Original Article

Association between tooth loss and hypertension: A cross-sectional study

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Abstract

Context: Cardiovascular diseases (CVD) are one of the leading causes of premature deaths among noncommunicable disease. Hypertension increases the risk of cardiovascular events. In addition to well-known risk factors for hypertension like obesity, lack of physical activity, studies have shown independent association between tooth loss and increased blood pressure and stroke. However, the relevant literature is not conclusive. **Aims:** Aim of our study was to investigate the association between tooth loss and increased blood pressure among adult patients. **Methods and Material:** A cross-sectional study among 270 adults aged 20–59 years was conducted. The dependent variables were systolic blood pressure (SBP) and diastolic blood pressure (DBP). The main exploratory variable was the number of self-reported natural teeth for each dental arch. They were recorded as 10 or more natural teeth, less than 10 natural teeth, and no natural teeth. Data were analyzed using descriptive statistics, independent *t*-test, ANOVA, and multiple linear regression analysis. **Results:** Mean SBP was 125.3 mmHg and DBP was 78.9 mmHg. Moreover, 29.3% of participants had hypertension, 8.9% were edentulous, 22.8% had lost more than 10 teeth, and 68.3% had lost less than 10 teeth. Increased SBP was seen with increased tooth loss among participants. After adjusting for all covariates, no significant association between tooth loss and SBP and DBP was seen. **Conclusions:** The mean SBP was higher among the participants who were edentulous than partially edentulous. However, there was no significant association between tooth loss and SBP and DBP after adjusting for confounding factors.

Keywords: Association, blood pressure, cross-sectional, tooth loss

Introduction

Cardiovascular diseases (CVD) are one of the leading causes of premature deaths among noncommunicable diseases worldwide.[1] CVD related premature deaths are higher in developing countries compared to the developed countries.[2] Malaysia is classified as a developing country.[3] The prevalence of hypertension in Malaysia was 66.8%, with 45.8% having prehypertension, 15.1% having Stage 1 hypertension, and 5.9% having Stage 2 hypertension. In a multivariate analysis, a higher likelihood of having prehypertension was observed among respondents with advancing age, males, Malay ethnicity, lower socioeconomic status, and excessive weight.[4] Hypertension increases the risk of various cardiovascular events.[4] Tooth loss and periodontal disease are considered to be markers of oral inflammation. Tooth loss is failure of oral health and complete tooth loss is a total failure of oral health.[5] The prevalence of edentulism in United States is around 30–35% among older adults and while in Malaysia it is around 30–40%.[6]

In addition to well-known risk factors for hypertension; obesity, lack of physical activity, smoking, low, income, and

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low education level, several studies have shown independent association between tooth loss and increased blood pressure[7-12] and stroke.[13,14] However, the relevant literature is not conclusive about the association. Volzke *et al.* (2006) study showed an inverse association between number of teeth, blood pressure, and hypertension among men but not in women.[15] The same authors in 2007 reported an inverse relationship between tooth loss and left ventricular mass, a major cardiac sequel to hypertension.[16] A multidisciplinary population-based study reported an association between tooth loss and increased levels of systolic blood pressure (SBP) in Brazilian population.[17] A study in South African population reported that complete edentulousness is a risk indicator for hypertension.[18] A positive association was noted in a study in Malaysian population between tooth loss and hypertension in postmenopausal women.[19] However, most of the studies have focused on older population and fewer studies have targeted Asian population. Furthermore, there is a need for further studies on diverse populations to strengthen the evidence for association between hypertension and tooth loss. Hence, the aim of our study was to investigate the association between tooth loss and increased blood pressure among adults who were attending the Outpatient Department, Faculty of Dentistry.

