

Path Analysis: The Effect of Smoking on the Risk of Periodontal Disease

Hilmiy Ila Robbihi¹⁾, Endang Sutisna Sulaeman²⁾, Setyo Sri Rahardjo²⁾

¹⁾Masters Program in Public Health, Universitas Sebelas Maret

²⁾Faculty of Medicine, Universitas Sebelas Maret

ABSTRACT

Background: Periodontal diseases are prevalent both in developed and developing countries and affect about 20-50% of global population. Several risk factors such as smoking, poor oral hygiene, diabetes, medication, age, hereditary, and stress are related to periodontal diseases. The purpose of this study was to determine the effect of smoking on the risk of periodontal disease, using path analysis.

Subjects and Method: A case control study was carried out in Tasikmalaya community health center, West Java, from October to November 2018. A sample of 200 patients was selected by fixed disease sampling. The dependent variable was periodontal disease. The independent variables were age, knowledge on oral health, education, income, smoking behavior, oral and dental health behavior, plaque, and calculus. The data were obtained from medical record and questionnaire. The data were analyzed by path analysis.

Results: The risk of periodontal disease directly increased by smoking behavior ($b = 0.92$; 95% CI = 0.09 to 1.75; $p = 0.030$), after controlling for the effect of calculus ($b = 1.23$; 95% CI = 0.40 to 2.07; $p = 0.004$) and age ($b = 1.63$; 95% CI = 0.76 to 2.50; $p < 0.001$). The risk of periodontal disease directly decreased by better knowledge on oral and dental health ($b = -0.92$; 95% CI = -1.72 to -0.12; $p = 0.023$) and high income ($b = -1.47$; 95% CI = -2.32 to -0.60; $p < 0.001$). It was indirectly affected by plaque and education.

Conclusion: The risk of periodontal disease directly increases by smoking behavior, after controlling for the effect of calculus and age. In addition, the risk of periodontal disease directly decreases by better knowledge on oral and dental health and high income. It is indirectly affected by plaque and education.

Keywords: periodontal disease, smoking, factors, path analysis

Correspondence:

Hilmiy Ila Robbihi. Masters Program in Public Health, Universitas Sebelas Maret, Surakarta, Jl. Ir. Sutami 36 A, Surakarta, Central Java 57126. Email: hilmiylarobbihi@gmail.com.
Mobile: +628975565050.

BACKGROUND

Periodontal disease is a chronic inflammatory infection that causes damage to the supporting tissues of the teeth, characterized by loss of connective tissue attachment and alveolar bone resorption (Ferreira et al., 2017). The main cause is bacteria found in dental plaque. If left untreated, this disease will cause tooth damage even to tooth loss (Harvey, 2017). Besides plaque, the main cause of periodontal disease is calculus, which is a continuous factor

causing irritation to the gums so that it can cause inflammation of the gums. If it is not removed or cleaned, it will continue to damage the periodontal tissue (tooth support) and over time cause the tooth to shake and release itself (Artawa and Swastini, 2010). The loss of one tooth or more can cause discomfort so that it can interfere in various daily activities such as talking, eating, drinking, socializing and also feeling traumatized (Maulana et al., 2016).

Study in Africa in 1990-2010, the prevalence of dental caries was very high reaching 60% -90% in children and adults, in the same period periodontal disease also increased between 68% -75% (WHO, 2016). The prevalence of dental caries in Indonesia until 2013 has reached 90.05% and continues to grow along with increasing age (Hanapi, 2014), and the prevalence of periodontal disease up to 2015 has reached 96.58% (Wijaksana, 2016). According to data from Tasikmalaya City Health Office, it was found that periodontal tissue disease was included in dental medical disorders (specifically dental and oral diseases) and was the second largest after pulp and periapical tissue (around tooth roots) with a total of 9,479 cases around 69.59% in 2017.

