

## Tobacco Smoking and the Degree of Severity of the Pain of Temporomandibular Disorders (TMD)

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### Abstract

In 2016, the Tobacco Atlas reported that 66% Indonesian males were cigarette smokers. Epidemiologic studies have indicated that smoking might be associated with musculoskeletal pain. Some studies have reported that there is a relationship between cigarette smoking and temporomandibular disorders (TMD) because the pain from TMD could originate from the musculoskeletal. But this kind of study has yet to be done in Indonesia. The aim of the current study was to evaluate the relationship of cigarette smoking on pain severity in TMD patients. Fifty-four TMD patients participated in the study. They were first divided into two groups: smokers and nonsmokers. Then, the smokers were further divided into three subgroups: light, moderate, and heavy smokers. The subjects were diagnosed according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I, and the TMD pain level was derived from the Visual Analog Scale (VAS). All the collected data were analyzed using Kruskal Wallis and post hoc Mann-Whitney tests. The TMD pain severity was significantly higher in smokers compared to nonsmokers, and a significant relationship was found between pain severity and the number of cigarettes smoked in a day. Smoking seems to affect TMD pain severity, so the control of smoking habits should be considered when treating TMD patients.

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### Introduction

The temporomandibular joint (TMJ) is one of the most complex joints in the body. It is formed by the mandibular condyle and the mandibular fossa of the temporal bone and is a compound joint. By definition, a compound joint requires the presence of at least three bones, yet the TMJ is made up of only two. The articular disc functions as a third bone that permits the complex movement of the joint. The TMJ is innervated by the trigeminal nerve. It is supplied by a variety of vessels. Ligaments, as in any system, play an important role in protecting the joint's structures.<sup>1</sup>

The term temporomandibular disorders (TMD) refer to a group of disorders affecting the

TMJ masticatory muscles and their associated structures. These disorders share the symptoms of pain, limited mouth opening, and joint noises.<sup>1</sup>

TMD is thought to have a multifactorial etiology. Okeson (2013) classified the etiology into five factors: occlusal factor, trauma, emotional stress, deep pain input, and para functioning activity. Parafunction activity, such as clenching and bruxism, biting habits, tongue thrust, one side chewing, and chin resting on the hand has been associated with TMD.<sup>1</sup>

The relationship between cigarette smoking and TMD has rarely been investigated. Altschuler (1999) hypothesized the role of smoking as a risk factor for the development of TMD based on his personal experience, and he encouraged researchers to investigate this relationship.<sup>2</sup> Similarly, Jay (2000) suggested exploring the effect of smoking on the genesis of symptoms of chronic fatigue syndrome, fibromyalgia, and TMD.<sup>3</sup> De Leeuw, Eisenlohr-

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Moul, and Bertrand (2013) collected data from 3.251 TMD patients, evaluating the symptoms of each patient. It was found that smokers with TMD reported a higher pain severity than nonsmokers with TMD.<sup>4</sup>

Smoking is not significantly associated with TMD formation, but it is related with pain from TMD. Nicotine has a negative effect on the pain of TMD patients. The nicotine in cigarettes can cause vasoconstriction and produce a higher level of CO in blood stream, inhibiting the level of oxygen in the blood stream.<sup>5,6</sup> In addition, smoking can cause protrusive jaw movements that give an excessive force or cause joint in its unstable position and higher muscle tone.<sup>7,8</sup>

In many countries, smoking is a daily habit. The World Health Organization (WHO) reported the prevalence of smokers in the world are higher in male (47%) than female (12%).<sup>9</sup> Out of the total population of males in Indonesia, 69% are smokers. The percentage of smokers in Indonesia is one of highest compared to other countries in Asia. For example, China is at 53.4%, Thailand 39.3%, and India 29.4%. A survey by Varenicline Asian Consumer Research conducted in the aforementioned four countries revealed that 48% of smokers in Indonesia smoke 11–20 cigarettes a day. About 12% smoke 21–30 cigarettes a day and only 4% smoke more than 30 cigarettes a day. Whereas, only 24% of smokers smoked 6–10 cigarettes, with 12% smoking 1–5 cigarettes in a day.<sup>10</sup>

Research on the relationship between one's smoking habit and TMD, specifically on the severity of TMD, is still rare, especially in Indonesia. To fill in this knowledge gap, this preliminary research was conducted. Because

the etiology of TMD is multifactorial, different factors in each individual, such as gender and parafunction habits, might affect the degree of severity of TMD pain. Therefore, this study simultaneously examined the relationship of gender and parafunction habits, such as grinding teeth, one-sided chewing, tongue thrusting, chin resting on the hand, and biting habits with the degree of severity of TMD pain. The findings are expected to provide the information regarding to the benefit of oral health.