Subjects and Methods

A cross-sectional study was conducted among adults aged 20–59 years reporting to the Outpatient Department, Faculty of Dentistry, of the private medical college of Malaysia. The sample size was calculated using the formula for single population proportion with the margin of error 5%, the assumption of 95% confidence level, and 81% of tooth loss more than 10 teeth in both arches.[17] The minimum sample size required was 245. We also included 10% for refusal and the final sample size required was 270. Nonprobability (purposive sampling) was used to select the participants. All subjects aged 20–59 years reporting to Out Patient Department, Faculty of Dentistry, Melaka-Manipal Medical College, Malaysia were eligible to participate. Ethical approval was obtained from Human and Ethics Committee (Date of approval - 07-03-2016), Faculty of Dentistry of Melaka-Manipal Medical College. Informed consent was taken from each participant. Subjects with decreased physical mobility such as amputees, those with an arm cast, pregnant women who are within 6 months from delivery, individuals who could not remain in proper position for the required measurements, those on antihypertensive medication, those who could not answer the questionnaire were excluded from the study.

The study procedure included a face to face interviewer-administered printed questionnaire, two blood pressure measurements and anthropometric measurements (height and weight). The dependent variables were systolic blood pressure (SBP) and diastolic blood pressure (DBP). SBP and DBP were assessed as continuous variables. Blood pressure levels were measured using a calibrated manual mercury sphygmomanometer (Accoson®). Blood pressure levels were calculated as the average between the two measurements taken with approximately 10-min interval. Blood pressure measurements were taken with the participant in a sitting position, with their feet planted on the floor, left arm relaxed and supported on a table at heart level, and with the palm facing upward.[20] People with undiagnosed hypertension were referred to the physician for further evaluation. The number of self-reported natural teeth for each dental arch was recorded as follows: 10 or more natural teeth, less than 10 natural teeth, and no natural teeth. We created a variable for each individual, including those with 10 or more natural teeth in both arches, less than 10 teeth in at least one arch, and edentulous (no natural teeth in both arches).

With reference from previous studies,[17] we considered age, smoking status, and other variables including demographics, socioeconomic position, health behaviors, diabetes, wearing a dental prosthesis, body mass index, and self-rated general health as the controlling variables. Age was categorized into four groups (20–29, 30–39, 40–49 and 50–59 years). We categorized education as primary school, secondary school, preuniversity, undergraduate, postgraduate education. Monthly per capita income was expressed in MYR (Malaysian Ringgit) and calculated as the sum of all earnings by all family members in the last month before the interview divided by the number of residents in the house; this was also analyzed as a continuous variable. Smoking status was assessed as: never smoked, former smoking, light current smokers (less than 10 cigarettes daily), moderate current smokers (10–20 cigarettes daily), and heavy current smoking (more than 20 cigarettes daily). The latter two categories were merged into one for analysis. The Alcohol Use Disorders Identification Test (AUDIT) was used to identify persons with hazardous and harmful alcohol consumption patterns.[21] Physical activity was assessed through a questionnaire used in the Telephone-based Surveillance of Risk and Protective Factors of Chronic Diseases (VIGITEL) in Brazil.[22] This was based on leisure-time physical activity, with inactive individuals defined as those who did not undertake any physical activity in leisure time or practiced less than once a week in the 3 months preceding the interview.[22] The interviewers asked participants whether they had ever been told by the doctor that they had diabetes. The self-reported use of dental prosthesis was a binary variable (yes versus no). Anthropometric measurements were considered. Weight was measured in kg and recorded twice using a portable and calibrated balance. Weight was recorded when the patients wore light clothing. They were asked to stand with their feet placed together and arms hanging beside the body. Height was measured twice using Stadiometer with a rigid measuring tape of 1 mm resolution. The average of the two measurements was taken as individual height. BMI was calculated and participants were categorized into obese (BMI <30 kg/m^2), overweight (BMI between 25.0 and 29.9 kg/m^2), and eutrophic (BMI <25 kg/m^2). The observers were calibrated for intra and interexaminer reliabilities.