The causes of periodontal disease are multifactorial, including: the main causative factors (plaque, calculus and age); predisposing factors (knowledge of dental and oral health, smoking behavior, and behavior in maintaining dental and oral hygiene); supporting factors (level of education and family income). Based on this background and the high number of periodontal diseases in Tasikmalaya, the authors are interested in further investigating the factors that influence the incidence of periodontal disease, one of which is smoking behavior and analyzing the determinants of the incidence of periodontal disease in Tasikmalaya.

SUBJECTS AND METHOD

1. Study Design

This was a case control study carried out in 21 community health centers in Tasikmalaya, West Java, from October to November 2018.

2. Population and Samples

The target population was patients who visit the dental clinic of the community health center in Tasikmalaya, West Java. A

sample of 200 patients was selected by fixed disease.

3. Study Variables

The dependent variable was periodontal disease. The independent variables were age, knowledge of dental and oral health, smoking behavior, oral and dental health behavior, oral and dental hygiene, education, family income, plaques, and calculus.

4. Operational Definition of Variables

Periodontal disease was defined as a state of chronic inflammatory infection that causes damage to the supporting tissues of the teeth, characterized by the loss of connective tissue attachment and resorption of alveolar bone.

Age was defined as length of time (year) from birth to the data collection. Knowledge of dental and oral health was defined as everything that is known to be related to the maintenance of oral and dental health, including the steps to brush teeth properly and correctly, regulate eating patterns, and check regularly every 6 months. Knowledge was measured by questionnaire. The measurement scale was continuous and transformed into dichotomous, coded 0 for low (score <16) and 1 for (≥score 16).

Education level was defined as the last formal education level taken by study subject. The measurement scale was categorical, coded 0 for <senior high school and 1 for ≥senior high school.

Family income was defined as a condition that describes the income of a husband, wife or family member obtained through work carried out with monthly average income in the last 6 months. The measurement scale was continuous and transformed into dichotomous, coded 0 for <Rp 1,931,435 and 1 for ≥Rp 1,931,435.

Oral and dental health behavior was defined as activity in maintaining the cleanliness of his teeth and mouth, including the

frequency of brushing teeth, how to brush teeth, when brushing teeth, tools and materials for brushing teeth. The measurement scale was continuous and transformed into dichotomous, coded 0 for <score 7 and 1 for \geq score 7.

Smoking behavior was defined as the status of smoking or not smoking by study subjects. Plaque was defined as a soft deposit that is firmly attached to the surface of the tooth. Plaque was measured from the results of dentist diagnosis in medical records. Calculus was defined as a source of periodontal inflammation and can cause irritation to the gingiva (gums), and will be the site of attachment of dental plaque. Data on calculus was obtained from medical record.

5. Study Instruments

The study instrument used for data collection was a questionnaire and medical record. Validity test included content validity and face validity. Reliability tests in this study were conducted on 20 patients. Reliability testing was measured by total item correlation (>0.20) and Cronbach alpha (≥ 0.70).

Table 1. Sample characteristics

Characteristics		Total (n)	Percentage (%)
Age	<35 years	118	59
	≥ 35 years	82	41
Family Income	Low	109	54.5
	High	91	45.5
Knowledge	Poor	111	55.5
	Good	89	44.5
Oral Hygiene	Poor	92	46
	Good	108	54
Smoking behavior	No	89	44.5
	Yes	111	55.5
Calculus	No	87	43.5
	Yes	113	56.5
Education	<Senior high school	96	48
	\geq Senior high school	104	52
Plaque	No	101	50.5
	Yes	99	49.5

6. Data Analysis

Univariate analysis was performed to see the frequency distribution and the percentage of the characteristics of the study subjects. Bivariate analysis was conducted using the Chi-square. Multivariate analysis was carried out by the path analysis model.

7. Research Ethics

The research ethics include informed consent, anonymity, confidentiality and ethical clearance. Ethical clearance in this study was obtained from at Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Central Java, with ID number 01/18/09/280.

