

Association between Stress and Periodontitis among Thai Elderly

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Abstract

The association between periodontal inflammation and stress is still limited to the evidence from Western countries. The aim of this study was to investigate whether stress was associated with periodontitis among Thai elderly. The cross-sectional study was conducted on 179 elderly aged 60 and over in Khon Kaen, Thailand. A calibrated dentist recorded clinical attachment levels (CAL) using the random half-mouth six-sites per tooth protocol. A face-to-face interview assessed stress level using Self-analyzed and Self-evaluated Stress Test (SSST). A structured questionnaire was used to obtain the information on demographics, medical history, and oral health behaviors. Logistic regression analysis was used to evaluate the association between periodontitis and stress while controlling for possible confounders. The result indicated that stress was associated with periodontitis (tertiary percentage of CAL \geq 5 mm) with three times higher odds ratio for those who had stress (OR = 3.0; 95 % confidence interval, 1.3 to 7.0) after controlling for all possible confounders. This study suggests that periodontitis is associated with stress in the elderly.

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Introduction

Thailand is experiencing an epidemiological transition characterized by a shift from infectious to non-communicable chronic diseases.¹ Systemic diseases and psychological problems due to aging are especially prevalent in old-aged people and adverse life events have a significant impact on psychological stress in the elderly. Moreover, high levels of tooth loss and high prevalence of periodontal disease, indicating poor oral health, are primarily seen in among older people.² National oral health survey in 2013 revealed that a subpopulation of 30 % to 89 % of Thai elderly, depending on the measure of disease applied was affected by advanced destructive periodontal disease.³

Periodontal disease is a low-grade inflammatory disease caused by specific periopathogenic bacteria.⁴ It is known to vary by systemic risk factors, such as diabetes mellitus, smoking, age, and genetic factors. The onset, progress, and severity of the disease are determined by the individual host response.⁵

Since the 1950s, psychological factors have been identified in periodontal disease development⁶ and several epidemiological surveys revealed that stress may be a contributing factor of periodontal disease.⁷⁻⁹ The possible role for an association is supported by some studies,^{10,11} showing that psychosocial conditions may affect the host immune response and cause the individual to be more susceptible to the development of unhealthy conditions including periodontal disease. In addition, stress may also influence a person's behavior and affect on periodontal conditions. Individuals with high stress levels tend to change their habits to be harmful to periodontal health, such as negligent oral hygiene, increased rate of tobacco use, or changes in eating behavior resulting in adverse effects for the function of immunologic system.⁹

Psychological stress has been shown to affect the periodontal status, but the findings are reported only in Western countries. Hence, we conducted a study

that aimed to investigate the relationship between stress and periodontitis of the elderly in Khon Kaen, Thailand.

Materials and Methods

This cross-sectional study was carried out among the elderly in Muang District of Khon Kaen province during June-September 2016. The study protocol was approved by Khon Kaen University Ethics Committee for Human Research (HE592183). Eligibility criteria of participants included being 60 years of age or above at the time of interview, and ability to communicate. Exclusion criteria were: (1) having dementia or schizophrenia; (2) having visual impairment, hearing impairment, or deafness; and (3) complete edentulousness. A stratified random sampling was employed to identify participants. Five sub-districts were randomly chosen to represent the central area of Muang District as well as surrounding areas in each direction. Eligible subjects in each sub-district were then randomly selected and invited to meet the investigators at sub-district health center. All participants provided written informed consent before taking part in the study.

Assessment of Stress

Data collection was conducted through face-to-face interview by a trained interviewer. A structured questionnaire was used to obtain the information on demographics, medical history, and oral health behaviors. Stress level was assessed using Self-analyzed and Self-evaluated Stress Test (SSST),¹² which is a standardized tool developed by the Department of Mental Health, Ministry of Public Health, Thailand. The test consists of 20 items measuring the level of perceived stress during the past 2 months. Each item was responded on a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often and 3 = regular). The total score is a sum of all items and interpreted as follows: 0-5 (less stress than a normal

level), 6-17 (normal level of stress), 18-25 (mild level of stress), 26-29 (moderate level of stress) and over 30 (severe stress). Participants with a total score of 18 or above were classified as having stress in this study.