At least two attempts were made to identify eligible adults when they enter the OPD before undergoing treatment. Cases were considered missing when the subjects refused to participate and

incomplete questionnaires. The reliability of the measurement of outcome variables was assessed using 10% of the total sample size (n = 270) for quality control. The intraclass correlation coefficient value for SBP and DBP were above 0.7.

After checking and coding the questionnaire, we used SPSS version 12 for data entry and data analysis. Descriptive statistics such as frequency and percentage were calculated for categorical variables, and mean and standard deviation were calculated for quantitative variables. We performed independent *t*-test and ANOVA for bivariate analysis between the association between independent variables including tooth loss and the outcome variable (SBP and DBP). Multiple linear regression models were also used to investigate the association between outcomes (SBP and DBP) with the main exposure (tooth loss) after adjusting for potential confounders. Firstly, demographic variables (age and sex) were included in the models, followed by socioeconomic position (per capita income and education), health-related behaviors (alcohol consumption, smoking status, physical activity, and BMI), health outcomes (diabetes and wearing dental prosthesis), and, finally, self-rated health. The final linear multivariable regression model was adjusted for all aforementioned covariates. The regression coefficient and its 95% confidence interval were calculated. Statistical significance was determined using *P* values less than 0.05.

Before data collection, the purpose of the study was explained to the respondents. Participation was strictly voluntary and the autonomy of the respondents was respected. Written informed consent was taken from each participant. Confidentiality was maintained and anonymity of respondents was ensured. In addition, data were kept secured and available only to the statistician. This study was approved by the research committee of faculty of dentistry of our college.

Results

A total of 269 participants from the Out-Patient Department of Faculty of Dentistry, Melaka-Manipal Medical College participated in this study. Table 1 displays the main characteristics of the studied sample. The mean SBP was 125.37 mmHg (SD 20.50), DBP was 78.87 mmHg (11.95), and 21.6% of participants had hypertension defined as SBP/DBP of >130/80 mmHg.[16] For tooth loss, 6.7% were edentulous, 16.7% had lost more than 10 teeth in both arches, and 76.6% had lost less than 10 teeth in both arches [Table 1, Appendix 1].

There was a significant association between tooth loss and SBP (*P*-value 0.001). The mean SBP was highest among edentulous (mean 136.00) followed by participants with teeth loss of more than or equal to 10 (mean 133.07) and less than 10 teeth loss in at least one arch. For DBP, the participants with tooth loss more than or equal to 10 had highest mean DBP of 135.60 followed by edentulous (mean 80.67) and teeth loss of less than 10 (mean 77.96). However, there was no significant association between tooth loss and DBP. The bivariate analysis of association between other variables such as sociodemographic characteristics, BMI, smoking, alcohol, prosthesis, and SBP and DBP are shown in Table 2 [Appendix 1].

Multiple linear regression analysis for the association between tooth loss, other variables and systolic and diastolic blood pressure is shown in Table 3. The participants with partial tooth loss had lower SBP than edentulous (regression coefficient b -5.34; 95% CI -14.48 to 3.79). For DBP, partial tooth loss had higher DBP than edentulous (regression coefficient b 1.7; 95% CI -3.65 to 7.04). After adjusting for other covariates, there was no significant association between tooth loss and SBP and DBP. There was also no significant association between ethnicity, education level, smoking, alcohol consumption, physical activity, presence of diabetes and use of dental prosthesis, and SBP and DBP. However, male had significantly higher SBP (regression coefficient b 7.66; 95% CI 2.45 to 12.87) and higher DBP (regression coefficient b 5.47; 95% CI 2.42 to 8.52) than female. Regards to age, the participants who were 40–49 and 50–59-year-old had significantly higher SBP and DBP than the participants who were aged 20–29 years. The participants who were obese had significantly higher SBP (regression coefficient b 9.88; 95% CI 1.80 to 17.96) and DBP (regression coefficient b 4.98; 95% CI 0.25 to 9.72) than normal weight. The DBP was significantly lower among underweight than normal weight (regression coefficient b -9.25; 95% CI -14.82 to 03.66) [Table 3, Appendix 1].