RESULTS

1. Sample characteristics

Table 1 showed the results of sample characteristics. Table 1 showed that as many as 118(59%) patients were at age <35 years, 104 patients (52%) had high education, 109 patients (54.5%) had low family income, 111 patients (55.5%), 108 patients (54%) had good hygiene, 108 patients (54%) were smoker, 113 patients (56.5%) had calculus, 101 patients (50.5%) did not have plaque.

2. Bivariate Analysis

Table 2 showed the results of bivariate analysis. Table 2 showed that age ≥ 35 years (OR= 2.82; 95% CI= 1.46 to 5.46; $p= 0.003$), smoking (OR= 3.34; 95% CI= 1.62 to 6.88; $p= 0.001$), calculus (OR= 2.77; 95% CI= 1.36 to 5.62; $p= 0.007$), and plaque (OR= 1.57; 95% CI= 0.82 to 3.01; $p= 0.221$) increased the risk of periodontal disease.

High family income (OR= 0.24; 95% CI= 0.11 to 0.51; $p<0.001$), high knowledge (OR= 0.26; 95% CI= 0.12 to 0.54; $p<0.001$), good oral and dental hygiene (OR= 0.47; 95% CI= 0.24 to 0.9; $p= 0.033$), and high education (OR= 0.33; 95% CI= 0.16 to 0.65; $p= 0.002$) decreased the risk of periodontal disease.

Table 2. Bivariate Analysis of Determinants of Periodontal Disease

Variable	Periodontal Disease				OR	CI 95%	p
	No		Yes				
	N	%	N	%			
Age							
< 35 years	98	83.1	20	16.9	2.82	1.46-5.46	0.003
≥ 35 years	52	63.4	30	36.6			
Family Income							
Low	70	64.2	39	35.8	0.24	0.11-0.51	<0.001
High	80	87.9	11	12.1			
Knowledge							
Poor	72	64.9	39	35.1	0.26	0.12-0.54	<0.001
Good	78	87.6	11	12.4			
Oral Hygiene							
Poor	62	67.4	30	32.6	0.47	0.24-0.9	0.033
Good	88	81.5	20	18.5			
Smoking behaviour							
No	77	86.5	12	13.5	3.34	1.62-6.88	0.001
Yes	73	65.8	38	34.2			
Calculus							
No	74	85.1	13	14.9	2.77	1.36-5.62	0.007
Yes	76	67.3	37	32.7			
Educational background							
< SHS	62	64.6	34	35.4	0.33	0.16-0.65	0.002
≥ SHS	88	84.6	16	15.4			
Plaque							
No	80	79.2	21	20.8	1.57	0.82-3.01	0.221
Yes	70	70.7	29	29.3			

3. Path analysis

Figure 1 depicted structural model with estimate. Figure 1 showed that the number of measured variables was 9, the endogenous variables were 3, and the exogenous variables were 6. Degree of freedom (df)= 28, which means overidentified.

Table 3 showed the results of path analysis. Table 3 showed that there was a direct effect of smoking behavior on perio-

dontal disease. Patients who smoked had logodd for periodontal disease by 0.92 units higher compared to patients who did not smoke ($b=0.92$; 95% CI= 0.09 to 1.75; $p=0.030$).

There was a direct effect of calculus on periodontal disease. Patients with calculus had logodd by 1.23 units higher to have periodontal disease than patients with no

calculus ($b = 1.23$; 95% CI= 0.40 to 2.07; $p = 0.004$).

There was a direct effect of age on periodontal disease which was statistically significant. Patients aged ≥ 35 years old

have a logodd for periodontal disease by 1.63 units higher compared to patients aged < 35 years old ($b = 1.63$; 95% CI= 0.76 to 2.50; $p < 0.001$).

