Association Between Tobacco Smoking and Gum Bleeding in Indonesian Population: Results of a National Study in 2018

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Abstract. Smoking is a risk factor for pathologic diseases both locally in the oral cavity and systemic diseases. Smoking tobacco has been associated with an increased risk of periodontitis. The National Basic Health Research, RISKESDAS 2018 conducted by the Ministry of Health of the Republic of Indonesia, shows a high prevalence (74.1%) of periodontitis in Indonesia. This study aimed to analyze the Indonesian population's association between tobacco smoking and gum bleeding. This is a cross-sectional data analysis using secondary data collected from RISKESDAS 2018. The study population included 34326 Indonesians from 26 provinces aged 15 years and older who underwent dental examinations and dental support tissues. The Community Periodontal Index (CPI) was used to measure periodontal status as the dependent variable. The independent variables were smoking status and level of exposure to cigarettes based on the Brinkman index. Multivariate logistic regression analysis was performed to determine the relationship between smoking status and smoking rate with gum bleeding. The results showed that 70.7% of the population experienced gum bleeding, with a slightly higher rate in women (71.4%) than in men (69.6%). Smoking behavior is 24.0% of current smokers and 5.2% of former smokers. The level of smoking consumption >=400 is 27.6%. Multivariate results showed that current smoking status affected gum bleeding in general respondents (aOR = 1.173; 95%CI = 1.084–1.269; $p < 0.001$), especially in the male group (aOR = 1.230; 95%CI = 1.127–1.342); $p < 0.001$). Heavy smoking affected gum bleeding in men (aOR = 1.143; 95%CI = 1.049–1.247; $p = 0.002$) and women (aOR = 0.795; 95%CI = 0.668–0.947; $p = 0.010$). This study shows that smoking is associated with gum bleeding in the Indonesian population.

Keywords: smoking · gum bleeding · Indonesia · Basic Health Research

1 Introduction

WHO data show that there are nearly one billion tobacco smokers aged 15 and up in the world. Since 2007, where there were just over one billion tobacco smokers, this

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figure has change little. Currently, 847 million men (46 million fewer than in 2007) and 153 million women smoke tobacco (36 million fewer than in 2007). Between 2007 and 2019 smoking rates fell from a global average of 22.7% to 17.5%, a 23% decrease in 12 years. Between 2007 and 2019, the relative reduction in smoking rates was 20% in high-income countries and 19% in low-income countries. In middle-income countries (home to three-quarters of the world population, the relative reduction was only 12% [1]. Among the 159 countries with population greater than one million, Timor-Leste, Indonesia, Armenia, Jordan and Georgia had the highest prevalence of smoking tobacco use in male aged 15 and older [2].

Previous studies estimating the burden of tobacco smoking have combined indirect estimates for cancer and chronic obstructive pulmonary disease using The Smoking Impact method, which uses observed lung cancer death to indirectly estimate the burden of disease attributable to tobacco smoking, with estimates for carviovascular disease, circulatory disease and all other health outcomes using the lagging prevalence of daily tobacco smoking use [2].

The teeth and soft tissues of the oral cavity are the first parts that are affected by the toxic composition of tobacco so they will tend to experience damage due to smoking, such as periodontal tissue [3]. Periodontitis is an inflammatory disease caused by infection of the periodontal tissue. The periodontal structure is diverse, consisting of the gingiva, underlying connective tissue, cementum on the root surface, alveolar bone, and the periodontal ligament between cementum and alveolar bone. The gingival junction epithelium is a unique structure, located at the bottom of the gingival sulcus, which controls the constant presence of bacteria at this site. The most distinctive feature of periodontitis is the activation of osteoclastogenesis and the consequent destruction of the alveolar bone, which is irreversible and leads to the loss of dental abutments [4]. Periodontal disease comprises a variety of inflammatory conditions affecting the supporting apparatus of the teeth and is very common in adults worldwide. Tobacco use the most important risk factor for periodontal disease as it negatively influences disease evolution and therapeutic strategies [5]. The 2018 National Basic Health Research (RISKESDAS) data shows a high prevalence of periodontitis (74.1%) in Indonesia [6]. Periodontal disease involves gingival inflammation and considerable angiogenesis due partly to local immune suppression and oxidative stress. Tobacco use, regardless of form, is associated with a higher risk of developing more severe periodontal disease [5]. This study was conducted to determine the relationship between smoking and periodontal rates (as seen from the presence of bleeding in the gums) in Indonesia by taking data from the Basic Health Research conducted in 2018.

