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Research Article

Periodontal Diseases in Elderly in Indonesia and The Risk Factors

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ABSTRACT

Objectives: To investigate the risk factors for periodontal diseases in rural elderly in Indonesia.

Material and methods: One-hundred and seventy five elderly in community subjects in the rural sites of Borobudur district in Central Java were included in this cross sectional study. Periodontal status was measured as a Total Periodontal score and was determined by oral examination using a compound score of the following variables of interest: average percentage of number teeth involved in Bleeding on Probing (BOP), Probing Pocket Depth (PPD), Loss of Attachment (LOA), Tooth Mobility (TM) and of Furcation Involvement (FI). In this study was also measured the number of remaining teeth (RT) and periodontitis status (PS is positive when clinical attachment loss > 3mm) for periodontal disease indicators. Plaque score was measured using a disclosing gel two tone. Volume of saliva was measured after stimulation by chewing paraffin and pH of saliva was measured by using pH paper. Demographic characteristics and life-style data (including oral hygiene, smoking and dietary intake) were obtained by questionnaire and face to face interviews.

Result: The selected respondents were all Javanese and 62% were women. Their age ranged between 60 and 90 years (mean±SD 70.7±7.8 years). Women reached 61.7%. The average educational level was low, 90.3% respondents had only obtained up to elementary school education and most were farmers or laborers. Risk factors for TPS using multiple linear regression was a high plaque score, while a high intake of fruit was protective. Risk factors for having few remaining teeth (RT) using multiple linear regression were a high plaque score, an older age, a low educational level, a history of smoking history and drinking tea. The only risk factor for PS was a high plaque score.

Conclusion: Regardless of the model used (logistic or linear regression), a high dental plaque score emerged as a main and independent determinant of periodontal disease. The status of periodontal disease can be reflected through total periodontal score, the number of remaining teeth and periodontitis status. This data indicates that maintenance of oral hygiene is crucial in preventing periodontal disease in the elderly.

Keywords: peridodontal disease , elderly, risk factors

INTRODUCTION

Periodontal disease(s) refers to the inflammatory processes that occur in the tissues surrounding the teeth in response to bacterial accumulations (dental plaque) on the teeth. [1)] Periodontal Disease (PD) is a common disease(s) found in older adults [2,3,4)]. Chronic periodontitis was found to be the most prevalent oral disease (74%) in the elderly and also appears to worsen with age [5,6)]. The increased severity of periodontal disease and bone loss with older age is probably related to the length of time the periodontal tissues have been exposed to bacterial plaque and is considered to reflect individual's cumulative oral history[7)]. Several possible risk factors for the initiation and progression of PD have been identified, such as genetic predispositions, an older age, the male gender, plaque formation, calculus, existing loss of attachment[6)] and smoking[8)]. A review concluded that possible risk factors for the initiation and progression of periodontitis were: age, gender, plaque, calculus and existing attachment loss[9)]. The high prevalence of PD in older adults should be of concern because PD directly increases the patient's risk of developing root caries, as well as tooth loss with resulting deficient masticatory ability, nutritional intake and speech, which can

worsen the patient's quality of life and health status[3]. It has also been hypothesized to increase patients' risk of systemic diseases, such as diabetes mellitus, lung disease, heart disease and stroke[3]. Periodontal disease is associated with an elevated systemic inflammatory state which increases cardiovascular disease (CVD) risk and can adversely affect glycaemic control in people with diabetes[10].

It is estimated that in developing countries 70% people will reach their elderly stage the year 2050[11]. Although there were only few data on PD in developing countries, but a study has reported that average 50% of the dental surfaces had a loss of attachment ≥ 4 mm in every Chinese community dwelling elderly in Beijing [12]. This was related to WHO statement that periodontal diseases and tooth loss cause other systemic problems, the condition will create a financial burden for individuals and society and can reduce self-confidence and quality of life[13]. WHO also stated that barriers to oral health care among elderly are condiserable. Impaired mobility impeded access to oral health care, particularly for those who reside in rural areas with poor public transport. The situation is worsened in developing countries when oral health services and domiciliary care are not available[14]. Studies in the Indian communities found 77% elderly had one or more signs of gingival and periodontal disease. The mean±SD total number of sextants with loss of attachment > 4mm was 2.13±2.0[15]. Survey conducted on Nigerian elderly in the community showed the mean tooth loss was 4.5±7.6. Percentage edentulousness was 1.3% and this was higher in males than in females. Trauma and periodontal disease were predominantly contributed to 98% loss of teeth[16]. It is important to identify risk factors for PD particularly in the elderly; who are perhaps most at risk for PD and systemic disease; living in rural parts of developing countries.

