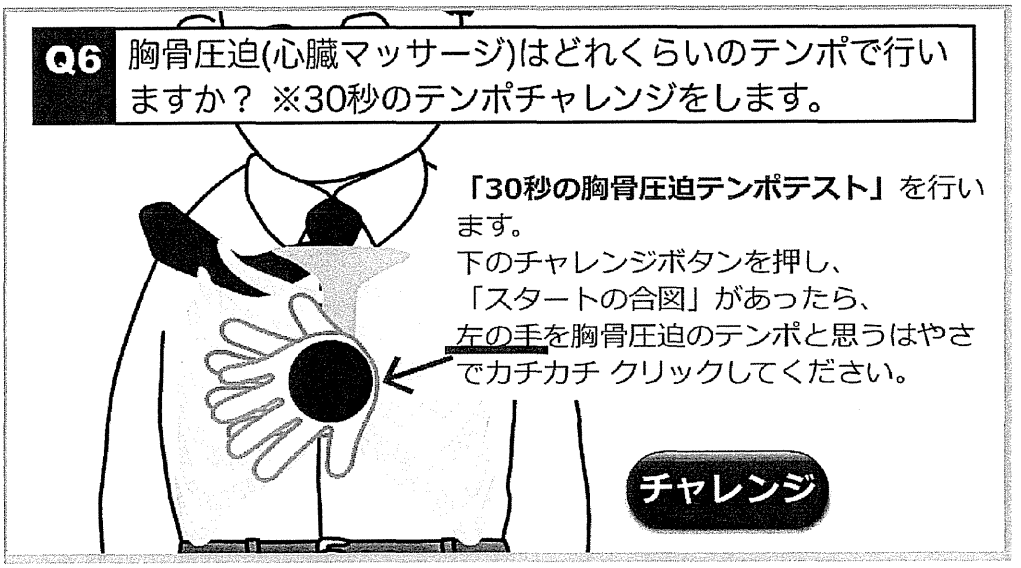
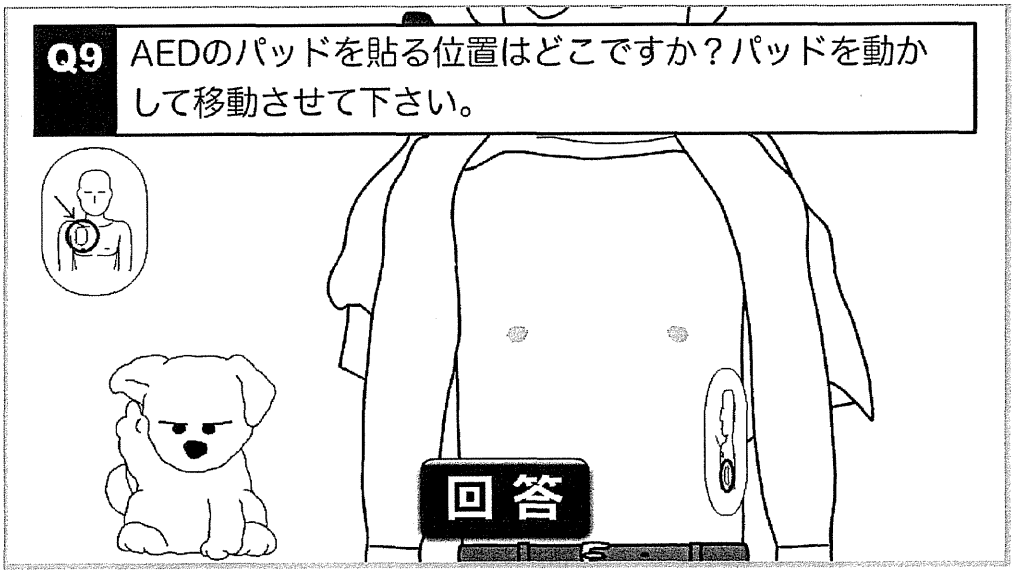
参考資料①　E ラーニング