### Materials and Methods

The study used an analytical cross-sectional design, and the participants were 54 patients who came to the Clinic of Prosthodontics, Faculty of Dentistry, Universitas Indonesia with TMD as their chief complaint. Of the 54 patients, there were 27 TMD patients who smoked and 27 TMD patients who did not smoke. To be accepted for the study, the patient must not have been consuming any drugs that relieve pain, not partaking in orthodontic treatment, and be willing to be a subject of research and sign an informed consent paper. The following information was collected: TMD diagnosis, TMD pain intensity, para function habit, smoking habit, number of cigarettes smoked per day, age, and gender.

TMD diagnosis was recorded based on Axis I of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Patients were diagnosed as having muscle disorders, joint disorders, degenerative disorders, or more than one diagnosis (combination).<sup>11</sup>

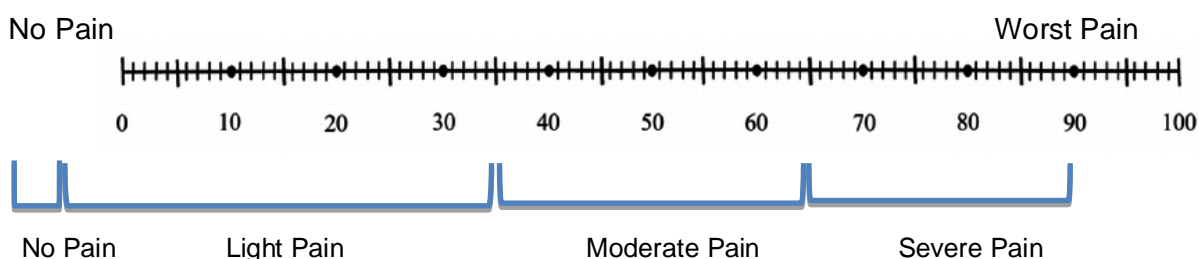


Figure 1. Visual Analog Scale (VAS)<sup>13</sup>

Pain measurement was performed using the Visual Analog Scale (VAS). VAS is a measurement instrument that measures a

characteristic or attitude that is normally hard to evaluate. Operationally, VAS usually is a horizontal line, 100 mm in length, and anchored

by word descriptors at each end of line (Fig. 1). The patient marks the line that represents his or her perception of his or her current state. To obtain an accurate result, each measurement is performed by the same operator.<sup>12,13</sup>

Parafuction habits and the number of cigarettes smoked in a day by each participant were recorded based on the patient's self-reporting. Subjects were first divided into two groups: smokers and non smokers. Then, the smokers were further divided into three subgroups: light smokers who reported 10 or less cigarettes a day; moderate smokers who reported 11–20 cigarettes a day; and heavy smokers who reported more than 20 cigarettes a day.

All the collected data were analyzed using Kruskal Wallis and post hoc Mann-

Whitney tests to evaluate the relationship between tobacco smoking and the degree of severity of TMD pain. The Mann-Whitney test was used to evaluate the relationship between gender, bruxism, one-sided chewing, lining of chin, tongue thrusting, and biting habits with the degree of severity of TMD pain. Differences were considered statistically significant when  $p < 0.05$ . All the data were tabulated, and statistical analyses were performed with SPSS.

### Results

All the subjects filled out the informed consent form, and the ethical commission from Faculty of Dentistry Universitas Indonesia approved this study.

**Table 1.** Distribution of patients based on gender and smoking habit

Variable	Non Smokers		Mild Smokers		Moderate Smokers		Heavy Smokers		Total	
	n	%	n	%	n	%	n	%	n	%
- Male	7	26.9	4	15.4	11	42.3	4	15.4	26	100
- Female	20	71.4	5	17.9	3	10.7	0	0	28	100
Total	27	50	9	16.7	14	25.9	4	7.4	54	100

The study was performed on 54 subjects who came to the clinic of prosthodontics Faculty of Dentistry, Universitas Indonesia with TMD as their chief complain. From the 54 subjects, there were 27 nonsmokers consisting of seven males (26.9%) and 20 females (71.4%), and there were 27 smokers consisting of 19 males (73.1%) and eight females (28.6%) (Table 1).