In the current study periodontal health status and the risk factors for PD in the elderly from rural sites of Central Java (Borobudur) was investigated. We investigated PD frequency and related lifestyle behaviors such as a healthy dietary pattern and oral hygiene measures (plaque score and pH plaque etc) to identify major risk and protective factors for PD. This information will be very useful to support policies to prevent periodontal disease in the elderly.

MATERIAL AND METHODS

Participants

This cross-sectional observational study included 175 elderly who were between 60 and 95 years of age from rural sites. Prior to the study all village elders and staff at local community health centers or care institutes had been informed of the study and they subsequently forwarded this information to potential participants. The participants had been asked to bring their caregivers and to arrive at the local health centers on the morning of agreed dates if they were interested in participating. None of the elderly approached refused participation after they had been given information about the study by trained research assistants and all signed the informed consent forms a day before measurements. No incentive was offered but all were given breakfast after participation. The investigation was carried out between April and June 2008 in the rural areas of Borobudur. Ethical approval from the Medical Faculty, Diponegoro Semarang and Loughborough University, informed consent, governmental and local permits were all obtained before study onset.

Assessments

All testing and measurements were done by trained and supervised research assistants between 09.00 and 12.00 to avoid circadian inference. The Principal Investigator (HS, a university trained qualified and practicing dentist) performed full periodontal examination consisting of Bleeding on Probing (BOP in percentage of teeth that bled on probing using periodontal probe gently along around gingival sulci divided by number of remained teeth), Probing Pocket Depth (PPD in percentage of teeth which had pockets, that the distance from gingival margin to base of pocket using scale periodontal probe, that were deeper than 3mm divided by number of remained teeth), Loss of Attachment (LOA in percentage of teeth had distance of amelo-cemental junction (ACJ) to pocket-base, using scale periodontal probe, more than 3mm divided by number of remained teeth), Tooth Mobility (TM in percentage of mobile teeth more than 0.2mm divided by all teeth) and Furcation Involvement (FI in percentage of tooth had furcation involved on multi-rooted teeth i.e. upper and lower molar and upper premolar, using probe curved furcation, divided by number of remained teeth). These 5 measurements were then transformed into a composite variable called the Total Periodontal Score (TPS). The TPS score combined all sub-variables with equal weight (using the formulae by adding individual percentage scores and dividing the total sum by 5 to obtain an average percentage score of periodontal disease). The higher the Total Periodontal Score, the worse the periodontal status. The number of Remaining Teeth (RT) was also measured as an indicator of long-term

periodontal disease. Periodontitis status (PS) was used to describe periodontal disease as measured by a clinical attachment loss level more than 3mm. This is used in several studies as an indicator of periodontal disease indicator[17]. Plaque score was evaluated as the average percentage of plaque covering teeth surface after applying two-tone disclosing gel to differentiate between old/mature and new/fresh plaque. Mature plaque showed violet color that more worsening effect to the periodontal tissue, whilst fresh plaque showed red color that less hazardous effect. This information can be support evidence of the level oral hygiene behavior conducted by respondents. The pH plaque was determined by testing the degree of acidity of the plaque after soaking the tooth surface and then dipping the teeth into a sucrose liquid using GC saliva test kit. Stimulated Saliva flow rate was measured as the total saliva volume (in ml) which was collected by secretion during 5 minutes after stimulation by paraffin chewing. pH saliva was measured using pH paper which was dipped in the saliva fluid after collecting. The participants were also surveyed for demographic and lifestyle variables (eq. frequency of tooth brushing, current smoking and coffee/tea intake and history of use) using standardized questionnaires. Detailed questions based on the Food Frequency Questionnaire about dietary intake were calculated as weekly total food intake (calculated from daily, weekly or monthly consumption, e.g. intake of a food once monthly = 0.25/week, 3 / a day = 21/week). This included the main variables of interest: intake of green, orange or red vegetables and fruits to investigate the association of a healthy dietary intake with dental health. The answers were substantiated by a caregiver when present.