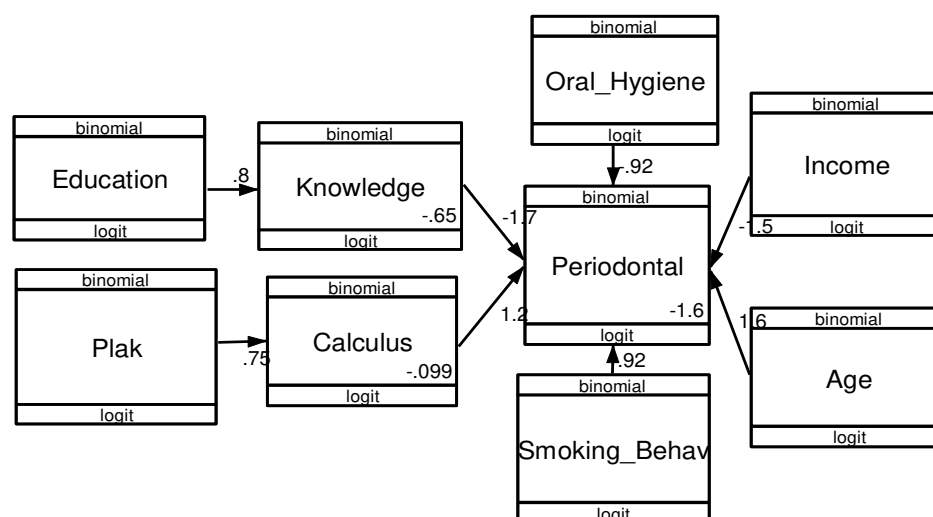


Figure 1. Structural model of path analysis with estimate

Table 3. The results of path analysis

Independent variables	Dependent variables	b	CI 95%		p
			Upper Limit	Lower Limit	
Direct Effect					
Periodontal disease	Smoking Behavior	0.92	0.09	1.75	0.030
	Calculus	1.23	0.40	2.07	0.004
	Age	1.63	0.76	2.50	<0.001
	Knowledge	-1.72	-2.65	-0.79	<0.001
	Oral Hygiene	-0.92	-1.72	-0.12	0.023
	Family Income	-1.46	-2.32	-0.60	<0.001
Indirect Effect					
Calculus	Plaque	0.75	0.18	1.32	0.010
Knowledge	Education	0.80	0.22	1.37	0.006
N Observation	200				
Log likelihood	-346.48				

There was a direct effect of knowledge of dental and oral health on periodontal disease which was statistically significant. Patients with high knowledge of dental and oral health have logodd for periodontal disease by 1.72 units lower than patients with low knowledge ($b = -1.72$; 95% CI= -2.65 to -0.79; $p < 0.001$).

There was a direct effect of behavior in maintaining oral hygiene on periodontal disease which was statistically significant. Patients with good oral hygiene behavior have logodd for periodontal disease by -0.92 units higher than patients with poor oral hygiene behavior ($b = -0.92$; 95% CI= -1.72 to -0.12; $p = 0.023$).

There was a direct effect of family income on periodontal disease which was statistically significant. Patients with high family income had logodds to periodontal disease by 1.47 units lower than patients with low family income ($b = -1.47$; 95% CI = -2.32 to -0.60; $p < 0.001$).

Plaque was indirectly affected periodontal disease through calculus. Patients with plaque had logodds by 0.75 units to have calculus compared to patients who have no dental plaque ($b = 0.75$; 95% CI = 0.18 to 1.32; $p = 0.010$).

Educational was indirectly affected periodontal disease through knowledge which was statistically significant. Patients with a high educational had logodds to increase knowledge about dental and oral health by 0.80 units compared to patients with low educational ($b = 0.80$; 95% CI = 0.22 to 1.37; $p = 0.006$).