心肺蘇生法の手順

1．119番通報とAEDの要請

倒れている人がいたら、軽く肩をたたきながら声をかける。

反応がなかったら、大丈夫じゃないから、すぐに・・・

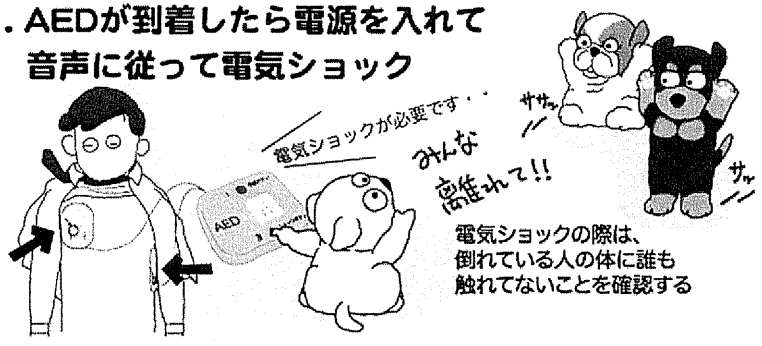
大声で助けを呼びます。

2．いつも通りの息をしていなければすぐに

胸骨圧迫開始

両手を重ね、胸の真ん中を1分間に100回以上のテンポで押し続ける

3．AEDが到着したら電源を入れて音声に従って電気ショック



電気ショックの際は、倒れている人の体に誰も触れてないことを確認する

PUSH PROJECT PUSHプロジェクト
http://osakalifesupport.jp/push/

メッセージビデオはこちら
http://www.youtube.com/watch?v=g27OCXp0HRs

胸をPUSH

突然倒れ、意識も呼吸もない人がいたら、AEDを要請するとともに119番通報し、直ちに胸を強く押します（胸骨圧迫）。

AEDのボタンをPUSH

AED（自動体外式除細動器）が到着したら、音声指示に従い、安全を確認してショックボタンを押します。

あなた自身をPUSH

救急蘇生法の中で一番難しいのは、倒れた方に近づいて、声をかけることかもしれません。まず、勇気を持って、声をかけて下さい。そして、できることを何かしてあげて下さい。

Eラーニングポジョレーに教わる で学ぼう!! 救命処置

10問のクイズで、いざという時の心肺蘇生法を学ぼう！
インターネットのクイズで楽しみながら学べます。

Eラーニング前後の意識の変化を調査するため、簡単なアンケートにご協力お願いします。

http://119aed.jp/maizuru/ にアクセス!!

スマートフォンの方はアプリをダウンロードして学べます。

大切な人を守るために

あなたの大切な人が、目の前でたおれたら… あなたは何ができますか？

舞鶴PUSHプロジェクト

舞鶴PUSHプロジェクトでは、短時間の簡易救命講習やEラーニング等を通じて、胸骨圧迫（心臓マッサージ）とAEDを学ぶ機会を増やすことで、突然の心停止となってしまった方を救命することのできる地域づくりを目指しています。

事業主体：厚生労働科学研究費補助金「慢性期ハイリスク者・脳卒中および心疾患患者に適切な早期受診を促すための地域啓発研究（H23－循環器等（生習）－一般－009）」
院外心停止の一次救命処置に関する啓発を進める手法の検討
協 力 ：NPO法人 大阪ライフサポート協会、京都府舞鶴市

Ⅳ．研究成果の刊行に関する一覧表

研究成果の刊行に関する一覧表

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堂川 冴子、谷口留美、土手 ひとみ、寺村 啓子、萩原 良子、茅野和子、玉井久美、金山 直美、圓若 明美、長井玲子、三石 哲也、金井 有吾、南部 拓央、米光 新、武呂 誠司	地域住民に対する効果的な啓蒙活動の仕方について	第55回日本糖尿病学会年次学術集会	横浜	2012
馬屋 原豊、小杉圭右、隠岐 尚吾、北川 良裕、浅沼伸行、徳田好男、谷本 吉造、川岸 隆彦、李 輝雄、橋本 久仁彦、谷口 敏雄、庄司 繁市、久米田 靖郎、武呂 誠司	大阪市南部地域における病診連携の試み（第12報）インクレチン関連薬に関する意識調査	第55回日本糖尿病学会年次学術集会	横浜	2012
Nakayama H	Effective methods for public education of TIA	International TIA/ACVS conference	Tokyo	2013

Ⅴ．資料

ORIGINAL ARTICLE

Additive Interaction of Oral Health Disorders on Risk of Hypertension in a Japanese Urban Population: The Suita Study

Yoshio Iwashima,[1] Yoshihiro Kokubo,[2] Takahiro Ono,[3] Yoko Yoshimuta,[3] Momoyo Kida,[3] Takayuki Kosaka,[3] Yoshinobu Maeda,[3] Yuhei Kawano,[1] and Yoshihiro Miyamoto[2]

BACKGROUND
This study assessed the relationship between different oral health markers—periodontitis, gingival bleeding, tooth number, and occlusal status—and hypertension in a Japanese urban population.

METHODS
A total of 1,643 participants with no prior cardiovascular disease (mean age = 66.6 years; 43.4% women) underwent comprehensive health checkups, including a lifestyle questionnaire and dental examination in the Suita Study.