2 Materials and Methods

This study uses data from the 2018 Indonesian Basic Health Survey from the Ministry of Health of the Republic of Indonesia with a national cross-sectional design. Furthermore, this study collected data in 514 districts/cities from May to July 2018 through interviews with household instruments and individual instruments.

The population of the 2018 Indonesian Basic Health Survey covers all Indonesian households. The sample structure of the survey was taken from the 2018 National Socio-Economic Survey conducted in March 2018. Furthermore, the survey visited 300,000

families from 30,000 census blocks in the 2018 Socio-Economic Survey (implemented by the Central Bureau of Statistics). Probability proportional to size (PPS) was conducted to select 30,000 census blocks, and 10 households by systematic sampling with the highest implicit stratification of education completed by the Head of Household in each Census Block. Data were collected on all individuals (all ages) in the selected households. Thus, data were collected for 1,091,528 individuals of all ages from 282,654 households that were successfully visited, and 818,507 respondents aged 10 years and over were interviewed. Dental and oral examination is a sub-sample of Riskesdas 2018 with a national level of representation. This oral examination was successfully carried out on 19,553 households in 24,990 Census Blocks out of 25,000 Census Blocks targeted in 26 Provinces.

2.1 Sample and Data Collection

The sample of this study was individuals aged 10 years and over, both male and female who were interviewed in the Indonesian Health Survey. The data collected includes data on demographic characteristics, oral examinations, health-related behaviors. Data was collected through face-to-face interviews by enumerators with trained health backgrounds, who visited respondents from house to house. Dentists carried out dental and oral examinations at designated health facilities.

The periodontal condition was assessed using the *Community Periodontal Index* (CPI) [7]. In the current study, participants with a probing pocket depth of ≥4 mm in more than one tooth were diagnosed with periodontal disease [8]. The data collected was recorded in a paper questionnaire and then entered into a computer. Collecting data in the field is monitored by a person in charge of the field at the district/city level. Ethical clearance of this study had been approved by Commission Health Research, National Institute of Health Research and Development, Indonesian Ministry of Health No. LB.02.01/2/KE.267/2017.

2.2 Definitions Dependent and Independent Variable

Dependent variable is condition periodontal. Periodontal condition is the condition of the supporting tissues of the teeth, as measured by the Community Periodontal Index (CPI index). Periodontal status examination using WHO probe. The examination was performed on all teeth by inputting the size of the deepest pocket after walking probing. Gum bleeding (bleeding on probing) is bleeding that occurs in the gingiva when walking probing is performed using the WHO CPI probe, observed one minute after probing. Gum bleeding was recorded with a score of 0 (no bleeding) and 1 (there was bleeding).

The main independent variable in this study was smoking activity, both qualitatively (smoking status: never, former smoker and current smoker) and the quantity of cigarette exposure. Classification of smoking exposure using the Brinkman index (BI). The Brinkman Index (BI) is an index of smoking exposure and is calculated by multiplying the average number of cigarettes smoked per day by the daily smoking duration (in years) [9]. In this study, heavy smokers were defined as having a BI of 400 [9]. Based on their smoking exposure, participants of this study were categorized into three groups:

(a) never smoked (BI = 0); (b) light smokers (BI 1–399); and (c) heavy smokers (BI ≥ 400).

The inclusion criteria of this study were if gum condition data were available, and excluded if smoking exposure (Brinkman index) could not be calculated (e.g. occasional smokers, former smokers, and regular smokers for which there was no data on smoking duration or use of shisha and e-cigarettes). The final sample was 34326 individuals.