Oral Examinations

Examinations of periodontal status and dental caries were performed at dental clinic in the sub-district health center using mouth mirror and periodontal probe. In two centers without dental clinic, the participants were examined on mobile dental chair under portable halogen light. Periodontal probing depth (PD) and clinical attachment levels (CAL) were examined using the random half-mouth six-sites per tooth protocol.¹³ The examiner was the sixth-year dental student who was well-calibrated with a periodontist. Duplicate examination was carried out in 10 percent of the samples. Intra-examiner and inter-examiner reliability of periodontal examination were good with an ICC>0.8 for each. Dental caries was evaluated using the World Health Organization (WHO) criteria, and decayed, missing and filled teeth (DMFT) index was calculated.

Statistical Analysis

Data are expressed as means and standard deviations (SDs) for continuous variables and as frequencies and percentages for categorical variables. Data were analyzed using IBM SPSS software version 19.0 (SPSS, Chicago, IL, USA). Periodontal status was a priori classified in tertiles based on the percentage of sites with CAL≥5 mm. Individuals in the lowest tertile (0 % - 12.4 %) were considered as no to mild periodontitis; those in the middle tertile (12.5 % - 52.7 %) as moderate periodontitis; and those in the highest tertile (≥52.8 %) as severe periodontitis. Additionally, we defined periodontitis as having 30 % of sites with CAL≥5 mm according to Hilgert *et al*¹⁴ in order to compare our results to their report. Logistic regression was performed with enter method to obtain odds ratios (ORs) and 95 % confidence intervals (CIs) of the relationships between moderate to severe periodontitis and associated factors. Potential confounders were included in multivariate analysis if

they changed the OR of the association between stress and periodontitis more than 10 percent. Important risk factors for periodontitis including age, gender and smoking were adjusted in the analyses.

Results

Characteristics of the elderly participants

There were 179 elderly subjects participated in this study. The average age (SD) of the participants was 67.1 (5.7) years. The oldest participant was 90 years old. The majority of participants were female (58.1 %), married (64.8 %), having primary school education (62.1 %), and living with family (93.8 %). Almost half (46.4 %) were not working, 41.3 % employed, and the rest were either had own business or worked in agriculture (Table 1). Most participants were non-smoker and non-alcohol drinker. Only 14.5 % were free of systemic diseases. Regarding oral health behaviors, 88.3 % of the participants brushed their teeth daily and 78.8 % used fluoride toothpaste. More than 80 % had previous dental treatment, but only 29.1 % had an annual dental visit (Table 2).

Table 1 Characteristics of Study Participants (n = 179)

Characteristic	N (%)
Gender	
- Male	75 (41.9)
- Female	104 (58.1)
Age in years	
- 60-69	131 (73.2)
- 70-79	40 (22.3)
- ≥80	8 (4.5)
Marital status	
- Never married	6 (3.4)
- Married	116 (64.8)
- Widowed	55 (30.7)
- Divorced	2 (1.1)
Education	
- No formal education	46 (25.7)
- Primary school	111 (62.1)
- Secondary school or higher	22 (12.2)
Occupation	
- Not working	83 (46.4)
- Employed	74 (41.3)
- Agriculture	14 (7.8)
- Business	8 (4.5)
Monthly family income in Thai Baht	
- <5,000	73 (40.8)
- 5,001-20,000	87 (48.6)
- >20,000	19 (10.6)
Living arrangement	
- Alone	11 (6.2)
- With children	86 (48.1)
- With spouse	76 (42.5)
- With relatives	6 (3.2)

Table 2 Health Behavior Information (n = 179)

Characteristic	N (%)
Current smoking	
- Yes	48 (26.8)
- No	131 (73.2)
Alcohol drinking	
- Yes	60 (33.5)
- No	119 (66.5)
Presence of systemic disease	
- Absent	26 (14.5)
- Cardiovascular disease	60 (37.5)
- Endocrine system disease	58 (36.3)
- Respiratory disease	17 (10.6)
- Other	25 (15.6)
History of dental treatment	
- No previous treatment	32 (17.9)
- Had previous treatments	147 (82.1)
Annual dental visits	
- Yes	52 (29.1)
- No	127 (70.9)
Frequency of tooth brushing	
- Less than once daily	21 (11.7)
- Once daily	64 (35.8)
- At least twice daily	94 (52.5)
Type of toothpaste	
- Fluoride toothpaste	141 (78.8)
- Non-fluoride toothpaste	35 (19.6)
- Tooth powder	3 (1.6)

Stress levels

Based on the SSST, 36.3 % of the elderly were under stressed condition. The majority had a mild level of stress (27.9 %). Only 3.9 % and 4.5 % were affected by moderate and high levels of stress, respectively (Table 3).