Discussion

This cross-sectional study was done to determine the association between tooth loss and increased blood pressure among adults in the Malaysian population. The mean SBP was higher among the participants with increased tooth loss and 25% had undiagnosed hypertension. However, multivariate regression analysis showed no significant association between SBP and tooth loss after adjusting confounding variables. Peres *et al.* reported a significant association between increased SBP and tooth loss. Their study was conducted in a multidisciplinary population in Brazil.[17] However, our study followed a similar protocol to the above-mentioned study but our results differed from their study. It could be due to the fact that our study was conducted in a clinical setting in a multi-ethnic Asian population.

The hypothesis that suggests a link between tooth loss and risk of hypertension is chronic immune dysfunction. Oral diseases like periodontitis lead to a hyperactive immune response. The endothelial cells lining the blood vessels are the primary target of hyperactive immune response cells leading to a procoagulatory state. In health, endothelial cells maintain vasodilator, antithrombotic, and anti-inflammatory state. Periodontitis, one of the major causes of tooth loss causes low-grade inflammation and might contribute to hypertension.[15] However, the epidemiological data do not show any strong causal association.

In a systematic review, two out of four moderate-to-high quality studies reported a relationship between a number of teeth and

all-cause mortality.[23] Few studies have investigated whether the prosthodontic replacement of missing teeth can affect all-cause mortality. Two studies showed effect of prosthodontic replacement on all-cause mortality. The authors have suggested that it is still not clear whether the other risks apart from circulatory mortality can reduce the risk of effect of reduced number of teeth on all-cause mortality.[23]

While trying to find the association between tooth loss and SBP, it is not clear if noninflammatory causes of tooth loss, for example, acute trauma, can confound the results. Besides, very few studies have studied if there is an association between the duration of tooth loss and hypertension. Furthermore, there are inherent problems with self-reported tooth loss like recall bias about the cause or duration of tooth loss. This problem is compounded in developing countries where oral health may not be among the top priority list in healthcare. Regular dental treatment may be luxury which not all people can afford due to socioeconomic reasons.[24]

Nonetheless, several studies have reported an association between tooth loss and hypertension.[17,23,24] Mustafa Al-Ahmad BE *et al.* in a cross-sectional study found that tooth loss is significantly associated with hypertension in postmenopausal women.[19] A study in Korean population found interaction between tooth loss and ischemic stroke.[25] In a short-term prospective cohort study, a significant association was found between the presence of periodontal disease and hypertension in Japanese university students. But, the risk of prehypertension was not associated with presence of periodontal disease.[26] A recent systematic review reported that the evidence suggesting that the treatment of inflammatory diseases like periodontitis could reduce BP is inconclusive. The authors opined that oral health assessment and management of periodontal disease could not only improve oral and overall health and quality of life but also be of relevance in the management of patients with hypertension.[27] A systematic review assessing evidence from Mendelian randomization and a randomized controlled trial of nonsurgical periodontal therapy reported a causal relationship between periodontitis and BP was observed. The authors suggested that this provides proof of concept for the development of clinical trials in a large cohort of hypertensive patients.[28]

Few knowledge, attitude, and practice (KAP) studies about the bidirectional relationship have been conducted among primary caregivers. The village health teams (VHTs), have the potential to play an important role in improving community awareness of noncommunicable disease (NCDs) as well as monitoring and referral of community members for NCD-related health issues.[29] More studies need to be done to assess the KAP among primary health caregivers regarding the above-mentioned topic. By improving awareness and providing proper training on recognizing and disseminating information about the bidirectional relationship between oral health care and systemic disease, primary caregivers can monitor and refer community members for early intervention. To accomplish this, they anticipated requiring context-specific and culturally adapted training as well as strong partnerships with facility-based medical personnel.[29]