RESULTS
In the multivariable-adjusted logistic model, none of the individual oral health markers, namely severe periodontitis, gingival bleeding, lowest quartile of tooth number, and malocclusion, were significantly associated with increased odds of hypertension. The additive effects of oral health markers on hypertension were examined and showed that, compared with subjects with no component of the oral health markers, the multivariale-adjusted odds ratio of hypertension in those with ≥3 components was 1.82 (95% confidence interval (CI) = 1.23–2.72; $P = 0.003$). In the subpopulation without antihypertensive medication (n = 1,148; 59.8% women), a significant graded relationship between multivariable-adjusted systolic blood pressure and the number of components was found ($P_{trend} = 0.03$), and, compared with subjects with no component of the oral health markers, having ≥3 components was related to a higher systolic blood pressure ($\beta = 5.41$; 95% CI = 1.16–9.66; $P = 0.01$).

CONCLUSIONS
There is an additive relationship between oral health disorders and risk of hypertension. Our results suggest that the existence of moderate or severe oral health disorders—that is, several concomitant oral health disorders—is associated with risk of hypertension.

Keywords: blood pressure; hypertension; life style; oral health disorder; risk factor.

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Several epidemiological surveys have suggested the existence of a positive relationship between oral health disorders and hypertension.[1–5] Among such disorders, periodontitis is a common chronic infectious disease of the adult population, characterized by an exaggerated gingival inflammatory response against pathogenic bacterial microflora. If left untreated, it leads to deterioration of the supportive tissue of the teeth and eventually to tooth loss.[6] Periodontal disease, gingival bleeding, and tooth loss have been reported to be associated with hypertension,[1–5,7,8] and the systemic inflammatory response that may accompany these conditions has been implicated as a mechanism in the development of hypertension.[9] Periodontal disease and subsequent tooth loss may lead to poor dietary habits, or vice versa, and patients with these conditions may be likely to favor soft carbohydrate foods[10] and restrict fruit intake,[11] which influences blood pressure.[12] The modification of diet that occurs with these conditions has been speculated to be another possible mechanism in the development of hypertension;[9,13] however, the clinical implication of lifestyle variables such as eating habits or physical activity in the association between oral health disorders and hypertension remains to be elucidated. Further, tooth loss could contribute to worse occlusal status or masticatory performance, which is also an important pathological condition in oral health disorders; however, the influence of worse occlusal status on hypertension is also unknown.

In an effort to enrich understanding in the emerging area of the association between oral health and hypertension, we investigated the potential interrelationship between different markers of oral health, lifestyle variables, and risk of hypertension in a Japanese urban population.

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METHODS

Study subjects

The data used in this research derive from the Suita Study, which consisted of a random sample of Japanese urban residents. The details of this study are described elsewhere.[14–16] Briefly, 6,485 men and women aged 30–79 years had a baseline survey at the National Cardiovascular Center (now the National Cerebral and Cardiovascular Center) between September 1989 and March 1994 and underwent a medical examination every 2 years. Of these, 1,797 underwent comprehensive regular health checkups and dental examinations between June 2008 and March 2012. Participants in the study population were excluded from these analyses if they had a past or present history of cardiovascular disease, including ischemic heart disease, acute coronary syndrome, congestive heart failure requiring hospitalization, valvular heart disease requiring medication, stroke, history of transient ischemic attack (n = 88), or atrial fibrillation (n = 35), or had not undergone baseline dental examination (n = 31). After applying these exclusions, a total of 1,643 participants aged 30–79 years were available for this analysis. Physicians or nurses administered the questionnaire on individual personal habits and present illnesses. Informed consent was obtained from all participants. All participants were Japanese, and this study was approved by the Institutional Review Board of the National Cerebral and Cardiovascular Center (M19-062-3).

Measurement of blood pressure and covariables

Well-trained physicians measured blood pressure twice in a seated position with an automated sphygmomanometer (Colin BP-I03ill; Omron, Kyoto, Japan) and an appropriately sized cuff according to a standard protocol after at least 5 minutes of rest before the initial blood pressure reading was obtained. Systolic (SBP) and diastolic (DBP) blood pressure were considered the average of 2 measurements recorded >1 minute apart. Hypertension was defined as SBP ≥140 mm Hg and/or DBP ≥90 mm Hg or use of antihypertensive medication.