DISCUSSION

1. The effect of smoking behavior on periodontal disease

The result of this study showed that there was an effect of smoking behavior on periodontal disease which was statistically significant. Patients who smoked had logodds for periodontal disease by 0.92 units compared to patients who did not smoke. This supported a study by Quamilla, (2016) which stated that smoking and the intensity of smoking habits have been shown to have a strong association with gingival tissue status, periodontal tissue was damaged and aggravated the periodontitis. Smokers have a risk of suffering from periodontitis by 2-7 times greater than nonsmokers. Evidence was seen in the form of severe attachment damage with the presence of deep pockets in smokers. This was also in line with research done by Ramadhani et al., (2014); Priskila, et al. (2015) which described the status of periodontal tissue in smokers

experiencing destruction of advanced periodontal tissue, because one of the substances contained in it was nicotine in blood vessels which resulted in vasoconstriction in blood vessels and lead to reduced blood flow in the periodontal tissue. In addition, nicotine was also a poison that inhibited the cell protoplasm and the proliferation of periodontal tissue, reduced antibody responses and inhibited oral neutrophil function (Quamilla, 2016).

Smoking was a significant risk factor for periodontal disease (Genco and Borgnakke, 2013), it can increase the prevalence and severity of periodontal tissue destruction (Quamilla, 2016), and was shown by increased attachment loss, development of periodontal inflammation, and increased gingival recession. It was estimated that smoking was the cause of half of all periodontal diseases. There was an epidemiology evidence that showed that smoking was a stronger risk factor for periodontitis compared with the presumption of certain periodontal pathogens. The number of cigarettes smoked per day was the main risk determinant, 2 times risk for those in the lowest consumption category and 6 times increased in the subgroup who smoke more than thirty cigarettes per day. Ex smokers have a lower periodontitis than current smoker. Longitudinal study showed that periodontal disease can develop faster in smokers compared to nonsmokers. Further research on this topic was needed to broaden the spectrum of knowledge gained to apply it clinically (Smejkalova *et al.*, 2012).

2. The effect of calculus on periodontal disease

The result of this study showed that there was an effect of calculus on periodontal disease which was statistically significant. Patients with calculus had logodds by 1.23 units to have periodontal disease compared to patients with no calculus in their teeth.

This study supported a study done by Laudénbach, (2014) which stated that calculus was a source of periodontal inflammation which resulted in irritation of the gingiva and allowed further retention of dental plaque.

Calculus was formed from bacterial plaques that have mineralization which attached to the surface of the teeth and the edge of the gingiva, bacteria released toxins and attacked the gingiva which caused an inflammation of the gingiva. The plaque that accumulated and formed calculus would trigger cavities (gum), gum disease (gingivitis) and even damage to the supporting tissues of the teeth (periodontitis) so that the teeth became rocky and must be removed (Sasea et al, 2013).

A study by Harvey (2017) showed that the causative factor for periodontal disease was multifactorial, bacteria was considered a primary etiological factor, whereas plaques and calculus were considered secondary etiological factors. In addition, there were systemic factors such as hormones and drugs, and also genetic factors such as immune disorders and malnutrition.

3. The effect of age on periodontal disease

The result of this study showed that there was an effect of age on periodontal disease which was statistically significant. Patients who were more than or equal to 35 years old have a logodd for periodontal disease by 1.63 units compared to patients under the age of 35 years old. Based on WHO data, severe periodontal (gum) disease, which can cause tooth loss, was found in 15-20% of middle-aged adults (35-44 years old). Research conducted by WHO on the prevalence of periodontal disease in the elderly in Chicago United States in 2010 showed that the prevalence of periodontal disease experienced an increase in elderly, which was 70.1% (Afrianti et al, 2018).

The age of a person was related to the body's response to the surrounding environment. As people get older, especially in the elderly (individuals over the age of 60 years old) there was often a decrease in the production of the amount of saliva that caused dehydration and the mouth became dry so as to facilitate the occurrence of plaque accumulation. Elderly were at risk for oral health problems due to lack of knowledge about oral hygiene, inability to carry out oral care, or the condition of teeth and mucosa that were susceptible to disease (Nur et al., 2017).