Statistical Analyses

Descriptive analyses were performed for the whole cohort and nonparametric Spearman's rank correlations were carried out to assess associations between the variables. Multiple Linear Regression and Multiple Logistic Regression were used to predict PD risk including life-style variables (smoking, tea & coffee consumption), oral hygiene conditions (plaque pH and plaque score), saliva (volume and pH), fruit and vegetables intake and including the following covariates: age at the time of testing, sex, years of further education and previous occupation. For all evaluations a p value of 0.05 was used and the analyses were performed in SPSS 11.5.

Results

Demographic Characteristics of the Study Sample

Demographic analyses for participants for the whole sample are presented in table 1. There were more women than men in this sample (ratio 3:2). Average obtained education was low, with the majority of the cohort being laborers and farmers, which reflects the characteristics of the rural Indonesian population.

Table 1:Demography, periodontal disease, oral hygiene, saliva condition, and life-style

Variables	Whole groups
Participants	175
Mean age±SD years & Range	70.74±7.8. 60-90.
Women, %	61.7
Education, %	
• None	45.7
• Elementary	44.6
• Primary	6.3
• High School and more	2.9
Profession, %	
• None	6.9
• Civil servant	2.9
• Army/police	2.3
• Entrepreneur	13.7
• Labour	20.0
• Farmer	53.7
Consumption of food (calculated as average intake per week/mean±SD and median)	
• Fruits	2.58±3.2 (2.0)
• Green vegetables	7.83±6.6 (4.0)
• Orange/red vegetables	2.44±3.7 (1.0)

Smoking History (%)	
• Yes	30.3
• No	69.7
Current smoking (%)	
• Yes	23.4
• No	6.9
Current Coffee consumption (%)	25.7
Current Tea consumption (%)	93.7
Saliva	
Mean±SD (median) Volume of saliva (ml)	5.1±1.8 (4.3)
Mean±SD (median) Resting saliva pH	6.4±0.4 (6.4)
Mean±SD (median) Stimulated saliva pH (ml)	7.1±0.5 (7.0)
Mean±SD (median) Saliva buffer capacity (ml)	0.69±0.5 (0.6)
Oral Hygiene	
Mean±SD Plaque pH	6.1±0.5
Mean±SD (median) Plaque score	28.4±27.9 (23.0)
Mean±SD (median) Tooth brushing frequency/day	1.54±1.1 (2.0)
Periodontal Disease	
• Mean percentage ±SD (median) BOP (#teeth bleeding/total teeth)	27.7±24.9 (26.0)
• Mean±SD (median) Percentage LOA	31.3±35.6 (17.0)
• Mean±SD (median) Percentage FI	9.2±21.9 (0.001)
• Mean±SD (median) Percentage TM	12.2±24.1 (0.001)
• Mean±SD (median) Percentage PPD	31.2±15.5 (17.00)
• Mean±SD (median) Total Periodontal Score	22.3±21.2(19.4)
• Mean±SD (median) Remaining teeth	7.2±7.3 (5.0)

Life-style

About one-third of respondents had a positive smoking history and a quarter still smoked, of whom most (73%) were men. About a quarter of respondents drank coffee and mostly drank tea. Black tea was a common drink in that area, whilst green tea was almost none.This kind of tea information obtained from some key person's source in tht community. About half of respondents consumed green vegetables but only few (<10%) reported to eat red/orange vegetables or fruits.

Periodontal Status

Oral hygiene was overall not very good, with average high plaque scores (even though measurements were taken in the morning after the respondents had usually brushed their teeth). Almost all respondents have violet mature plaque (more than 48 hours plaque) on their teeth surface, indicating oral hygiene behavior was inadequate. The pH plaque was also low. The volume of saliva produced on average was adequate (≥ 5 ml). Both resting and simulated pH of saliva was good but acidity of resting saliva pH was moderate to high.