Table 3 Stress levels of the participants based on Self-analyzed and Self-evaluated Stress Test (SSST)

SSST score	N (%)
No stress	
0-5 (Less than normal level)	25 (14.0)
6-17 (Normal level)	89 (49.7)
With stress	
18-25 (Mild level)	50 (27.9)
26-29 (Moderate level)	7 (3.9)
≥30 (Severe level)	8 (4.5)

Oral health status

The prevalence of caries experience (DMFT>0) among the elderly was 83.8 %, with the average DMFT of 16.0 (SD = 7.3). The average number of teeth with untreated caries was 2.7 (SD = 2.7). Regarding the periodontal status, the participants had an average CAL of 4.1 (SD = 1.5) mm. Most participants (90 %) had at least 1 site with CAL≥5 mm. When the participants were classified based on the percentage of sites with CAL≥5 mm in tertiles, 25.7 % represented no to mild periodontitis,

48.6 % were moderate periodontitis, and 25.7 % were severe periodontitis.

Stress and periodontitis

Table 4 shows the bivariate logistic regression analysis of factors related to moderate to severe periodontitis. Stress was significantly associated with increased odds for moderate to severe periodontitis (OR = 2.8, 95 % CI = 1.4-5.7). The other characteristic that had a significant influence on periodontal status was gender (OR = 2.1, 95 % CI 1.1-4.1 for males).

Table 4 Factors Associated with Moderate to Severe Periodontitis among Elderly in Khon Kaen Province in Simple Logistic Regression

Characteristic		Periodontiti		Odds ratio (95 % Confidence Interval)	P-value
		No to Mild N (%)	Moderate to severe N (%)		
Gender	Female	42 (40.4)	62 (59.6)	1	0.02
	Male	18 (24.0)	57 (76.0)	2.1 (1.1-4.1)	
Age	60-69 years	44 (33.6)	87 (66.4)	1	0.98
	70 years or above	16 (33.3)	32 (66.7)	1.0 (0.5-2.0)	
Marital status	Single (never married, divorced, widowed)	17 (26.9)	46 (73.1)	1.6 (0.8-3.1)	0.17
	Married	43 (37.1)	73 (62.9)	1	
Having formal education	No	15 (32.6)	31(67.4)	1.1 (0.5-2.2)	0.88
	Yes	45 (33.8)	88 (66.2)	1	
Currently working	No	24 (28.9)	59 (71.1)	1.5 (0.8-2.8)	0.23
	Yes	36 (37.5)	60 (62.5)	1	
Monthly family income	≤5,000 Baht	23 (31.5)	50 (68.5)	1.2 (0.6-2.2)	0.64
	>5,000 Baht	37 (34.9)	69 (65.1)	1	
State of living	Alone	2 (18.2)	9 (81.8)	2.4 (0.5-11.3)	0.28
	With family	58 (34.5)	110 (65.5)	1	
Smoking	No	46 (35.1)	85 (64.9)	1	0.46
	Yes	14 (29.2)	34 (70.8)	1.3 (0.6-2.7)	
Alcohol drinking	No	42 (35.3)	77 (64.7)	1	0.48
	Yes	18 (30.0)	42 (70.0)	1.3 (0.7-2.5)	
Systemic disease	No	6 (23.1)	20 (76.9)	1.8 (0.7-4.8)	0.23
	Yes	54 (35.3)	99 (64.7)	1	
Diabetes mellitus	No	41 (33.1)	83 (66.9)	1.1 (0.6-2.1)	0.85
	Yes	19 (34.5)	36 (65.5)	1	
DMFT	≤17	34 (39.1)	53 (60.9)	1	0.13
	>17	26 (28.3)	66 (71.7)	1.6 (0.9-3.0)	
History of dental visit in the past year	No	43 (24.0)	84 (76.0)	1.6 (0.8-3.1)	0.21
	Yes	23 (12.8)	29 (87.2)	1	
Ever received dental treatment	No	9 (5.1)	23 (94.9)	2.1 (0.8-5.5)	0.14
	Yes	57 (31.8)	90 (68.2)	1	
Stress	No	47 (41.2)	67 (58.8)	1	0.005
	Yes	13 (20.0)	52 (80.0)	2.8 (1.4-5.7)	
Toothbrushing	Less than twice daily	26 (30.6)	59 (69.4)	1.3 (0.7-2.4)	0.43
	At least twice daily	34 (36.2)	60 (63.8)	1	
Fluoride toothpaste use	No	8 (21.1)	30 (78.9)	2.2 (0.9-5.1)	0.07
	Yes	52 (36.9)	89 (63.2)	1	

Boldface indicates statistical significance.