At the baseline examination, routine blood tests were performed, including triglycerides, high-density lipoprotein cholesterol, glucose, and hemoglobin A1c. Height and body weight were measured, and body mass index was calculated as weight (kg) divided by the square of height (m^2). Dyslipidemia was defined according to the guidelines of the National Cholesterol Education Program Third Adult Treatment Panel.[17] Diabetes mellitus was defined according to the American Diabetes Association criteria.[18] Estimated glomerular filtration rate was calculated using the Japanese coefficient-modified Chronic Kidney Disease Epidemiology Collaboration equation in milliliters per minute per 1.73 m^2, as previously described.[19–21]

Oral examination

All participants received a complete oral examination by trained, certificated dentists. The periodontal condition was assessed using a modified Community Periodontal Index of Treatment Needs (CPITN)[22] in 8 designated molars (first and second molars) and 2 incisors (upper right and left central incisors) by applying the following scores: 0 indicates healthy periodontal tissue; 1 indicates gingival bleeding; 2 indicates calculus and/or overhanging restorations; 3 indicates pocket depth of 4–5 mm; and 4 indicates pocket depth of ≥6 mm. All periodontal examinations were performed by 4 experienced dentists, and the interobserver Cohen's kappa coefficient for grading was 0.78. The periodontal condition of every patient was reported as the worst CPITN condition. The presence or absence of gingival bleeding was also assessed by salivary occult blood test using a paper test strip (Salivaster; Showa Yakuhin, Tokyo, Japan).

The number of remaining teeth was counted in the full mouth with the exception of the third molars, which tend to be impacted, congenitally missing, or surgically removed because of anticipated pericoronitis.[23] Therefore, the maximum number of teeth was 28.

The status of occlusal support or masticatory performance was recorded by means of the Eichner index,[24] which is based on occlusal contact areas for the natural dentition in antagonist jaws, including fixed dentures. Class A contains 4 support zones; this means there is a minimum of 1 tooth in contact between the maxilla and the mandible in both the premolar and molar regions on each side. Class B contains 3, 2, or 1 support zone or support in the anterior area only. In class C, there are no antagonist contacts in the dentition.

Maximal bite force was measured by using the Dental Prescale System (GC, Tokyo, Japan), which consists of a horseshoe-shaped bite foil of pressure-sensitive film (50H, type R) and a computerized scanning system for analysis of the load.[25,26]

Lifestyle variables

Information on lifestyle was collected with a standardized questionnaire by physicians or nurses through face-to-face interviews, including demographic information such as smoking habit, dietary practices and usual frequency of food intake, exercise/sports and walking hours a day, and sleeping hours. Smoking status was defined as never smoker, former smoker, or current smoker. Alcohol consumption was categorized as none, social, or daily. Consumption of fruit and sugar-sweetened soft drinks was ascertained by questions as "fruit (citrus fruit, other fruit, and fresh fruit juice) intake ≥1 /day" and "sugar-sweetened soft drink intake ≥3 times /day," respectively. Sugar-sweetened soft drinks included all types of non-low-calorie, concentrated, carbonated, and ready-to-drink soft drinks. All low-calorie, no-added-sugar, and sugar-free types of concentrated, carbonated, and ready-to-drink soft drinks were not classified as sugar-sweetened soft drinks in this study. Physical activity was ascertained by question as"'>1 hour walking or equivalent physical activity on average a day." Average sleep duration was classified into 8 categories: <4, 4–5, 5–6, 6–7, 7–8, 8–9, 9–10, and ≥10 hours per day.

Statistical analysis

Summary statistics are presented as mean (±SD) for continuous variables and as percentage for categorical

variables unless otherwise specified. First, the participants were divided into 2 groups according to the presence/absence of hypertension, and then the significance of any differences between groups was evaluated using unpaired t test or χ^2 test, as appropriate. Second, patients were stratified into 3 or 4 groups according to the status of oral health disorders. Differences in characteristics between groups were tested using χ^2 test for dichotomous variables and 1-way analysis of variance with Sheffe's post-test for continuous variables, as appropriate. Logistic regression analysis was used to determine the odds ratio (OR) of hypertension as a function of individual components of oral health markers, such as CPITN stage, gingival bleeding, tooth number, and Eichner index, as well as combinations of 2 oral health markers. In multivariable-adjusted models, we included variables that might confound the relationship between hypertension and oral health markers: age, body mass index, diabetes, dyslipidemia, estimated glomerular filtration rate, smoking status (3 categories), daily alcohol consumption, daily fruit intake, daily sugar-sweetened soft drink intake, physical activity, and nocturnal sleep duration.