Many of respondents suffered from PD, with a one-third suffering from deep periodontal pockets (PPD) bleeding of gums on probing/BOP (27.7%) and loss attachment on the amelo-cemental junction (LOA 31.3%). The total periodontal score (TPS, the average percentage of the sum of BOP, PPD, LOA, FI, TM) was 22.3%. This indicated that on average respondents had evidence of periodontal disease on more than one in five of their remaining teeth. Only 29.1% elderly had no PD, including 26.3% was edentolous. The average number of remaining teeth was low, with only 7.2 element.

Associations between Demographics, Life-style, Oral Hygiene and Periodontal Disease

Spearman rank correlations (Table 2) performed on periodontal status showed that the Total Periodontal Score (TPS) was associated with lower green vegetables consumption a higher plaque score, and a positive coffee drinking history. Using Remaining Teeth (RT) as a periodontal disease indicator, there was association with a higher plaque score, higher stimulated pH saliva, a younger age, higher educational level, and no current coffee consumption.

In table 3 showed the distribution and risk size of categorized data. An older age (≥ 70 year) increased the risk for having less than 10 teeth by almost a factor 6 (OR 5.55; 95% CI: 2.55-12.21), whereas a high dental plaque score was a risk factor to both the Total Periodontal Score (OR: 7.86; 95% CI: 3.81-16.38) and Periodontitis Status (OR: 2.74; 95% CI: 1.23-6.15).

Table 2. Spearman Correlation between periodontal diseases and risk factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Remaining teeth																			
2. BOP	.53 <.0001																		
3. LOA	0.48 <0.0001	0.69 <0 0001																	
4. PPD	.47 <.0001	0.69 <0 0001	0.99 <.0001																
5. FI	.48 <0.0001	0.23 0.002	0.24 .002	0.23 .002															
6. TM	.20 0.007	0.51 <0 0001	0.52 <.0001	0.52 <.0001	NS														
7. Total Period Score	.53 <.0001	0.82 <0 0001	0.93 <.0001	0.93 <.0001	0.35 <.0001	0.64 <.0001													
8. Green Vegetables (x/week)	NS	NS	-0,156 .039	NS	NS	NS	-0,161 .033												
9. Red/ Orange Veg (x/week)	NS	NS	NS	NS	NS	NS	NS	0.225 .003											
10. Fruit (x/week)	NS	NS	NS	NS	NS	-0,199 .008	NS	NS	0.24 .002										
11. Plaqu	0.46	0.70	0.51	0.51	025 .00	0.40	0.65	NS	NS	NS									

e Score	<.0001	<.0001	<.0001	<.0001	1	<.0001	<.0001												
12. pH plaque	NS	NS	NS	NS	NS	NS	NS	0.298 .017	NS	NS	NS								
13. Volume Saliva	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.19 .028							
14. Stimulated pH saliva	0.21 .006	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.51 <.0001						
15. Age	-0.50 <.0001	-0.17 .023	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS					
16. Education	0.22 .004	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-0.32 <.0001				
17. Sex	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-0.33 <.0001	-		
18. Ever Smoker	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-.28 <0.0001	0.73 <.00001	-	
19. Drinking Coffee	-0,180 .017	NS	-0,153 .043	-0,156 .040	-0,174 .021	NS	-0.18 .017	NS	NS	NS	NS	-0.12 .041	NS	NS	-.267 <.0001	0.20 .007	-.180.018	0.267 <.00001	0.27 <.0001	-
20. Drinking Tea	NS	NS	NS	NS	NS	NS	NS	0.172 .023	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.171 .024	NS

Table 3. Summary of bivariate analysis on risk factors to periodontal diseases in elderly