Table 5 presents multivariate logistic regression analyses of the associations between stress and moderate to severe periodontitis. Elderly persons with stress were 3 times more likely to have moderate to severe periodontitis compared to those without stress (adjusted OR = 3.0, 95 % CI = 1.3-7.0). The analysis was adjusted for gender,

age, working status, diabetes, smoking and history of dental treatment. Similar results in model II were obtained when using Hilgert *et al.*'s definition of periodontitis. Stress was associated with an adjusted OR of 3.9 (95 % CI = 1.7-9.0) for the development of periodontitis.

Table 5 Associations between stress and periodontal disease among elderly in Khon Kaen province in multivariate logistic regression

Variable	Odds ratio (95 % Confidence Interval)	
	Model I	Model II
Stress	3.0 (1.3-7.0)	3.9 (1.7-9.0)
Male gender	2.2 (1.1-4.5)	3.6 (1.7-7.5)
Aged 70 years or above	1.3 (0.6-2.8)	1.1 (0.5-2.3)
Employed/actively working	2.4 (1.2-5.0)	3.4 (1.5-7.2)
Diabetes	1.3 (0.6-2.7)	2.1 (0.9-4.5)
Smoking	0.9 (0.4-2.2)	1.9 (0.8-4.8)
Ever received dental treatment	2.4 (0.9-6.5)	1.5 (0.6-3.7)

Boldface indicates statistical significance.

Discussion

Studies relating psychosocial stress to periodontal disease have been conducted for many years.¹⁵⁻¹⁷ To our knowledge, this was the first epidemiologic study investigating the association between stress and periodontitis among Thai elderly. Our results support the hypothesis that stress may be associated with an increased risk of periodontitis. The present study found that persons subjected to stress have higher risk of severe attachment loss than those without stress in which potential confounders such as gender, age, occupation, diabetes mellitus, smoking, and history of dental treatment could be controlled.

The major strength of this study is that we determine the main outcome variable by measuring the CAL for evaluating periodontitis. Periodontitis is a disease that can newly develop, regress or progress over time. As an attachment loss requires long periods to develop,⁴ CAL measurement can support the validity of periodontitis

case ascertainment. According to the high prevalence of periodontal disease among Thai elderly³ therefore, we categorized the subjects based on the percentage of sites with CAL≥5 mm to determine the severity of the periodontitis. Full-mouth periodontal examination (FMPE) is time-consuming in periodontal surveys then the random half-mouth six-sites per tooth protocol was used. This method produces the smallest bias and provides the best agreement with FMPE in estimating periodontitis severity as determined by CAL, PD, and BOP.¹³

The conclusion of our study is based on self-reported psychosocial traits, the reliability of the psychosocial instruments used was therefore important. “Self Analyzed and Self Evaluated Stress Test (SSST),¹² which is a standardized questionnaire in Thailand was used to measure stress level. It was developed by the Department of Mental Health, Ministry of Public Health.

This is a measure with high sensitivity and has been widely used in health service system and general population of Thailand.

Since the first study⁶ provided the positive evidence that psychosocial stress was associated with periodontitis, some studies further demonstrated that stress may contribute in the etiology of periodontal disease development.^{18,19} Other studies revealed that individuals under high working load, bad marital status,²⁰ occupational dissatisfaction,²¹ and high psychological strain caused by negative life events²² indicated more periodontal destruction. Negative life events such as the loss of a spouse may cause a change of immunological system.²³ An association between psychosocial stress assessed as financial pressure and increased attachment loss as well as alveolar bone loss has been determined.²⁴ All those studies provide evidence that psychological factors influence the periodontal status most likely by modulating the function of the immunological system. A systematic review has confirmed that epidemiological studies of periodontal diseases are complicated by the different criteria used to define periodontal disease.²⁵ Moreover; the prevalence of periodontal disease among Thai elderly is high.³ Therefore, we categorized the subjects by tertiles based on the percentage of sites with CAL \geq 5 mm. Subjects were classified into three periodontitis groups: no/mild, moderate and severe to assess the extent of periodontitis. This was the same method as in the study of Sim *et al.*²⁶ However, in order to compare our results to other similar study, we conducted additional analysis by using Hilgert *et al.*¹⁴'s cut-off points with 30 % of the sites with CAL \geq 5 mm. Similar results were found. Hilgert *et al.*¹⁴ found that cortisol levels were positively associated with 30 % of the sites with CAL \geq 5 mm (OR = 6.9; 95 % CI: 1.7 to 27.1). Our results also showed similar association between periodontitis and stress (OR of 3 with tertile of percentage of site with CAL \geq 5 mm and OR of 3.9 with 30 % of the sites with CAL \geq 5 mm.) The results indicated that individuals with higher stress level are more likely to have greater risk