We next divided the subjects into 4 groups according to the number of oral health disorders present (0, 1, 2, or ≥3). The relative ORs of hypertension were assessed in age and sex-adjusted or multivariable-adjusted logistic regression models and calculated using the subgroup with no component of oral health markers as a reference for each. Differences in characteristics among the 4 groups were determined by 1-way analysis of variance with Scheffe's multiple comparison post-test for continuous variables and χ^2 test for categorical variables. Multivariable linear regression analyses using SBP or DBP as the dependent variable were also performed in the subjects not taking antihypertensive medication. Mean and SE were calculated in the case of linear regression, and OR and 95% confidence interval (CI) were calculated in the case of logistic regression. All P values were 2-sided, and those <0.05 were considered statistically significant. All of the calculations were performed using a standard statistical package (JMP 8.0; SAS Institute, Cary, NC; and SPSS version 17.0; SPSS, Chicago, IL).

RESULTS

General characteristics

The baseline characteristics of the study subjects are shown in Table 1. Mean age was 66.6 ± 7.9 years, and 43.4% of subjects were men. We first divided the subjects into 2 groups according to the presence/absence of hypertension and found that hypertensive subjects showed a significantly worse CPITN stage, higher prevalence of gingival bleeding, lower tooth number, and worse Eichner index.

Relations among oral health markers

To examine the relationships among oral health markers, we next divided the patients into 3 or 4 groups according to the status of oral health disorders (Table 2). There were significant trends toward higher prevalence of gingival bleeding, lower remaining tooth number, and worse Eichner index with increasing stage of CPITN. Similarly, there were significant trends toward higher prevalence of gingival bleeding, worse CPITN stage, and worse Eichner index with decreasing remaining tooth number. The Eichner index C group showed significantly lower remaining tooth number and worse CPITN stage than the Eichner A group (Table 2).

Relations of oral health disorders to hypertension

Age- and sex-adjusted logistic regression analysis found that only the presence of gingival bleeding was significantly associated with risk of hypertension, and the relation between individual oral health markers (CPITN stage 4, presence of gingival bleeding, lowest quartile of remaining tooth number, and Eichner index C) and hypertension was no longer significant throughout the adjustment process (Table 3). The Nagelkerke's adjusted R^2 value of the overall multivariable-adjusted logistic regression model without including oral health markers was 0.210 and was increased in the model after adding CPITN stage 4 (adjusted R^2 = 0.230), presence of gingival bleeding (adjusted R^2 = 0.230), lowest quartile of remaining tooth number (adjusted R^2 = 0.230), or Eichner index C (adjusted R^2 = 0.229).

Combined effects of oral health markers on hypertension

We next examined the combined effects of oral health markers on hypertension—that is, CPITN stage and gingival bleeding, CPITN stage and remaining tooth number, CPITN stage and Eichner index, gingival bleeding and remaining tooth number, gingival bleeding and Eichner index, and remaining tooth number and Eichner index. In the multivariable-adjusted logistic regression model, the combination of CPITN stage and gingival bleeding, the combination of CPITN stage and Eichner index, the combination of gingival bleeding and remaining tooth number, and the combination of gingival bleeding and Eichner index, but not the combination of CPITN stage and remaining tooth number and the combination of remaining tooth number and Eichner index, were independently associated with hypertension (Table 3).

The total subjects were then divided into 4 groups by the number of components of oral health markers, including CPITN stage 4, presence of gingival bleeding, sex-specific lowest quartile of remaining tooth number, and Eichner index C (Table 4). There was a significant graded relationship between the number of components present and the corresponding prevalence of hypertension. The age- and sex-adjusted relative OR of hypertension in subjects with 0, 1, 2, and ≥3 components of oral health disorders were 1.0 (reference), 1.06 (95% CI = 0.83–1.34; P = 0.66), 1.19 (95% CI = 0.87–1.63; P = 0.28), and 1.71 (95% CI = 1.18–2.49; P = 0.004). In multivariable-adjusted logistic regression analysis, subjects with ≥3 components of oral health disorders had 1.82 times higher odds of hypertension compared with those with no component (Figure 1). The adjusted R^2 value of the overall model after adding the number of components of oral health markers was 0.249.