In addition to the dependent and independent variables, covariate variables are included: demographic characteristics (age, gender, education level, occupation, economic status, type of residence), tooth brushing behavior, consumption habits of sweet foods, sugary drinks, soft drinks and energy drinks. The age of the respondents at the time of the study was divided into 10–14 years, 15–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years and 65 + years. The last education level achieved by the respondent according to the diploma obtained: no/never attended school, did not graduate from elementary school, graduated from elementary school, graduated from junior high school, graduated from high school, graduated from diploma, graduated from university. Main occupation: Army/ Police/ Government/private employees, self-employed, laborers, unemployed, others. Economic status is calculated based on household goods ownership index divided into 5 quintiles: Quintile I (highest), Quintile II, Quintile III, Quintile IV and Quintile V (lowest). Type of residence: rural or urban. The correct behavior of brushing teeth if done after breakfast and before bed: true or not true. Food consumption pattern based on food frequency: never up to twice per week, 3 times a week up to >=1 time per day.

2.3 Statistical Analysis

Descriptive analysis was carried out to produce a description of the distribution of the sample according to the characteristics. Data analysis with chi-square test examines the relationship between bleeding gums condition and exposure to smoking. Multivariate logistic regression models were performed to estimate the association between bleeding gums and heavy smoking at the 5% significance level. Multivariate logistic regression also estimates the adjusted OR between the desired outcome and the covariate factors. All analyzes were performed using SPSS software.

3 Results

Table 1 presents the characteristics of the participant in this study. Most of our respondents were in the productive age group of 25–54 years (66.6%), women (59.4%), elementary school graduates (29.9%) and high school graduates (23.5%), unemployed (48, 9%) and labor (23.9%). Almost half of the sample is in the rich group (very rich and rich), and more than half live in urban areas (64.5%). A total of 24% of the samples were still smoking and 5.2% were former smokers, with 27.6% with heavy smoking levels (>=400 cigarettes).

Table 2 showed that 70.7% of the population experienced bleeding gums, higher in women (71.4%) than in men (69.6%). The older you get, the greater the bleeding gums, in both men and women. The proportion of bleeding gums is more common in heavy

Table 1. Demographic characteristics, behavior and gum health conditions of respondents

Characteristic	n	%	Characteristic	n	%
Age (year)			Tooth brushing behavior		
10–14	2959	8.6	Yes	21799	65.5
15–24	5781	16.8	No	11491	34.5
25–34	6443	18.8	Sweet food consumption		
35–44	6948	20.2	never up to twice per week	13601	39.6
45–54	6028	17.6	3 times a week up to >=1 time per day	20725	60.4
55–64	3794	11.1	Sugary drink consumption		
65+	2373	6.9	never up to twice per week	8881	25.9
Gender			3 times a week up to >=1 time per day	25445	74.1
Male	13930	40.6	softdrink consumption		
Female	20396	59.4	never up to twice per week	32671	95.2
Level of education			3 times a week up to>=1 time per day	1655	4.8
no/never attended school	1906	5.6	Energy drink consumption		
did not graduate from elementary school	5439	15.8	never up to twice per week	33208	96.7
graduate from elementary school	10259	29.9	3 times a week up to >=1 time per day	1118	3.3
graduate from junior high school	6794	19.8	Smoking exposure (Brinkman Index)		
graduate from high school	8074	23.5	never (0)	24577	71.6
graduate from diploma	730	2.1	light smoker (1–399)	289	0.8
graduate from university	1125	3.3	heavy smoker (>=400)	9460	27.6
Occupation			Smoking status		
Army/Police/Gov/Private Employees	3160	9.2	Never smoker	24320	70.9
Merchants	4489	13.1	Former smoker	1768	5.2
Labour	8189	23.9	Smoker	8238	24
Unemployed	16782	48.9	Periodontal Status		
Others	1706	5	No bleeding gum	10060	29.3
Socioeconomic quintile			Bleeding gum	24266	70.7
Quintile I (highest)	8275	24.1	Total	34326	100

(*continued*)

Table 1. (*continued*)

Characteristic	n	%	Characteristic	n	%
Quintile II	6925	20.2			
Quintile III	6132	17.9			
Quintile IV	6555	19.1			
Quintile V (lowest)	6439	18.8			
Recidence					
Urban	22123	64.5			
Rural	12203	35.5			
Total	34326	100			

smokers (71.8%), especially in men (72.1%). Gum bleeding is almost evenly distributed at all levels of education, but occurs the least in the college graduate group. In general, gum bleeding is most experienced by workers and other workers, also more in the labor group, and the self-employed, but in men who do not work. There are also more women in the labor and self-employed groups, but women who work in the government sector and private workers. Gum bleeding is more common in rural areas than in urban areas (Table 3).