Conclusion

Mean SBP was higher among the participants with increased tooth loss. However, when confounding factors were adjusted there was no significant association between SBP and tooth loss. Almost one-fourth of the participants had undiagnosed hypertension. While studies are yet exploring the relationship between tooth loss and hypertension, it is essential that these findings need to be discussed with primary care providers. Further studies on interprofessional practice among dentists and physicians in the management of noncommunicable disease and hypertension are required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

1. Taguchi A, Sanada M, Suei Y, Ohtsuka M, Lee K, Tanimoto K, *et al.* Tooth loss is associated with an increased risk of hypertension in postmenopausal women. Hypertension 2004;43:1297-300.
2. Joshi R, Jan S, Wu Y, MacMahon S. Global inequalities in access to cardiovascular health care: Our greatest challenge. J Am Coll Cardiol 2008;52:1817-25.
3. How Does the World Bank Classify countries? Country Classification. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/378834.
4. Mahadir Naidu B, Mohd Yusoff MF, Abdullah S, Musa KI, Yaacob NM, Mohamad MS, *et al.* Factors associated with the severity of hypertension among Malaysian adults. PLoS One 2019;14:e0207472.
5. Burt B, Eklund SA. Dentistry, Dental Practice and the Community. 4th ed. Philadelphia, PA, USA: WB Saunders; 1992. p. 83-9.
6. Tyrovolas S, Koyanagi A, Panagiotakos DB, Haro JM, Kassebaum NJ, Chrepa V, *et al.* Population prevalence of edentulism and its association with depression and self-rated health. Sci Rep 2016;6:37083.
7. Joshipura KJ, Douglass CW. Oral and cardiovascular disease associations do not call for extraction of teeth. J Evid Dent Pract 2002;2:261-6.