4. The effect of knowledge of dental and oral health on periodontal disease

The result of analysis in this study showed that there was an effect of knowledge of dental and oral health on periodontal disease which was statistically significant. Patients with good knowledge of dental and oral health have logodd for periodontal disease by -1.72 units compared to patients who did not have this knowledge. This study supported a study done by Sugiarti and Santik (2017) about the incidence of periodontitis in Magelang Regency and the results showed that study subjects with poor knowledge were 2.575 times more likely to suffer from periodontitis than study subjects with good knowledge. Someone who has good knowledge would know the right action if she/he was infected by a disease so that there would be no complications (Sugiarti&Santik, 2017). This study explained that knowledge was related to education (Sugiarti and Santik, 2017).

Knowledge of dental and oral health was defined as information about dental and oral health which was believed to be true. Feelings of confidence influenced the individuals to subjectively accept an object or a particular action and the consequences of these actions. Knowledge was one of the

individual's factors that can influence and determine a person's behavior to make efforts in order to reduce the risk of the threat of health problems (Hollund, 1990 in Yuniarly, 2015; Maulana et al., 2016).

5. The effect of oral hygiene behavior on periodontal disease

The result of analysis in this study showed that there was an effect of oral hygiene behavior on periodontal disease which was statistically significant. Patients with good oral hygiene behavior have logodd for periodontal disease by -0.92 units compared to patients who did not have the behavior. This study supported a study by Ambarwati (2014), which reported that there was a relationship between the habit of brushing teeth with the incidence of periodontitis. This study also explained that the habit of brushing teeth that was inappropriate in terms of the way, time, frequency, tools and materials can increase the accumulation of bacterial and calculus plaques that could lead to periodontitis (Sugiarti and Santik, 2017).

Periodontal disease and caries were the effects of poor oral hygiene. The prevalence of periodontal disease increased with age. This was due to lack of maintenance of oral hygiene. Oral hygiene has an important role in dental health, because poor oral hygiene can lead to various diseases both locally and systemically (Adriansyah et al., 2017).

One of the factors that influence the level of dental and oral hygiene was behavior. Behavior was a form of experience and interaction of a person with his/her environment, especially relating to knowledge, attitudes, and actions about health. Dental health behavior included knowledge, attitude, and actions which related to the concept of healthy and toothache, maintenance of personal dental and oral hygiene and

prevention efforts (Sugiarti and Santik, 2017).

Hygiene of the dental and oral can also be affected by oral hygiene maintenance behavior. The formation of behavior can be obtained from the environment in the form of experiences from everyday life, the willingness to maintain oneself in order to achieve a good level of oral hygiene was a condition that encouraged high or low status of oral hygiene (Sasea et al., 2013).

6. The effect of family income on periodontal disease

The result of analysis in this study showed that there was an effect of family income on periodontal disease which was statistically significant. Patients with high family income had logodd to have periodontal by -1.47 units compared to patients with low family income. This study supported a study done by Kim et al., (2013) which stated that there was a significant relationship between self-reported symptoms of periodontal disease according to work, education, and income.

In the study, it was explained that study subjects from low socio-economic reported more severe periodontal symptoms. In contrary, subjects in the higher socioeconomic group reported more general gingival bleeding. This mean that gingival bleeding was a useful indicator of periodontal health, because it was the initial sign of gingival inflammation and the most obvious sign because it can recognize and or diagnose self-periodontal disease. The subjects in the study must be instructed to see, and not ignore the gingival bleeding, then they must get an education and knowledge that gingival bleeding can occur as an early symptom of periodontal disease (Kim et al., 2013).