The results of the multivariate logistic regression analysis showed that in general, current smoking status increased the risk by 17% for gum bleeding (aOR = 1.173; 95%CI = 1.084–1.269; $p < 0.001$). Likewise, in the male group, current smoking increased the risk by 23% for bleeding gums (aOR = 1.230; 95%CI = 1.127–1.342; $p < 0.001$), but not so in female smokers. Overall, heavy smoking did not significantly increase the risk of gum bleeding. In men, heavy smoking increased the risk by 14% for gum bleeding (aOR = 1.143; 95%CI = 1.049–1.247; $p = 0.002$), but decreased the 20% chance for women to experience bleeding gums (aOR = 0.795; 95%CI = 0.668–0.947; $p = 0.010$).

4 Discussion

The periodontium health is defined if there is no attachment loss and gingival inflammation is limited to less than 10% and bleeding on probing (BOP) is considered the gold standard for assessing gingival inflammation [10].

Many studies have demonstrated the major impact of smoking on the molecular aspects, inflammation, and gingival thickness. Smoking induces inflammation at the molecular level, decreases immunoglobulin G (IgG) and immunoglobuin A (IgA), alters humoral immune responses and increases levels of inflammatory markers such as CRP, interleukin (IL-6), selectins E and P, Alpha 1-antitrypsin (A1AT) and haptoglobin (acute phase reactant) compared with nonsmokers [11].

Smoking is associated with an increased risk of gingival bleeding on probing (BOP), which can be used as an indicator to reflect the general degree and extent of gingival inflammation in the clinical setting [12]. In addition, smoking is associated with an

Table 2. Gum bleeding conditions according to characteristics and gender

	Male				p-value	Female				p-value	Overall				p-value
	Healthy gums		Bleeding gums			Healthy gums		Bleeding gums			Healthy gums		Bleeding gums		
	n	%	N	%		n	%	n	%		n	%	n	%	
Age (year)					<0.001					<0.001					<0,001
10–14	750	50 .4	738	49 .6		775	52 .7	696	47 .3		1524	51 .5	1435	48 .5	
15–24	743	30 .9	1661	69 .1		1104	32 .7	2273	67 .3		1847	32 .0	3933	68 .0	
25–34	650	28 .3	1645	71 .7		1063	25 .6	3084	74 .4		1713	26 .6	4729	73 .4	
35–44	666	25 .2	1978	74 .8		1067	24 .8	3236	75 .2		1734	25 .0	5215	75 .0	
45–54	657	26 .8	1796	73 .2		859	24 .0	2716	76 .0		1516	25 .1	4512	74 .9	
55–64	431	26 .1	1221	73 .9		560	26 .2	1581	73 .8		991	26 .1	2802	73 .9	
65+	332	33 .4	661	66 .6		402	29 .1	979	70 .9		733	30 .9	1640	69 .1	
Gender															<0,001
Male											4230	30 .4	9700	69 .6	
Female											5830	28 .6	14566	71 .4	
Level of education					<0.001					<0.001					<0,001
no/never attended school	174	29 .6	414	70 .4		371	28 .2	946	71 .8		545	28 .6	1361	71 .4	
did not graduate from elementary school	810	36 .6	1406	63 .4		1048	32 .5	2175	67 .5		1858	34 .2	3581	65 .8	
graduate from elementary school	1202	29 .7	2845	70 .3		1629	26 .2	4583	73 .8		2831	27 .6	7429	72 .4	
graduate from junior high school	744	28 .4	1877	71 .6		1169	28 .0	3003	72 .0		1913	28 .2	4880	71 .8	
graduate from high school	1062	29 .0	2596	71 .0		1214	27 .5	3201	72 .5		2276	28 .2	5798	71 .8	
graduate from diploma	74	26 .5	205	73 .5		157	34 .7	295	65 .3		231	31 .6	499	68 .4	
graduate from university	165	31 .6	357	68 .4		242	40 .1	362	59 .9		406	36 .1	718	63 .9	
Occupation					<0.001					<0.001					<0,001
Army/ Police/ Gov/ Private Employees	614	31 .6	1332	68 .4		398	32 .8	815	67 .2		1013	32 .1	2147	67 .9	