Table 1. Characteristics of study population

Characteristics	Total	Hypertension	
		No	Yes
No.	1,643	865	778
Age, years	66.6±7.9	64.6±7.9	68.8±7.3**
Male, %	43.4	39.9	47.3**
Body mass index, kg/m^2	22.7±3.2	21.9±2.9	23.6±3.3**
Diabetes, %	10.6	5.4	16.3**
Dyslipidemia, %	38.2	30.2	47.2**
Antihypertensive medication, %	30.1	0	36.4**
Systolic blood pressure, mm Hg	128±20	116±13	142±17**
Diastolic blood pressure, mm Hg	78±11	72±9	84±10**
Heart rate, bpm	69±11	68±10	70±12**
Triglycerides, mmol/L[a]	1.20±0.69	1.11±0.62	1.30±0.73**
HDL cholesterol, mmol/L	1.60±0.42	1.64±0.42	1.57±0.41**
Blood glucose level, mmol/L[a]	5.79±1.07	5.77±0.77	6.03±1.29**
Hemoglobin A1c, %[a]	5.47±0.64	5.37±0.52	5.58±0.73**
eGFR, ml/min/1.73 m^2	75.0±11.0	77.3±8.5	72.5±12.8**
CPITN stage, %			
0	35.4	37.8	32.8*
1	0.9	0.7	1.0
2	11.5	12.7	10.2
3	32.2	32.0	32.5
4	20.0	16.8	23.5**
Gingival bleeding +, %	35.6	32.7	38.8**
Number of remaining teeth	21.8±7.7	22.6±7.4	20.9±7.9**
Eichner index, %			
A	60.4	65.8	54.3**
B	28.1	24.9	31.8**
C	11.5	9.3	13.9**
Maximum bite force, no.	502±310	504±296	501±325
Smoking status (never/former/current), %	61.4/27.8/10.8	62.7/24.7/12.6	60.0/31.1**/8.9**
Daily alcohol intake, %	54.8	56.5	52.8
Daily fruit intake, %	53.6	53.3	53.9
Daily sugar-sweetened soft drink intake ≥3 cups/day, %	7.7	9.7	5.5**
Physical activity ≥1 hour/day, %	40.4	40.5	40.2
Nocturnal sleep duration, hours	6.55±1.10	6.46±1.04	6.66±1.15**

Values are mean ± SD or frequency (%).

Abbreviations: CPITN, Community Periodontal Index of Treatment Needs; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein.

[a]Values were log-transformed for analysis.

*P < 0.05 and **P < 0.01 vs. patients without hypertension.

On the other hand, except for prevalence of smoking habit or daily sugar-sweetened soft drink intake, no significant graded relationship between the number of components present and the corresponding prevalence of poor lifestyle, including smoking habit, prevalence of daily alcohol consumption, daily fruit intake, daily sugar-sweetened drink intake, physical activity, and nocturnal sleep duration, was found (Table 4).

Table 2. Associations between markers of oral health disorders

Variables	CPITN stage 0	1 or 2	3	4	P_{trend}
Gingival bleeding*, %	26.3	28.1	42.8**	45.1**	<0.01
Remaining tooth number, no.	22.6±6.4	24.7±4.8**	23.4±5.6	16.0±10.8**	<0.01
Remaining tooth number ≤18 in men, ≤21 in women, %	26.5	11.3**	20.4	48.5**	<0.01
Eichner index, %					
A	62.7	76.4**	66.4	36.6**	<0.01
B	29.4	18.7*	28.7	30.8	0.01
C	7.9	4.9	4.9	32.6**	<0.01

Variables	Remaining tooth number: 1st quartile ≤18 in men ≤21 in women	2nd quartile 19–25 in men 22–25 in women	3rd quartile 26–27 in men 22–25 in women	4th quartile 28 in men 27–28 in women	P_{trend}
Gingival bleeding*, %	37.4	40.2	33.0	30.5	0.02
CPITN stage, %					
Stage 0	34.7	33.2	37.1	37.2	0.56
Stage 1 or 2	5.2	12.9**	13.5**	19.7**	<0.01
Stage 3	24.3	34.5*	39.3**	31.1	<0.01
Stage 4	35.8	19.4**	10.1**	12.0**	<0.01
Eichner index, %					
A	5.2	51.7**	96.1**	100**	<0.01
B	52.2	48.3	3.9**	0**	<0.01
C	42.6	0**	0**	0**	<0.01

Variables	Eichner index: A	B	C	P_{trend}
Gingival bleeding*, %	33.1	44.6**	27.0	<0.01
Remaining tooth number, no.	26.3±2.0	19.2±4.8**	4.5±4.4**	<0.01
Remaining tooth number ≤18 in men, ≤21 in women, %	2.3	50.2**	100.0**	<0.01
CPITN stage, %				
Stage 0	36.8	37.0	24.3**	<0.01
Stage 1 or 2	15.6	8.2**	5.3**	<0.01
Stage 3	35.5	32.9	13.8**	<0.01
Stage 4	12.1	21.9**	56.6**	<0.01

Values are mean ± SD or frequency (%).
Abbreviation: CPITN, Community Periodontal Index of Treatment Needs.
*P < 0.05, and **P < 0.01 vs. patients with CPITN stage 0, lowest quartile in remaining tooth number, or Eichner index A, respectively.