Risk Factors		Total Periodontal Score		Remaining Teeth		Periodontitis Status	
		High (%)	Low (%)	10 units	≤ 10 units	High	Low
Sex	Male	32 (47.8)	35 (52.2)	46 (68.7)	21 (31.3)	13 (19.4)	54 (80.6)
	Female	53 (50.9)	53 (49.1)	78 (72.2)	30 (27.8)	20 (25.9)	80 (74.1)
		OR 0.88 (95% CI:0.46-1.70)		OR 0.84 (95% CI:0.41-1.73)		OR 0.69 (95% CI:0.31-1.53)	
Age	≥ 70 year	42 (42.9)	56 (57.1)	84 (85.7)	14 (14.3)	23 (23.5)	75 (76.5)
	< 70 year	45 (58.4)	32 (41.6)	40 (51.9)	37 (48.1)	18 (23.4)	59 (76.6)
		OR 0.53 (95% CI: 0.28-1.02)		**OR 5.55 (95% CI: 2.55-12.21)**		OR 1.01 (95% CI: 0.47-2.16)	
Education level	≤ elementary	84 (49.7)	85 (50.3)	121 (71.6)	48 (28.4)	39 (23.1)	130 (76.9)
	>elementary	2 (40.0)	3 (60.0)	3 (60.0)	2 (40.0)	1 (20.0)	4 (80.0)
		OR 1.40 (95% CI: 0.20-13.05)		OR 1.68 (95% CI: 0.19-3.89)		OR 1.20 (95% CI: 0.12-29.04)	
Job efore retirement	Low	20 (41.7)	56 (57.1)	35 (72.9)	13 (27.1)	13 (27.1)	35 (72.9)
	Fair	63 (53.4)	32 (41.6)	85 (72.0)	33 (28.0)	27 (22.9)	91 (77.1)
	Good	4 (44.4)	5 (55.6)	4 (44.4)	5 (55.6)	1 (11.1)	8 (88.9)
		OR_1: 1.69; OR_2: 1.2; p-value: 0.33		OR_1: 0.96; OR_2: 0.30 p-value: 0.28		OR_1: 0.80; OR_2: 0.34 p-value: 0.33	
Smoking history	Yes	27 (50.9)	26 (49.1)	40 (75.5)	13 (24.5)	11 (20.8)	42 (79.2)
	No	60 (49.2)	62 (50.8)	84 (68.9)	38 (31.1)	30 (24.6)	92 (75.4)
		OR 1.07 (95% CI: 0.54-2.15)		OR 1.39 (95% CI: 0.63-3.10)		OR 0.80 (0.34-1.87)	
Fruit intake	Inadequate	60 (50.8)	58 (49.2)	88 (74.6)	30 (25.4)	30 (25.4)	88 (74.6)
	Adequate	27 (47.4)	30 (52.6)	36 (63.2)	21 (36.8)	1 (19.3)	46)80.7)
		OR 1.15 (95% CI:0.58-2.27)		OR 1.54 (95% CI: 0.61-3.83)		OR 1.43 (95% CI: 0.62-3.34)	
Green vegetables intake	Inadequate	51 (56.7)	39 (43.3)	66 (73.3)	24 (26.7)	1 (21.1)	71 (78.9)
	Adequate	36 (42.4)	49 (57.6)	58 (68.2)	27 (31.8)	22 (25.9)	63 (74.1)
		OR 1.78 (95% CI:0.94-3.39)		OR 1.28 (95% CI:0.63-2.59)		OR 0.77 (95% CI: 0.36-1.63)	
Red/Orange Vegetables intake	Inadequate	47 (49.5)	48 (50.5)	68 (71.6)	27 (28.4)	24 (25.3)	71 (74.7)
	Adequate	40 (50.0)	40 (50.5)	56 (70.0)	24 (30.0)	17 (21.3)	3 (78.8)
		OR 0.85 (95% CI: 0.45-1.59)		OR 1.08 (95% CI: 0.53-2.18)		OR 1.25 (95% CI: 0.58-2.70)	
pH plaque	< 6.8	78 (65.5)	41 (34.5)	75 (63.0)	44 (37.0)	37 (31.1)	82 (68.9)
	≥ 6.8	7 (58.3)	5 (41.7)	5 (41.7)	7 (58.3)	4 (33.3)	8 (66/7)
		OR 1.36 (95% CI:0.35-5.18)		OR 2.39 (95% CI: 0.63-9.33)		OR 0. 90 (95% CI:0.23-3.84)	
Dental plaque score	Bad	64 (73.6)	23 (26.4)	60 (69.0)	27 (31.0)	28 (32.2)	59 (67.8)
	Good	23 (26.1)	65 (73.9)	64 (72.7)	24 (27.3)	13 (14.8)	75 (85.2)
		OR 7.86 (95% CI: 3.81-16.38)		OR 0.83 (95% CI: 0.41-1.68)		**OR 2.74 (95% CI: 1.23-6.15)**	
Saliva buffer capacity	Bad	62 (47.7)	68 (52.3)	97 (74.6)	33 (25.4)	30 (23.1)	100 (76.9)
	Good	25 (58.1)	18 (41.9)	26 (60.5)	17 (39.5)	10 (23.3)	33 (76.7)
		OR 0.66 (95% CI: 0.31-1.39)		OR 1.92 (95%CI: 0.87-4.23)		OR 0.99 (95% CI: 0.41-2.43)	
Stimulated pH saliva	< 6.8	11 (36.7)	19 (63.3)	23 (76.7)	7 (23.3)	5 (16.7)	25 (83.3)
	≥ 6.8	76 (53.1)	67 (46.9)	100 (69.9)	43 (30.1)	35 (24.5)	108 (75.5)
		OR 0.51 (95% CI: 0.21-		OR 1.41 (95% CI:		OR 0.62 (95% CI: 0.19-	