(*continued*)

Table 2. (*continued*)

	Male				p-value	Female				p-value	Overall				p-value
	Healthy gums		Bleeding gums			Healthy gums		Bleeding gums			Healthy gums		Bleeding gums		
	n	%	N	%		n	%	n	%		n	%	n	%	
Merchants	700	28 .2	1778	71 .8		556	27 .6	1456	72 .4		1256	28 .0	3233	72 .0	
Labour	1250	24 .9	3768	75 .1		719	22 .7	2452	77 .3		1970	24 .1	6220	75 .9	
Unemployed	1509	38 .8	2378	61 .2		3873	30 .0	9022	70 .0		5382	32 .1	11400	67 .9	
Socioeconomic quintile					<0.001					<0.001					<0,001
Quintile I (highest)	1159	33 .6	2287	66 .4		1582	32 .8	3247	67 .2		2741	33 .1	5535	66 .9	
Quintile II	886	31 .8	1901	68 .2		1154	27 .9	2984	72 .1		2040	29 .5	4885	70 .5	
Quintile III	738	29 .6	1752	70 .4		1023	28 .1	2619	71 .9		1761	28 .7	4371	71 .3	
Quintile IV	699	26 .5	1940	73 .5		1052	26 .9	2864	73 .1		1751	26 .7	4804	73 .3	
Quintile V (lowest)	748	29 .1	1820	70 .9		1019	26 .3	2851	73 .7		1767	27 .4	4672	72 .6	
Recidence					<0.001					<0.001					<0,001
Urban	2816	31 .9	6008	68 .1		2336	28 .5	5874	71 .5		6812	30 .8	15311	69 .2	
Rural	1414	27 .7	3692	72 .3		3494	28 .7	8691	71 .3		3247	26 .6	8955	73 .4	
Tooth brushing behavior					0 .539					<0.001					<0,001
Yes	2794	30 .1	6474	69 .9		3428	27 .4	9104	72 .6		6222	28 .5	15578	71 .5	
No	1244	30 .7	2811	69 .3		2248	30 .2	5188	69 .8		3492	30 .4	7999	69 .6	
Sweet food consumption					0 .002					0 .731					0,023
never up to twice per week	1556	28 .9	3835	71 .1		2336	28 .5	5874	71 .5		3892	28 .6	9709	71 .4	
3 times a week up to >=1 time per day	2674	31 .3	5866	68 .7		3494	28 .7	8691	71 .3		6168	29 .8	14557	70 .2	
Sugary drink consumption					0 .539					0 .358					0,108
never up to twice per week	739	29 .8	1737	70 .2		1803	28 .2	4601	71 .8		2543	28 .6	6338	71 .4	
3 times a week up to >=1 time per day	3490	30 .5	7963	69 .5		4027	28 .8	9965	71 .2		7517	29 .5	17928	70 .5	
softdrink consumption					0 .128					0 .974					0,138

(*continued*)

Table 2. (*continued*)

	Male				p-value	Female				p-value	Overall				p-value
	Healthy gums		Bleeding gums			Healthy gums		Bleeding gums			Healthy gums		Bleeding gums		
	n	%	N	%		n	%	n	%		n	%	n	%	
never up to twice per week	3895	30 .2	9004	69 .8		5652	28 .6	14120	71 .4		9548	29 .2	23124	70 .8	
3 times a week up to >=1 time per day	335	32 .5	697	67 .5		178	28 .5	446	71 .5		512	31 .0	1142	69 .0	
Energy drink consumption					0 .031					0 .860					0,201
never up to twice per week	4012	30 .6	9110	69 .4		5740	28 .6	14346	71 .4		9752	29 .4	23456	70 .6	
3 times a week up to >=1 time per day	218	27 .0	590	73 .0		90	29 .0	220	71 .0		308	27 .5	810	72 .5	
Smoking exposure (Brinkman Index)					<0.001					0.292					0,015
never (0)	1702	34 .6	3210	65 .4		5605	28 .5	14060	71 .5		7307	29 .7	17270	70 .3	
light smoker (1–399)	74	31 .5	161	68 .5		14	25 .9	40	74 .1		89	30 .7	201	69 .3	
heavy smoker (>=400)	2453	27 .9	6330	72 .1		211	31 .2	466	68 .8		2664	28 .2	6796	71 .8	
Smoking status					<0.001					0.206					<0,001
Never smoker	1634	34 .7	3072	65 .3		5592	28 .5	14022	71 .5		7226	29 .7	17094	70 .3	
Former smoker	464	33 .3	931	66 .7		122	32 .7	251	67 .3		585	33 .1	1183	66 .9	
Smoker	2132	27 .2	5697	72 .8		117	28 .6	292	71 .4		2249	27 .3	5989	72 .7	