Relations of oral health disorders to blood pressure

The influence of these additive effects of oral health markers on blood pressure was examined in the subpopulation of 1,148 subjects (687 women) not taking antihypertensive medication. In the model including CPITN stage 4, presence of gingival bleeding, sex-specific lowest quartile of remaining tooth number, and Eichner index C, SBPs/DBPs (±SDs) in subjects with 0 (n = 190 men; n = 331 women), 1 (n = 142 men; n = 236 women), 2 (n = 72 men; n = 77 women), and ≥3 (n = 57 men; n = 43 women) components of oral health disorders were 123±20/76±11, 125±18/76±11, 129±20/78±12,

Table 3. Associations of markers of oral health disorders with diagnosis of hypertension

	Age- and sex-adjusted			Multivariable-adjusted[a]		
Variables, unit of increase	**Odds ratio**	**95% CI**	***P* value**	**Odds ratio**	**95% CI**	***P* value**
CPITN stage 4	1.27	0.99–1.64	0.07	1.05	0.96–1.16	0.27
Gingival bleeding +	1.25	1.01–1.54	0.04	1.17	0.94–1.47	0.16
Remaining tooth number ≤18 for men, ≤21 for women[b]	1.16	0.92–1.48	0.21	1.17	0.90–1.51	0.24
Eichner index C	1.17	0.85–1.61	0.33	1.09	0.78–1.55	0.62
CPITN stage 4 and gingival bleeding +	1.83	1.03–2.63	<0.01	1.71	1.17–2.50	<0.01
CPITN stage 4 and tooth number ≤18 for men, ≤21 for women[b]	1.34	0.95–1.91	0.10	1.34	0.92–1.94	0.13
CPITN stage 4 and Eichner index C	1.45	0.98–2.17	0.06	1.44	1.02–2.02	0.04
Gingival bleeding + and tooth number ≤18 for men, ≤21 for women[b]	1.94	1.37–2.77	<0.01	1.63	1.07–2.47	0.01
Gingival bleeding + and Eichner index C	2.26	1.22–4.40	<0.01	2.51	1.30–5.00	<0.01
Tooth number ≤18 for men, ≤21 for women[b] and Eichner index C	1.24	0.90–1.71	0.18	1.23	0.91–1.69	0.08

Abbreviation: CPITN, Community Periodontal Index of Treatment Needs.

[a]*Multivariable-adjusted model included age, sex, body mass index, diabetes, dyslipidemia, estimated glomerular filtration rate, smoking status* (3 categories), daily alcohol intake, daily fruit intake, daily sugar-sweetened soft drink intake, physical activity, and nocturnal sleep duration.

[b]Sex-specific lowest quartile of remaining tooth number.

and 132±22/79±12mm Hg, respectively (P_{trend} < 0.01, respectively). Age- and sex-adjusted SBPs (±SEs) in subjects with 0, 1, 2, and ≥3 components of oral health disorders were 124±1, 125±1, 128±2, and 131±2mm Hg (p for trend <0.01), and DBP (±SE) was 76±1, 76±1, 78±1, and 79±1 mmHg (P_{trend} = 0.04), respectively. Multivariable linear regression analysis revealed that SBP significantly differed among groups, with the highest SBP in the subgroup with ≥3 components (130±2 mmHg) (Table 5; Figure 2).

DISCUSSION

Our study identified an additive relationship between oral health disorders and risk of hypertension. Worse occlusal status was suggested to be responsible in these relationships. Our findings were noteworthy because they were based on a large, representative sample of the Japanese general urban population. In addition, careful measures of study exposure and outcome variables allowed precise estimation of the association.

Our results showed that the associations between individual oral health markers (CPITN stage 4, presence of gingival bleeding, lowest quartile of remaining tooth number, and Eichner index C) and risk of hypertension did not remain significant after adjustment for several potential confounding factors. Although previous investigations identified that periodontal disease, as well as lower tooth number, was independently associated with risk of hypertension,[1–5,7–9] we could not confirm these associations in this study. Alternatively, we examined the combined effects of oral health markers on hypertension. Combinations of oral health markers—that is, severe periodontal disease and presence of gingival bleeding, severe periodontal disease and worse occlusal status, presence of gingival bleeding and lower tooth number, and presence of gingival bleeding and worse occlusal status—were each independently associated with risk of hypertension. Our results suggested that worse occlusal status, which was assessed by Eichner index, was responsible for the relationship between oral health disorders and hypertension. Occlusal status may better reflect chewing status than does tooth number, which may lead to alterations not only in food selection and dietary quality but also in masticatory performance. This, in turn, would affect body composition and nutritional status,[11] both of which are causal factors in the development of hypertension. Apart from masticatory performance, dental malocclusion may lead to mandibular malposition, which induces narrowing of the upper airway, resulting in obstructive breathing disorders. Mandibular position has been implicated in nocturnal oxygenation and pharyngeal collapsibility,[27] and in healthy subjects with obstructive sleep apnea, treatment with an oral jaw-positioning appliance has been reported to improve cardiac autonomic modulation.[28] Of the combinations of oral health disorders, in this study, the strongest risk of hypertension was observed with the combination of the presence of gingival bleeding and Eichner index. The mechanism by which the concomitance of gingival