8. Lowe G, Woodward M, Rumley A, Morrison C, Tunstall-Pedoe H, Stephen K. Total tooth loss and prevalent cardiovascular disease in men and women. Possible roles of citrus fruit consumption, vitamin C, and inflammatory and thrombotic variables. J Clin Epidemiol 2003;56:694-700.
9. Holmlund A, Holm G, Lind L. Severity of periodontal disease and number of remaining teeth are related to the prevalence of myocardial infarction and hypertension in a study based on 4,254 subjects. J Periodontol 2006;77:1173-8.
10. Tsakos G, Herrick K, Sheiham A, Watt RG. Edentulism and fruit and vegetable intake in low-income adults. J Dent Res 2010;89:462-7.
11. Völzke H, Schwanh C, Hummel A, Wolff B, Kleine V, Robinson DM, *et al.* Tooth loss is independently associated with the risk of acquired aortic valve sclerosis. Am Heart J 2005;150:1198-203.
12. Okoro CA, Balluz LS, Eke PI, Ajani UA, Strine TW, Town M, *et al.* Tooth loss and heart disease. Am J Prev Med 2005;29:50-6.
13. Heitmann BL, Gamborg M. Remaining teeth, cardiovascular morbidity and death among adult Danes. Prev Med 2008;47:156-60.
14. Leong XF, Ng CY, Badiah B, Das S. Association between hypertension and periodontitis: Possible mechanisms. ScientificWorldJournal 2014;2014;768237. doi: 10.1155/2014/768237.
15. Völzke H, Schwahn C, Dörr M, Schwarz S, Robinson D, Dören M, *et al.* Gender differences in the relation between number of teeth and systolic blood pressure. J Hypertens 2006;24:1257-63.
16. Völzke H, Schwahn C, Dörr M, Aumann N, Felix SB, John U, *et al.* Inverse association between number of teeth and left ventricular mass in women. J Hypertens 2007;25:2035-43.
17. Peres MA, Tsakos G, Barbato PR, Silva DA, Peres KG. Tooth loss is associated with increased blood pressure in adults--A multidisciplinary population-based study. J Clin Periodontol 2012;39:824-33.
18. Ayo-Yusuf OA, Ayo-Yusuf IJ. Association of tooth loss with hypertension. S Afr Med J 2008;98:381-5.
19. Mustafa Al-Ahmad BE, Kashmoola MA, Mustafa NS, Hassan H, Arzmi MH. The relationship between tooth loss, body mass index, and hypertension in postmenopausal female. Eur J Dent 2018;12:120-2.
20. Ogedegbe G, Pickering T. Principles and techniques of blood pressure measurement. Cardiol Clin 2010;28:571-86.
21. Babor TF, Higgins-Biddle JC, Saunders JB, D Monteiro MG. The Alcohol Use Disorders Identification Test (AUDIT) Manual: Guidelines for Use in Primary Care. 2nd ed. Department of Mental Health and Substance Dependence. Geneva: World Health Organization, WHO/MSD/MSB/01.6a, 2001. p. 4-32. Available from: http://whqlibdoc.who.int/hq/2001/who_msd_msb_01.6a.pdf.
22. Florindo AA, Hallal PC, Moura EC, Malta DC. Prática de atividades físicas e fatores associados em adultos, Brasil, 2006. Rev Saude Publica 2009;43:65-73.
23. Polzer I, Schwahn C, Völzke H, Mundt T, Biffar R. The association of tooth loss with all-cause and circulatory mortality. Is there a benefit of replaced teeth? A systematic review and meta-analysis. Clin Oral Investig 2012;16:333-51.
24. Kossioni AE. Current status and trends in oral health in community dwelling older adults: A global perspective. Oral Health Prev Dent 2013;11:331-40.
25. Kim SW, Cho KH, Han KD, Roh YK, Song IS, Kim YH. Tooth loss and metabolic syndrome in South Korea: The 2012 Korean national health and nutrition examination survey. Medicine (Baltimore) 2016;95:e3331.
26. Kawabata Y, Ekuni D, Miyai H, Kataoka K, Yamane M, Mizutani S, *et al.* Relationship between prehypertension/hypertension and periodontal disease: A prospective cohort study. Am J Hypertens 2016;29:388-96.
27. Muñoz Aguilera E, Suvan J, Buti J, Czesnikiewicz-Guzik M, Barbosa Ribeiro A, Orlandi M, *et al.* Periodontitis is associated with hypertension: A systematic review and meta-analysis. Cardiovasc Res 2019;24. doi: 10.1093/cvr/cvz201.
28. Czesnikiewicz-Guzik M, Osmenda G, Siedlinski M, Nosalski R, Pelka P, Nowakowski D, *et al.* Causal association between periodontitis and hypertension: Evidence from Mendelian randomization and a randomized controlled trial of non-surgical periodontal therapy. Eur Heart J 2019:ehz646. doi: 10.1093/eurheartj/ehz646.
29. Ojo TT, Hawley NL, Desai MM, Akiteng AR, Guwatudde D, Schwartz JI. Exploring knowledge and attitudes toward non-communicable diseases among village health teams in Eastern Uganda: A cross-sectional study. BMC Public Health 2017;17:947

Appendix 1

Table 1: Characteristics of the studied adult population (*n*=269)