Another study by Pangau, et al. (2018) stated that there was a meaningful relationship between economic level and the inci-

dence of periodontitis. Respondents who have a poor economic level were 14 times more likely to suffer from periodontitis compared to good economic levels. Individuals with a low socio-economic status showed a higher risk of losing dental support tissue. This increased risk was occurred because of the low income which associated with a lack of access to dental nursing.

The possible relationship between periodontal disease and economic status was found in several studies. The condition of the periodontal tissue was related to a lower economic level, but the relationship with periodontitis was lacking. The health of periodontal tissue was better in individuals who have high education income (Aljehani, 2014).

7. The effect of plaque on periodontal disease through calculus

The result of analysis in this study showed that there was a significant effect of plaque on calculus. There was an indirect effect of plaque on periodontal disease through calculus which was statistically significant. In this study, patients with plaque on their teeth had logodds by 0.75 units to have calculus compared to patients who have no dental plaque. The result of this study was in line with a study done by Laudenbach (2014) which stated that calculus was formed by the calcification of plaque that was firmly attached to the surface of the uncleaned tooth.

A study by Tyas *et al.*, (2016) stated that the cause of periodontal disease was in a cumulative process, the consequences of which can be calculated from the size of the plaque accumulation and the length of plaque accumulated. Calculus was mineralized bacterial plaque but not all plaques were mineralized, because there were some calculus formed from plaque which was directly exposed to saliva which was a

mineral source from calculus, and it was also called as supragingival calculus. Whereas there was also a calculus which formed from the gingival fluid exudate and it called subgingival calculus (Putri et al, 2011).

Calculus was formed from calcified plaque and was deposited with calcium in alkaline plaques and calcification was occurred. Dental calculus was a hard tissue that was tightly attached to the teeth which consisted of mineral materials such as Ca, Fe, Cu, Zn, and Ni (Artawa and Swastini, 2010). There was a lot of calculus in the upper part of the molars and the inside of the front teeth of the lower jaw, also in the teeth that were often not used (Putri et.al, 2011).

8. The effect of educational on periodontal disease through knowledge

The result of analysis in this study showed that there was an indirect effect of educational level on periodontal disease through knowledge of dental and oral health which was statistically significant. Patients with a high educational level had logodds to increase knowledge about dental and oral health by 0.80 units compared to patients with low educational levels. This study supported a study by Sugiarti and Santik (2017) which stated that knowledge was closely related to education.

According to Maulana et al., (2016) people who have a high level of education would have good knowledge and attitudes towards health so that it would affect the behavior of healthy living and can maintain the health of their dental and oral. Generally, people with a high level of education have a higher economic status than people with low level of education, therefore, they can conduct dental and oral care according to the advice of the dentist.