Table 4. Characteristics of study population by number of oral health disorder components: Community Periodontal Index of Treatment Needs stage 4, presence of gingival bleeding, sex-specific lowest quartile of remaining tooth number, and Eichner index C

Characteristics	0	1	2	3	4	P_{trend}
No.	703	527	241	151	21	NA
Age, years	64.4±7.9	66.5±7.8**	69.7±6.7**	72.0±5.5**	69.7±7.0*	<0.01
Men, %	40.0	41.6	48.6	58.3**	38.1	<0.01
Body mass index, kg/m^2	22.4±3.0	23.0±3.2*	22.9±3.5	23.2±3.6*	22.8±3.0	<0.01
Diabetes, %	7.0	12.3	12.5	19.9**	0	<0.01
Dyslipidemia, %	34.3	38.3	41.9	48.3*	52.4	<0.01
Hypertension, %	42.7	44.6	53.9*	66.2**	61.9	<0.01
Antihypertensive medication, %	25.9	28.3	38.2*	44.4**	23.8	<0.01
Systolic blood pressure, mm Hg	126±20	128±19	132±20**	134±20**	139±19	<0.01
Diastolic blood pressure, mm Hg	77±11	78±11	79±11	80±11	83±12	<0.01
Heart rate, bpm	69±11	69±10	70±11	69±11	71±11	0.43
Triglycerides, mmol/L[a]	1.16±0.65	1.21±0.70	1.24±0.68	1.28±0.77	1.26±0.63	0.08
HDL cholesterol, mmol/L	1.68±0.43	1.58±0.40**	1.54±0.38**	1.45±0.41**	1.53±0.46	<0.01
Blood glucose level, mmol/L[a]	5.68±0.89	5.85±1.24	5.82±0.96	6.08±1.38**	5.56±0.47	<0.01
Hemoglobin A1c, %[a]	5.41±0.55	5.51±0.68	5.50±0.60	5.62±0.82**	5.25±0.67	<0.01
eGFR, ml/min/1.73m^2	76.1±10.9	76.1±10.5	72.6±11.6**	70.2±11.2**	73.9±7.8	<0.01
CPITN stage, %						
Stage 0	45.8	33.8**	29.5**	7.3**	0**	<0.01
Stage 1 or 2	18.5	11.4**	3.7**	2.7**	0	<0.01
Stage 3	35.7	40.2	21.6**	9.9**	0*	<0.01
Stage 4	0	14.6**	45.2**	80.1**	100**	<0.01
Gingival bleeding +, %	0	62.1**	71.4**	43.1**	100**	<0.01
Remaining tooth number ≤18 in men, ≤21 in women, %	0	23.3**	61.8**	100.0**	100**	<0.01
Eichner index, %						
A	85.2	60.2**	30.7**	1.3**	0**	<0.01
B	14.8	39.9**	47.7**	21.9	0	<0.01
C	0	0	21.6**	76.8**	100**	<0.01
Maximum bite force, *N*	609±297	495±298**	404±290**	229±172**	191±134**	<0.01
Smoking status (never/former/current), %	65.9/25.2/9.0	63.0/25.4/11.6	55.2/33.2/11.6	46.4**/37.8*/15.9	52.4/38.1/9.5	<0.01
Daily alcohol intake, %	52.5	57.7	51.9	59.6	57.1	0.23
Daily fruit intake, %	54.3	51.6	56.9	53.6	38.1	0.40
Daily sugar-sweetened soft drink intake ≥3 cups/day, %	6.3	7.8	9.5	8.6	28.6**	<0.01
Physical activity ≥1 hour/day, %	38.3	40.2	46.1	38.4	61.9	0.07
Nocturnal sleep duration, hours	6.5±1.1	6.5±1.1	6.7±1.2	6.7±1.3	6.6±1.2	0.11

Values are mean ± SD or frequency (%).

Abbreviations: CPITN, Community Periodontal Index of Treatment Needs; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; NA, not applicable.

[a]Values were log-transformed for analysis.

*P < 0.05 and **P < 0.01 vs. subgroup with no component.