The subjects were equally distributed (27 TMD patients who smoked and 27 TMD patients who did not smoke); however, in the smokers group, there was a lack of equal distribution regarding the amount smoked, at nine light smokers (16.7%), 14 moderate smokers (25.9%), and four heavy smokers (7.4%).

**Table 2.** Distribution of patients based on DC/TMD diagnosis and smoking habit

Diagnosis		Cigarettes Smoke									
		Non smokers		Light smokers		Moderate smokers		Heavy smokers		Total	
		n	%	n	%	n	%	n	%	n	%
Muscle D	Joint D	9	33.3	8	88.9	5	35.7	4	100	26	48.1
	Combination	14	51.9	1	11.1	2	14.3	0	0	17	31.5
	Total	4	14.8	0	0	7	14	0	0	11	20.4
Total		27	100	9	100	14	100	4	100	54	100

The diagnosis of TMD was made based on the Axis I of the Research Diagnostic Criteria

for TMD. From the 54 subjects, 26 (48.1%) were diagnosed as having a muscle disorder, 17

(31.5%) as having joint disorders, and 11 (20.4%) as having more than one symptom. No one was placed into the degenerative group. In the nonsmokers group, 14 (51.9%) were diagnosed as having joint disorders, nine (33.3%) as having muscle disorders, and four (14.8%) as having more than one symptom. In this study was found that most of smoker subjects diagnosed with muscle disorders followed by combination and by joint disorders (Table 2).

The Kruskal-Wallis test was performed to analyze the relationship of tobacco smoking

and DC/TMD diagnoses. There was a significant relationship between smoking and DC/TMD diagnosis ( $p=0.008$ ). To find the differences between the groups, a post hoc analysis using a Mann-Whitney test was performed. The data analysis showed that different tobacco consumption between muscle disorders and joint disorders group, and also can be seen between joint and combination disorders groups. Although, there was no significant difference for the muscle and combination disorders groups (Table 3).

**Table 3.** Analysis the DC/TMD diagnosis and cigarette smoking habits

		n	Median (Min.-Max.)	$\rho$
Cigarettes smoking habits	Muscle disorders	26	1 (0-3)	0.008
	Joints disorders	17	0 (0-2)	
	Combination	11	2 (0-2)	

Kruskal-Wallis test, post hoc Mann-Whitney test; Muscle disorders vs, joint disorders  $\rho=0.004$ ; joint disorders vs. combination  $\rho=0.009$ ; and muscle disorders vs. combination  $\rho=0.689$

The measurement of pain was performed using VAS. In the nonsmoking group, nine (33.3%) patients reported no pain, 17 (63%) patients reported mild pain, and one (3.7%) patient reported moderate pain.

Meanwhile, in the smoking group, there were no (0%) patients who reported no pain, eight (28.6%) patients reported mild pain, 16 (59.2%) patients reported moderate pain, and three (11.1%) patients reported severe pain (Table 4).

**Table 4.** Distribution of the amount smoked and the severity of TMD pain (VAS)

	Severity of TMD Pain							
	No Pain		Mild Pain		Moderate Pain		Severe Pain	
	n	%	n	%	n	%	n	%
Nonsmokers	9	33.3	17	63	1	3.7	0	0
Light smokers	0	0	6	22.2	3	11.1	0	0
Moderate smokers	0	0	2	7.4	11	40.8	1	3.7
Heavy smokers	0	0	0	0	2	7.4	2	7.4
Total	9	16.7	25	46.3	17	31.5	3	5.5

All collected data were analyzed using Kruskal Wallis and post hoc Mann-Whitney tests to evaluate the relationship between tobacco smoking and the degree of severity of TMD pain. The differences were considered statistically significant when  $p<0.001$ . All the data were tabulated, and statistical analyses were performed with SPSS. The data from the post

hoc Mann-Whitney showed the differences of the degree of severity of TMD pain between the nonsmokers and smokers group ( $p=0.000$ ), light smokers and moderate smokers ( $p=0.001$ ), and light smokers and heavy smokers (0.012). There was no difference in the degree of severity of TMD pain between moderate smokers and heavy smokers (0.059) (Table 5).