Variable	*n* (%)
Gender	
Male	119 (44.2)
Female	150 (55.8)
Age (years)	
20-29	63 (23.4)
30-39	36 (13.4)
40-49	55 (20.4)
50-59	115 (42.8)
Ethnicity	
Malay	94 (34.9)
Chinese	134 (49.8)
Indian	41 (15.2)
Educational Level	
Primary School	29 (10.8)
Secondary School	132 (49.1)
PreUniversity	21 (7.8)
Undergraduate	75 (27.9)
Postgraduate	12 (4.5)
Per Capita Family Income	
Higher tertile (>RM 5000)	91 (33.8)
Intermediary tertile (RM2000-RM5000)	102 (37.9)
Lower tertile (<RM2000)	76 (38.3)
Smoking status	
Never	227 (84.4)
Former	12 (4.5)
Current	30 (11.2)
Alcohol Consumption	
No	223 (82.9)
Yes	46 (17.1)
Physical activity (IPAQ score)	
HEPA	116 (43.1)
Inactive	69 (25.7)
Minimally active	84 (43.1)
Body Mass Index (kg/m^2)	
Underweight (<18.5 kg/m^2)	16 (5.9)
Normal (18.5-24.9 kg/m^2)	153 (56.9)
Overweight (>25.0 kg/m^2)	72 (26.8)
Obese (>30.0 kg/m^2)	28 (10.4)
Diabetes	
No	240 (89.2)
Yes	29 (10.8)
Use of dental prosthesis	
No	173 (64.3)
Yes	96 (35.7)
Tooth loss	
Edentulous	18 (6.7)
<10 teeth loss at least in one arch	206 (76.6)
≥10 teeth loss in both arches	45 (16.7)
Hypertension	
Yes	58 (21.6)
No	211 (78.4)
Systolic Blood Pressure[a]	125.37 (20.50)
Diastolic Blood Pressure[a]	78.87 (11.95)

[a]Mean (SD)

Table 2: Bivariate analysis of the association between tooth loss, other variables and systolic blood pressure (SBP) and diastolic blood pressure (DBP)

Variable	Systolic Blood Pressure (mmHg)		Diastolic Blood Pressure (mmHg)	
	Mean (SD)	*P*	Mean (SD)	*P*
Tooth loss[b]				
Edentulous	136.00 (24.82)	0.001	80.67 (13.12)	0.076
<10 teeth loss in at least one arch	122.76 (18.70)		77.96 (11.82)	
≥10 teeth loss in both arches	133.07 (20.50)		135.60 (11.95)	
Gender[c]				
Male	130.90 (17.47)	<0.001	82.46 (10.80)	<0.001
Female	120.98 (21.69)		76.02 (12.08)	
Age (years)[b]				
20-29	111.60 (14.49)	<0.001	71.16 (10.85)	<0.001
30-39	117.50 (15.73)		76.83 (12.89)	
40-49	131.05 (18.25)		81.89 (10.36)	
50-59	132.65 (21.14)		82.29 (10.93)	
Ethnicity[b]				
Malay	127.15 (21.12)	0.508	80.35 (12.57)	0.318
Chinese	124.86 (19.25)		78.22 (11.52)	
Indian	122.37 (20.50)		77.61 (11.83)	
Educational Level[b]				
Primary School	127.45 (23.7)	0.001	79.93 (10.78)	0.003
Secondary School	129.77 (19.18)		81.21 (11.29)	
PreUniversity	126.33 (17.65)		78.76 (12.14)	
Undergraduate	117.43 (19.30)		74.45 (12.30)	
Postgraduate	119.83 (25.32)		78.33 (13.32)	
Per Capita Family Income[b]				
Higher tertile	121.95 (17.82)	0.003	76.82 (11.86)	0.017
Intermediary tertile	123.82 (20.13)		78.36 (11.87)	
Lower tertile	131.96 (22.60)		82.00 (11.69)	
Smoking status[b]				
Never	124.51 (21.06)	0.199	78.28 (12.23)	0.130
Former	134.17 (23.66)		83.75 (11.15)	
Current	128.33 (13.05)		81.53 (9.32)	
Alcohol Consumption[c]				
No	125.83 (21.09)	0.417	79.18 (11.84)	0.344
Yes	123.13 (17.39)		77.35 (12.50)	
Physical activity (IPAQ score)[b]				
HEPA	125.34 (17.21)	0.748	79.11 (11.65)	0.465
Inactive	126.78 (21.87)		79.97 (12.52)	
Minimally active	124.24 (23.49)		77.63 (11.92)	
Body Mass Index[b]				
Underweight	114.13 (19.22)	0.001	67.00 (9.96)	<0.001
Normal	122.94 (21.89)		77.93 (12.32)	
Overweight	128.93 (17.98)		81.11 (9.51)	
Obese	135.89 (12.70)		85.00 (11.35)	
Diabetes[c]				
No	124.60 (20.89)	0.075	78.58 (12.30)	0.131
Yes	131.76 (15.85)		81.24 (8.27)	
Use of dental prosthesis[c]				
No	123.73 (20.82)	0.079	77.89 (12.01)	0.071
Yes	128.31 (19.68)		80.64 (11.70)	