of having periodontitis. Compared to the report by Genco *et al.*²⁴ indicated that, of all the daily strains investigated, only financial strain was associated significantly with greater attachment and bone loss (OR = 1.70; 95 % CI: 1.09 to 2.65 and OR = 1.68; 95 % CI: 1.20 to 2.37, respectively). These results support the hypothesis that stress is associated with an increased risk of periodontitis.

However, the impact of stress seems to be more complex. The potential role is that stress is a mediating mechanism between individual characteristics and periodontal disease. It may lead to the lower host resistance which may mediate the putative relationship between psychosocial factors and periodontal disease.²⁷ Stress is proposed as an important disruptive factor in the homeostatic regulation between oral pathogenic bacteria and the host's immune system. The decreased immune reactions would offer the bacteria an opportunity to proliferate and invade the periodontal tissues. As an indirect way, stress may affect health behavior of persons with high stress by changing their habits to be harmful to periodontal condition, such as negligent oral hygiene, resulting in negative effects for the function of immune system.⁹ In a laboratory studies using mice, Shapira *et al.*^{28,29} found that an 'emotional' stressor (isolation) and a physical stressor (cold), compared to control group, had the effect of modifying the inflammatory response following introduction of *Porphyromonas gingivalis*, through suppression of macrophages, increased secretion of nitric oxide and reduction of tumor necrosis factor- α . Deinzer *et al.*³⁰ reported a study to determine the association between academic stress and gingival inflammation, assessing changes in interleukin-1 beta, a component of the immune system thought to play a role in periodontal tissue destruction. It revealed that examination students showed significantly higher levels of interleukin-1beta at both the experimental gingivitis sites (area under the curve, exam group: 1240.64 \pm 140.07; control group: 697.61 \pm 111.30; p = 0.004) and the sites of good oral hygiene (exam group: 290.42 \pm 63.19; control group: 143.98 \pm 42.71; p = 0.04), indicating

that stress may affect periodontal health through suppressed immune system activity, especially when oral hygiene is neglected. In an exploratory case-control study of psychosocial factors and adult periodontitis, Moss *et al.*³¹ defined cases as those individuals with active periodontal disease and who also demonstrated further periodontal attachment loss at 1-year follow up. Immune system response was examined according to median splits for level of serum immunoglobulin G (IgG) antibody to three periodontal pathogens, *Bacteroides forsythus*, *P. gingivalis*, and *Actinomyces actinomycetemcomitans*. The results showed significantly elevated odds ratios (OR) for cases and associated with IgG *P. gingivalis* (OR = 4.55) and IgG *A.actinomycetemcomitans* (OR = 5.29) while IgG *B. forsythus* was significantly associated with elevated odds for being a periodontal disease case, but only among individuals who had higher scores for daily strains. This exploratory analysis has served to identify specific lines of inquiry concerning psychosocial measures as important environmental factors in adult periodontitis.

The finding reported in our study does not establish causality. Cross-sectional study would be difficult to infer the temporal association between a risk factor and an outcome. Therefore, only an association can be inferred. Our study was limited to the young old (60 to 69) group; the mean age of this study population is 67.1 ± 5.7 years. Most people in their 60s and early 70s are still fit, active, and able to take care of themselves and may consent to take part in the study different from middle-old (75–84), and oldest-old (85+).³² These may be prone to non-response bias therefore; the results cannot be automatically applied to middle-old, and oldest-old groups.

Suggestions for the future research are to increase the number of subjects and collect more psychosocial stress factors which would allow for analysis of possible confounding factors. Further longitudinal studies are needed to examine whether stress is an independent risk factor for periodontal disease. In addition, the findings

suggest that this research highlights the importance for interdisciplinary approach between dentist and mental health personnel who involve in both preventive and curative approaches. Decision makers should give some more attention; thus, elderly will gain considerable improvement in oral health and psychological health under globalization.

Conclusions

This study provides some evidence of an association between stress and periodontitis in older adults when various potential confounders, including gender, age, occupation, diabetes mellitus, smoking, and history of dental treatment were controlled. Although our results cannot prove a causal relationship, these findings might have valuable implications for the prevention of periodontitis.

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