point, especially on the curve between the ANS and PNS point. The research states that body posture can affect the occurrence of TMD, could not be proved in this research.

Predisposing factors other than age and gender are education and employment. Between the two variables that can be entered into the multivariate analysis is education, but the end result obtained education could not enter into the equation models of etiology of TMD.

In etiology of TMD, occlusion was a predisposing or perpetuating factor, although some research proves the absence of a relationship between occlusion and the occurrence of TMD. In accordance with the results of this study, there were no relationships between occlusion factor and the occurrence of TMD. However, there are some variables that can be entered into the multivariate analysis, i.e. the relationship of the transversal molar tooth loss, a region of missing teeth, overjet and free way space. From the results of the logistic regression analysis, free way space entered into the model of TMD etiology index. This confirmed by Harper who was said that the increased of an occlusal vertical dimension could cause the muscles mastication hyperactivity. Instead of the decreased of occlusal vertical dimension related to the occurrence of internal derangement of TMJ or osteoarthritis.^{14,15}

From the multivariate analysis, it was concluded that variables in the final result had a relation with the occurrence of the TMD. The risk of each variable based on the Odds Ratio was as followed; a subject who had stress had a risk of TMD 25.04 times greater than the subject who had no stress. Female had a risk of TMD 4.25 times greater than male subjects. Subjects who had a bad habit had a risk of TMD 2.70 times greater than a subject that has no bad habits. Subject who had an abnormal free way space, had a risk of TMD 1.99 times greater than a subject that has a normal free way space (2-4 mm).

Age plays a role against the occurrence of TMD, but it could not enter into the model. Factors of head and neck posture, macro trauma and malocclusion, such as molar relations, canine relations, occlusion scheme, transversal relationship on right and left molar, the amount of missing teeth on the maxilla and mandible, the region of missing teeth, overjet, overbite, crossbite based on region, slide in centric, tooth wear, and the midline had not played a role in the occurrence of TMD. Similarly, the predisposing factors of education and profession.

Conclusions

The TMD etiology index consists of several components, i.e. stress, gender, bad habits, and free way space. This is an easy, simple, and accurate index in determining the

etiology of TMD. The biggest contribution to get the etiology of TMD are stress, female gender, bad habits, and Free way space which is a component of the malocclusion.

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Declaration of Interest

The authors report no conflict of interest.

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