[b]ANOVA; [c]Independent *t*-test; *P* value<0.05 is significant

Table 3: Multiple linear regression analysis of the association between tooth loss, other variables, and systolic and diastolic pressure

Variable	Systolic Blood Pressure (mmHg)		Diastolic Blood Pressure (mmHg)	
	Adjusted b (95% CI)	*P*	Adjusted b (95% CI)	*P*
Tooth loss				
Edentulous	Reference		Reference	
Partial tooth loss	-5.34 (-14.48, 3.79)	0.250	1.70 (-3.65, 7.04)	0.533
Gender				
Female	Reference	0.004	Reference	
Male	7.66 (2.45, 12.87)		5.47 (2.42, 8.52)	<0.001
Age (years)				
20-29	Reference		Reference	
30-39	3.58 (-5.30, 12.46)	0.428	3.97 (-1.23, 9.16)	0.134
40-49	16.69 (7.65, 25.73)	<0.001	9.08 (3.78, 14.37)	0.001
50-59	20.86 (12.70, 29.02)	<0.001	10.64 (5.86, 15.42)	<0.001
Ethnicity				
Malay	Reference		Reference	0.050
Chinese	-4.35 (-9.73, 1.03)	0.113	-3.15 (-6.30, -0.01)	0.090
Indian	-6.54 (-13.60, 0.53)	0.070	-3.58 (-7.71, 0.56)	
Educational Level				
Primary School	Reference		Reference	
Secondary School	3.13 (-4.56, 10.81)	0.424	1.16 (-3.34, 5.66)	0.611
PreUniversity	-2.08 (-12.69, 8.53)	0.700	-2.56 (-8.78, 3.65)	0.417
Undergraduate	2.72 (-6.59, 12.02)	0.566	0.94 (-4.51, 6.39)	0.735
Postgraduate	-1.57 (-14.42, 11.27)	0.810	0.90 (-6.62, 8.42)	0.814
Smoking status				
Never	Reference		Reference	
Former	2.10 (-9.21, 13.41)	0.714	-0.450 (-7.07, 6.17)	0.894
Current	-5.77 (-13.59, 2.05)	0.147	-2.75 (-7.33, 1.83)	0.238
Alcohol Consumption				
No	Reference	0.986	Reference	0.880
Yes	0.06 (-6.25, 6.36)		-0.28 (-3.98, 3.41)	
Physical activity (IPAQ score)				
HEPA	Reference		Reference	
Inactive	0.57 (-5.01, 6.15)	0.840	0.29 (-2.98, 3.56)	0.862
Minimally active	1.46 (-3.76, 6.67)	0.582	0.25 (-2.80, 3.31)	0.870
Body Mass Index				
Normal	Reference		Reference	
Underweight	-4.49 (-14.02, 5.04)	0.355	-9.25 (-14.83, -3.66)	0.001
Overweight	2.89 (-2.57, 6.36)	0.298	1.32 (-1.88, 4.52)	0.416
Obese	9.88 (1.80, 17.96)	0.017	4.98 (0.25, 9.72)	0.039
Diabetes				
No	Reference		Reference	
Yes	-5.15 (-13.02, 2.72)	0.199	-4.49 (-9.10, 0.12)	0.056
Use of dental prosthesis				
No	Reference		Reference	
Yes	-0.94 (-6.02, 4.14)	0.717	0.54 (-2.43, 3.52)	0.719

b: regression coefficient; 95% CI: 95% confidence interval; *P* value<0.05 is significant