		1.23)		0.52-3.94)		1.07)	
Resting pH saliva	< 6.8	69 (49.6)	70 (50.4)	100 (71.9)	39 (28.1)	33 (23.7)	106 (76.3)
	≥ 6.8	18 (50.0)	18 (50.0)	24 (66.7)	12 (33.3)	8 (22.2)	28 (77.8)
		OR 0.99 (95% CI: 0.45-2.18)		OR 1.28 (95% CI: 0.54-3.00)		OR 1.09 (95% CI: 0.42-2.88)	
Coffee Drinking History	No	57 (43.8)	73 (56.2)	97 (74.6)	33 (25.4)	28 (21.5)	102 (78.5)
	Yes	30 (66.7)	15 (33.3)	27 (60.0)	18 (40.0)	13 (28.9)	71.1)
		OR 0.39 (95% CI: 0.18-0.84)		OR 1.96 (95% CI: 0.90-4.25)		OR 0.66 (95% CI: 0.29-1.56)	
Tea Drinking History	No	5 (45.5)	6 (54.5)	6 (64.5)	5 (45.5)	3 (27.3)	8 (72.7)
	Yes	82 (50.0)	82 (50.0)	118 (72.0)	46 (28.0)	38 (23.2)	126 (76.8)
		OR 0.83 (95% CI: 0.21-3.24)		OR 0.47 (95% CI: 0.12-1.88)		OR 1.24 (95% CI: 0.25-5.52)	

Further analysis using multiple linear regression are summarized in Table 4. These showed that a high dental plaque score and low intake of fruit was associated with a higher Total Periodontal Score. Predictors for number of remaining teeth, consisted of a high dental plaque, a younger age, lower educational level, positive smoking ever and positive drinking tea

Table 4. Multiple linear regression analyses controlled for age, sex, education (step 1) and, in step 2, for life-style behavior and oral hygiene measures

Variable	Total Periodontal Score (TPS)	Remaining Teeth (RT)
• Dental Plaque Score	β = 0.378, p<0.0001	β = 0.043, p=0.011
• Fruit Intake (Computed weekly intake)	β = -0.795, p=0.063	NS
• Ever smoker	NS	β = 2.423, p=0.026
• Tea drinking	NS	β = -4.196, p=0.032
• Age	NS	β = -0.394, p<0.0001
• Education level	NS	β = -2.235, p=0.018
• Sex	NS	NS

Subsequent analysis using Multiple Logistic Regression showed that the risk factors for Total Periodontal Score (using a median split for low/high TPS) were an younger age and higher dental plaque score. The only predictor for remaining number of teeth (using the 30% of percentile of ≥ 10 teeth remaining vs less than 10 teeth remaining) was an older age. Finally, the only risk factor for periodontitis status (using a clicinal attachment loss > 3 mm or more) was a high dental plaque score. (Table 5)

Table 5. Summary of Multivariate Logistic Regression on the risk factors to periodontal diseases in elderly