REFERENCES

- Adriansyah M, Saputri D, Rahmayani L (2017). Pengaruh tingkat pendidikan dan pekerjaan terhadap oral hygiene pada ibu hamil di RSUD Meuraxa Banda Aceh. *Journal Caninus Dentistry*, 2: 84-91.
- Afrianti, Sety LOM, Tina L (2018). Analisis faktor risiko kejadian penyakit periodontal pada usia dewasa muda (20-44 tahun) di Puskesmas Poasia Kota Kendari Tahun 2017. *Jimkesmas Jurnal Ilmiah Mahasiswa Kesehatan Masyarakat*, 3(2): 1-8.
- Aljehani YA (2014). Risk factors of periodontal disease. Review of the literature. *International Journal of Dentistry*. King Saud University. Saudi Arabia.
- Ambarwati (2014). Hubungan kebiasaan menyikat gigi dan kebiasaan merokok dengan kejadian periodontitis di Kabupaten Magelang. *STIKES Ngudi Waluyo*.
- Artawa IMB, Swastini IGAA (2010). Perbedaan kondisi karang gigi pada masyarakat yang mengkonsumsi air sumur dengan bukan air sumur. *Jurnal Periodontology*; 8: 1-2.
- Ferreira MC, Dias-Pereira AC, Branco-de-Almeida LS, Martins CC, Paiva SM (2017). Impact of periodontal disease on quality of life: a systematic review. *Journal of Periodontal Research*, (10). doi: 10.1111/jre.12436.
- Genco RJ, Borgnakke WS (2013). Risk factors for periodontal disease. *Periodontology*. 62: 59-94.
- Hanapi ADEN (2014). Angka kejadian karies dan gingivitis pada anak sekolah dasar usia 8-12 tahun di Kabupaten Maros Tahun 2014. (Skripsi).
- Harvey JD (2017). Periodontal microbiology. *Dental Clinics of NA*. Elsevier Inc, 61(2): 253-269. doi: 10.1016/j.cden.2016.11.005.
- Kim H. et al. (2013). Socioeconomic status and self-reported periodontal symptoms in community-dwelling individuals: data from the Korea Community Health Surveys of 2011 and 2013. doi: 10.1111/idj.12407.
- Laudenbach JM (2014). Common dental and periodontal diseases evaluation and management. *Medical Clinics of NA*. Elsevier Inc, 98(6): 1239-1260. doi: 10.1016/j.mcna.2014.08.002.
- Maulana EGS, Adhani R, Heriyani F (2016). Faktor yang mempengaruhi kehilangan gigi pada usia 35-44 tahun di Kecamatan Juai Kabupaten Balangan Tahun 2014. *Jurnal Kedokteran Gigi*. (1): 98-103.
- Nur RM, Krismariono A, Rubianto M (2017). Keparahan gingivitis pada pasien poli gigi puskesmas sawahan surabaya tahun 2016 menggunakan gingival index (GI).
- Pangau RR, Nelwan JE, Tumurang M (2018). Hubungan kebersihan mulut, kebiasaan merokok dan tingkat ekonomi dengan kejadian periodontitis di BLU RSUP Prof. Dr. R.D Kandou Manado. 19-32.
- Putri MH, Herijulianti E, Nurjannah N (2011). Ilmu pencegahan penyakit jaringan keras dan jaringan pendukung gigi, 3th ed, Jakarta: EGC.
- Priskila F, Pangemanan DHC, Juliatri (2015). Gambaran status periodontal pada perokok di Desa Watutumou 3 Jaga 8 Kecamatan Kalawat Kabupaten Minahasa Utara. *Jurnal e-Gigi*. 3: 1-5.
- Quamilla N (2016). Stres dan kejadian periodontitis (kajian literatur), *Journal Of Syiah Kuala*, 1(2): 161-168.
- Ramadhani ZF, Putri DKT, Cholil (2014). Prevalensi penyakit periodontal pada perokok di lingkungan Batalyon

- Infanteri 621/Manuntung Barabai Hulu Sungai Tengah. *Jurnal Kedokteran Gigi*, 2(2): 2–6.
- Sasea A, Lampus B, Supit A (2013). Gambaran status kebersihan rongga mulut dan status gingiva pada mahasiswa dengan gigi berjejal, *Jurnal e-Gigi (eG)*, 1(1): 52–58.
- Smejkalova J et al. (2012). The influence of smoking on dental and periodontal status. oral health care – pediatric, research, *Epidemiology and Clinical Practices*. 249–270.
- Sugiarti T, Santik YDP (2017). Kejadian periodontitis di Kabupaten Magelang. *Higiene Journal of Public Health*, 1(4): 97–108.
- WHO (2016). Regional oral health strategy 2016-2025: addressing oral disease as part of noncommunicable diseases. 19–23.
- Wijaksana IKE (2016). Infectobesity dan periodontitis: Hubungan dua arah obesitas dan penyakit periodontal. 3: 67–73.
- Yuniarly E. (2015). Pengaruh tingkat pendidikan dan pola asuh orangtua serta tingkat pengetahuan anak terhadap kebersihan gigi dan mulut anak sekolah dasar. Tesis. Program Pascasarjana Universitas Sebelas Maret.