Table 3. Multivariate logistic regression smoking rates and gum bleeding

	Men			Female			Overall		
	aOR (95% CI)		p-value	aOR (95% CI)		p-value	aOR (95% CI)		p-value
Smoking exposure (Brinkman Index)									
never (0)	1			1			1		
light smoker (1–399)	1.255	(0.938–1.679)	0.127	1.016	(0.542–1.907)	0.960	1.202	(0.923 - 1.564)	0.172
heavy smoker (>=400)	1.143	(1.049–1.247)	0.002	.795	(0.668–0.947)	0.010	1.057	(0.980 - 1.140)	0.151
Have you ever smoke?									
Never smoker	1			1			1		
Former smoker	0.832	(0.724–0.956)	0.010	0.752	(0.598–0.944)	0.014	0.786	(0.699 - 0.883)	<0.001
Smoker	1.230	(1.127–1.342)	<0.001	0.909	(0.722–1.145)	0.418	1.173	(1.084 - 1.269)	<0.001

aOR[1] = adjusted with age, education level, ocupation,socioeconomic quintile, residence, sweet food consumption, energy drink consumption.
aOR[2] = adjusted with age, education level, ocupation,socioeconomic quintile, residence, tooth brushing behavior.
aOR[3] = adjusted with age, gender, education level, ocupation,socioeconomic quintile, residence, tooth brushing behavior, sweet food consumption.

increase in gingival thickness, which has a major dental therapeutic impact on smokers, especially during root closure procedures so that some management options are less effective, such as in scaling and root planing [13].

Increased alveolar bone loss, tooth mobility, pocket depth and ultimately tooth exfoliation have been reported in smokers compared to non-smokers. Nicotine contained in cigarettes has side effects in the form of peripheral blood vessel vasoconstrictors, namely a decrease in gingival blood flow which results in inflammation and tooth bleeding [13].

The results in Srinagar showed no significant difference for the gingival bleeding index, in the smokers and non-smokers groups [13]. The results in CapeTown showed that more than two thirds of respondents experienced bleeding gums (68.3%), with more distribution in males and decreasing prevalence with increasing age [14].

Studies on women, showed high gingival bleeding in the group of smokers. And there is a significant difference in gingival bleeding according to the length of smoking

consumption period, namely that the gingival bleeding decreases along with the increase in the length of smoking period. The mean of gingival bleeding in smokers with more than 10 sticks per day is actually lower than non-smokers [15].

This pattern is similar to our finding, that the proportion of gingival bleeding was lower in the non-smoker group than in the smokers, both in the male, female and overall groups.

Smoking enhances the pathogenicity of periodontopathogens, especially the red complex microorganisms, by promoting their colonization and infection and regulating the expression and function of multiple virulence factors. Furthermore, smoking hurts periodontal microecological homeostasis, which is reflected in the decrease of commensal bacteria and the increase of periodontopathogens, as well as the changes in the interaction between periodontopathogens and their commensal microbes in subgingival biofilm, thus influencing the pathogenicity of the subgingival plaque [16].

In contrast to the favorable effects of smoking on gingival bleeding. It is possible that poorer oral hygiene is to blame for the higher rates of gingival bleeding in smokers compared to non-smokers, even when plaque levels are not considered.

5 Conclusion

Gum bleeding is generally worse in smokers than in non-smokers. This shows that chronic smoking has an adverse effect on the gums. Bleeding gums can be used as an early marker of the development of periodontal disease, but this requires further research to prove the correlation. The largest number of population is a fairly young adult age group and shows a high prevalence of bleeding gums. Of course this is a concern for prevention programs.

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