Variable	Model 1 : DV Total Periodontal Score R^2 : 23%	Model 2 : DV Remaining Teeth R^2 : 12.9%	Model 3 : DV Periodontitis Status R^2 : 4.2%
Age (≥ 70 year)	0.46 (95% CI:0.23-0.92)	5.55 (95% CI:2.69-11.41)	-
Dental plaque score (High)	8.33 (95% CI:4.17-16.66)	-	2.74 (95% CI: 1.30-5.70)

DISCUSSION

The present study has shown that a high plaque score played the most important role in different aspects of periodontal disease (PD) in the elderly in rural Central Javanese communities. American Academy of Periodontology based on several studies stated that plaque deposits are closely correlated with gingivitis, a relationshiop long considered one of cause-and-effect. But while there is a clear causal relationship between oral hygiene and gingivitis, the relationship of oral hygiene to periodontitis is less straightforward[18].However, further a study found the association of certain subgingival microorganisms with CAL (Clinical Attachment Loss) changes in relation to supragingival plaque levels in older adult women[19].

The importance role of dental plaque score as a main determinant of PD may be related to the presence of certain pathogens. Three pathogens have an especially strong association with the presence of progressive periodontal disease: Actinobacillus actinomycetemcomitans, spirochetes of acute necrotizing gingivitis, and Porphyromonas gingivalis. One potential virulent factor recently ascribed to P. gingivalis and A. actinomycetemcomitans, and which is shared by a number of respiratory and enteric pathogens, is the ability enter mammalian cells[20]. Periodontitis is resulting from a complex interplay of bacterial infection and host response, often modified by behavioral factors[21]. Again, this current finding supported this interplay of bacterial infection that can be found in dental plaque.

Dental plaque is a natural biofilm develop within a few months of birth. A biofilm is a community of microorganisms attached to a solid surface, with the bacteria encapsulated in polymers derived from the bacteria and exhibiting specific biofilm characteristics, including increased resistance to antimicrobials and biocides (chemicals used to kill bacteria) and the production of novel proteins[22]. Another study found at high supragingival plaque levels, the presence of Tannerella forsythensis (OR: 2.40, 95%(CI: 1.42 to 4.04) and Porphyromonas gingivalis (OR: 3.71, 95%.CI: 1.63 to 8.42) was significantly associated with increased risk of attachment loss. With this finding the association between dental plaque and peridodontitis may be confirmed[19]. Before this only gingivitis and supragingival plaque have been confirmed[23]. But recent prospective study conducted reported only age, subgingical calculus and subgingival presence of A. actinomycetemcomitans were determinants for the onset of periodontitis. Supragingival plaques were not significant[24]. This might be explained by understanding that the study was a prospective study.

A major limitation of the present study was its cross-sectional design. The periodontal status is a dynamic process, not static, so a one time measurement makes it difficult to judge the extent of the severity of periodontal disease. This study also only used clinical measurement in the oral cavity, and did not do microbiological examination nor oral radiograph.

The strength of this study was the inclusion of a significant number of elderly people from the rural communities in Central Java with low social-economic status. Our measurement to judge periodontal status with 5 sub-variable were including Bleeding on Probing (BOP), Probing Pocket Depth (PPD), Loss of Attachment (LOA), Tooth Mobility (TM) and Furcation Involvement (FI), and remaining teeth will be more accurate than a single PD measurement.

Regardless of the model used (logistic or linear regression), a high dental plaque score emerged as a main and independent determinant of periodontal disease. The status of periodontal disease can be reflected through total periodontal score, the number of remaining teeth and periodontitis status. This data indicates that maintenance of oral hygiene is crucial in preventing periodontal disease in the elderly. Many older adults have difficulty achieving effective daily plaque control[25]. There is a major role of the dentists at the health-centers or within rural area in aiding the elderly to motivate them to brush their teeth regularly even if they have only few teeth. The dental plaque biofilm cannot be eliminated. However, the pathogenic nature of the dental plaque biofilm can be reduced by reducing the bio-burden (total microbial load and different pathogenic isolates within that dental plaque biofilm) and maintaining a normal flora with appropriate oral hygiene methods that include daily brushing, flossing and rinsing with antimicrobial mouth rinses[26]. There may be a need to develop a special dental care system designed for the elderly people in the rural communities of developing countries, because oral disease is the fourth most expensive disease to treat[27].

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