**Table 5.** The relationship between smoking and the severity of TMD pain (VAS)

		n	Median (Min.-Max.)	p
Severity of TMD pain (VAS)	Nonsmokers	27	1 (0–2)	0.000
	Light smokers	9	1 (1–2)	
	Moderate smokers	14	2 (1–3)	
	Heavy smokers	4	2.5 (2–3)	

Kruskal-Wallis test, post hoc Mann-Whitney test: nonsmokers vs. light smokers  $p=0.007$ ; nonsmokers vs. moderate smokers  $p=0.011$ ; light smokers vs. heavy smokers  $p=0.012$ ; moderate smokers vs. heavy smokers  $p=0.05$ .

**Table 6.** Distribution of etiology factors of TMD

Variable	n	%
Gender		
- Male	26	48.1
- Female	28	51.9
Tooth grinding		
- Yes	29	53.7
- No	25	46.3
One-sided chewing		
- Yes	46	85.2
- No	8	14.8
Lining on chin		
- Yes	54	100
- No	0	0
Tongue thrusting		
- Yes	54	100
- No	0	0
Biting objects		
- Yes	54	100
- No	0	0

**Table 7.** The relationship between smoking and severity of TMD pain (VAS)

		n	Median (Minimum- Maximum)	p
Gender				
- Male	26	2(0–3)	0.0	
- Female	28	1(0–3)	11	
Tooth grinding				
- Yes	29	1(0–2)	0.3	
- No	25	1(0–3)	37	
One sided chewing				
- Yes	8	1.5(0–3)	88	
- No				

Mann-Whitney Test

Based on the data collected, found that there were 25 (46.3%) subjects have a tooth-grinding habit and eight (14.8%) subjects with one-sided chewing habit. However, based on the examination of the 54 subjects, none (0%) had lining of the chin, tongue thrusting, or the habit of biting objects (Table 6). The analysis of

the Mann-Whitney test did not show any significant relationship between the etiological factors (tooth grinding and one-side chewing) and the severity of TMD pain. However, the Mann-Whitney analysis showed that gender had a significant relationship to the severity of TMD pain (Table 7).



## Discussion

The study used an analytical cross-sectional design to analyze the relationship of smoking tobacco with the severity of TMD pain. A cross-sectional design has several advantages. It can be used to examine several variables at the same time, be used as a basis for further research, and can make use of the general public as participants. In addition, it is relatively easy and cheap, and results can be obtained quickly. However, this design cannot determine causal variables, and it requires a number of subjects.<sup>14</sup>

The minimum sample required for this study was 44 subjects. However, there were 54 subjects for the current study. All of the participants had agreed to take part in the research. All of the subjects were analyzed based on the relationship of their smoking habits and the severity of TMD pain.

Based on data, shows that most of smokers were male. In addition, in Indonesia, the prevalence of male smokers was at 64.9% while only 6.7% was female.<sup>10</sup> Its explains the study having a higher proportion of male smokers than female.

Subjects on this research were evenly distributed in each group. However, there were uneven distributions in the smokers group. Based on data collected, most of the participants were moderate smokers (10–20 cigarettes a day).

According to the DC/TMD Axis I index, it was found that most of smoker subjects diagnosed with muscle disorders followed by combination and by joint disorders. The statistical results showed that there was a relationship between smoking habit and diagnosis of TMD ( $p < 0.05$ ). However, this contrasts with Melis et al. (2010), who reported that there is no relationship between smoking and Axis I.<sup>5</sup> In this study was also found that most of the subjects in the joint disorders group were nonsmokers (51.9%). In the muscle disorders group, the most of the subjects were smokers (63%). These findings are in line with de Leeuw et al.'s research (2013), in which the RDC/TMD method was used. De Leeuw et al. (2013) reported that most smokers are diagnosed in RDC/TMD group I.<sup>4</sup> In this study

was found that most of smoker subjects diagnosed with muscle disorders followed by combination and by joint disorders. From the results, it appears that muscle disorders and combination disorders are often found in smokers. This might be caused by protrusive jaw movements that give an excessive force or causes joint in its unstable position while they are smoking.<sup>7,8</sup>

In nonsmokers group, the most of the subject were reported had light pain, followed by no pain and moderate pain. Meanwhile, in the smokers group, there were no patient who reported had any pain but most of the subjects were reported had moderate pain followed by severe pain. These results show that there are differences in the perception of pain; for instance, there were 11 moderate smokers who reported moderate pain, but only one moderate smoker reported severe pain. There was a positive relationship between severity of TMD pain and number of cigarettes smoked per day, which is in line with Melis et al. (2010), who reported a positive relationship between the intensity of pain and the number of cigarettes smoked a day.<sup>5</sup> However, Wänman (2005) reported that there was no difference in the signs and symptoms of smokers and nonsmokers.<sup>6</sup> Reducing the number of cigarettes smoked a day and temporarily stopping smoking may be a consideration for the management of TMD patients.<sup>4</sup>

The aim of this study was to determine the relationship between smoking and the severity of TMD pain, which was obtained from a VAS-based questionnaire. The Kruskal Wallis analysis showed that there was a significant relationship between smoking habit and the TMD pain severity ( $p = 0.000$ ). The Mann-Whitney analysis also showed that there was a significant relationship of TMD pain severity between smokers group and nonsmokers group. It is also shown the same result between mild smoker with moderate and heavy smoker. However, the results showed that there were no significant differences in TMD pain severity between moderate and heavy smokers. The number of cigarettes consumed increased the severity of TMD pain. This finding is in line with Melis et al. and de Leeuw et al. (2013), who concluded that smoking is a key factor when it comes to the intensity of TMD pain.<sup>4,5</sup> De Leeuw et al. (2013) also explained that smokers with

TMD pain reported higher pain levels compared to non smokers.<sup>4</sup>

Smoking has not been significantly associated with TMD formation, but has been related with the pain. Joseph et al reported that smoking has been associated with changes in the levels of neuropeptides. Fibromyalgia patients who smoke had higher levels of substance P in their cerebral spinal fluid, which related with pain. Smokers had lower plasma beta-endorphin levels than nonsmokers.<sup>15</sup> The nicotine in cigarettes can cause vasoconstriction and produce higher levels of CO in blood stream, inhibiting the level of oxygen in blood stream.<sup>5,6</sup>

Nicotine has a negative effect on the pain of TMD patients. In addition, smoking can cause protrusive jaw movements that give an excessive forces or causes joint in its unstable position and higher muscle tone. Smokers sometimes have the habit of holding a cigarette in their mouth. This activity affects the muscles and joint, keeping them from relaxing.<sup>5,7</sup> The results of this study are consistent with previous studies in which tobacco smoking habits were shown to positively impact on the severity of TMD pain.<sup>3,4,5</sup>

The Mann-Whitney result showed no significant relationship between the etiological factors of grinding teeth and one-sided chewing with the severity of TMD pain. Therefore, grinding teeth and chewing on one side does not affect the severity of TMD pain. Bertazzo-Silveira et al. reported bruxism is often associated with smoking.<sup>16,17</sup> It was reported that the chances of a smoker having bruxism is 2.4 times higher than for a nonsmoker.<sup>17</sup> The absence of subjects who reported chin resting on the hand, tongue thrusting, and the habit of biting objects could have been because of the low participant pool.

Gender had a significant relationship with the severity of TMD pain. This could be because most of the smokers groups are male. This was in line with data that reported most of the smokers in Indonesia consist of men.<sup>9,18</sup>

The limitation of this study is the small sampling size. Thus, having subjects with various etiological factors of TMD (confounding factor) was not achieved. There were some difficulties experienced during this study, such as finding TMD subjects categorized as heavy smokers. This may be because of people living

in big cities trying to live healthier. In addition, the popularity of electric cigarettes is increasing, which could have affected the number of smokers as well.

## Conclusion

Based on the results, there was a significant relationship between smoking habit and the severity of TMD pain. Gender was related to the severity of TMD pain. Para function activity, such as grinding teeth and chewing on one side, was not related to the severity of TMD pain. Other factors, such as lining on chin, tongue thrusting, and the habit of biting objects, were not studied.

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