

# Interruption of regular dental visits during the COVID-19 pandemic due to concerns regarding dental visits was associated with periodontitis in Japanese office workers

Masanori Iwasaki<sup>1</sup>  | Michihiko Usui<sup>2</sup>  | Wataru Ariyoshi<sup>3</sup> | Keisuke Nakashima<sup>2</sup>  | Yoshie Nagai-Yoshioka<sup>3</sup> | Maki Inoue<sup>4</sup> | Kaoru Kobayashi<sup>5</sup> | Tatsuji Nishihara<sup>4</sup>

<sup>1</sup>Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan

<sup>2</sup>Division of Periodontology, Kyushu Dental University, Kitakyushu, Japan

<sup>3</sup>Division of Infections and Molecular Biology, Kyushu Dental University, Kitakyushu, Japan

<sup>4</sup>Dental Center for Regional Medical Survey, Kyushu Dental University, Kitakyushu, Japan

<sup>5</sup>Graduate School of Dentistry, MSc Program, Kyushu Dental University, Kitakyushu, Japan

## Correspondence

Masanori Iwasaki, Tokyo Metropolitan Institute of Gerontology, 35-2 Sakae-cho, Itabashi-Ku, Tokyo 173-0015, Japan.  
Email: iwasaki@tmig.or.jp

## Funding information

Kyushu Dental University

## Abstract

**Objective:** To investigate the interrelationships among concerns regarding dental visits, the status of regular dental visits, and periodontal health during the coronavirus disease 2019 (COVID-19) pandemic.

**Background:** Continuous oral health care and regular dental visits are important for maintaining periodontal health. Due to the possibility of contracting COVID-19, individuals have been reluctant to visit medical institutions. It is unclear how the periodontal health of the Japanese population has been affected by the interruption of regular dental visits during the COVID-19 pandemic and how concerns regarding dental visits have affected attendance at regular dental visits.

**Methods:** This study included 199 Japanese office workers in one municipal office at Fukuoka Prefecture, Japan (average age = 42.6 years; age range = 19–77 years; 123 men and 76 women). Periodontitis was defined based on a full-mouth periodontal examination. The status of regular dental visits during the COVID-19 pandemic and concerns regarding dental visits were obtained via questionnaire. We tested the hypothesis that concerns regarding dental visits would indirectly affect periodontal health through the interruption of regular dental visits during the COVID-19 pandemic. We used mediation analysis, in which concerns regarding dental visits (present or absent) were set as the exposure, periodontitis (present or absent) was set as the outcome, and the status of regular dental visits (continued during the COVID-19 pandemic or not) was set as the mediator.

**Results:** Of the 199 study participants, 108 had a habit of attending regular dental visits. Of these, 31 (28.7%) discontinued regular dental visits during the COVID-19 pandemic. Compared to the individuals who continued regular dental visits, those who discontinued regular dental visits had a higher prevalence of periodontitis (49.4% vs 77.4%,  $p < 0.05$ ) and concerns regarding dental visits (22.1% vs 64.5%,  $p < 0.05$ ). Discontinuing regular dental visits significantly mediated the association between concerns regarding dental visits and periodontitis (natural indirect effect: odds ratio = 1.68, 95% confidence interval = 1.02–2.79, proportion mediated = 64.3%).

**Conclusion:** The study results showed that individuals who discontinued regular dental visits during the COVID-19 pandemic due to concerns regarding dental visits had relatively poor periodontal health.

**KEYWORDS**

Coronavirus disease 2019, epidemiology, periodontal diseases, regular dental visits

## 1 | INTRODUCTION

Periodontitis is a chronic bacterial infection that results in inflammatory destruction of the connective tissue and bone supporting the teeth.<sup>1</sup> In Japan, periodontitis is common, with an estimated prevalence of 49.4%,<sup>2</sup> and is the leading cause of tooth loss in adults.<sup>3</sup> Furthermore, periodontitis is associated with systemic diseases (such as diabetes mellitus, chronic kidney disease, and cardiovascular disease),<sup>4-7</sup> increased medical care costs,<sup>8</sup> and mortality.<sup>9</sup> Regular dental care with plaque removal by dental professionals is an effective method of maintaining good periodontal health.<sup>10,11</sup>

The coronavirus disease 2019 (COVID-19) pandemic has spread worldwide, with many cases occurring in Japan. People are reluctant to visit healthcare facilities due to concerns regarding contracting COVID-19.<sup>12</sup> According to a recent survey of 1000 men and women in their teens to their 70s conducted by the Japanese Association of Private Dental Schools,<sup>13</sup> 21.4% of those surveyed reported that they discontinued regular dental visits during the period from February to August 2020, indicating that many individuals missed opportunities to receive professional dental care.

It is unclear how the periodontal health of the Japanese population has been affected by the interruption of regular dental visits during the COVID-19 pandemic and how concerns regarding dental visits have affected attendance at regular dental visits. This cross-sectional study aimed to examine the interrelationships among concerns regarding dental visits, the status of regular dental visits, and periodontal health among Japanese individuals during the pandemic. Our study hypothesis was that concerns regarding dental visits would indirectly affect periodontal health through the interruption of regular dental visits during the COVID-19 pandemic.

## 2 | MATERIALS AND METHODS

### 2.1 | Study design, setting, and population

The study population was composed of a cohort of workers in one municipal office at Fukuoka Prefecture, Japan. Individuals who participated in annual health checkups at the workplace between November 10, 2020, and November 19, 2020, were invited to participate in the current study. In Japan, employees undergo periodical medical examinations at least once a year if their workplaces regularly employ 50 or more workers, as mandated by the Industrial

Safety and Health Act. Our study, which involved the administration of a questionnaire and performance of a periodontal examination, was designed to be conducted during this periodical medical examination.

The inclusion criteria were as follows: at least 18 years of age and able to read and understand Japanese. The exclusion criteria were as follows: having fewer than 2 teeth and previous diagnosis of a severe or terminal disease, such as advanced heart failure, end-stage kidney disease, or advanced-stage cancer. This study was designed as a part of employee welfare efforts. No sample size calculation was performed prior to the study. We invited all the workers who met the criteria for inclusion in our study to participate.

All the study participants provided written informed consent prior to being included in the study. The present study was conducted in full accordance with the ethics principles of the Declaration of Helsinki and was approved by the Ethics Committee of Kyushu Dental University (approval number: 19-32).

### 2.2 | Questionnaire

The status of regular dental visits during the COVID-19 pandemic and concerns regarding dental visits were obtained via questionnaire. Regarding the status of regular dental visits during the COVID-19 pandemic, study participants were asked the following question: "Did you visit dental clinics for regular checkups during the COVID-19 pandemic between 1 March 2020 and the present [ie, 10 November 2020]?" The possible answers were as follows [1]: "I visited as I did before the pandemic, OR I postponed or discontinued dental visits but have resumed them." Participants who gave this response were categorized in the group that continued regular dental visits. [2]: "I postponed or discontinued dental visits and am currently not attending them." Participants who provided this response were categorized in the group that discontinued regular dental visits. [3]: "I do not attend regular dental visits." Participants who provided this response were categorized in the group that did not attend regular dental visits. For simplicity and ease of interpreting the study results, the responses "I visited as I did before the pandemic" and "I postponed or discontinued dental visits but have resumed them" were combined and included in one category. We assumed that separate analyses on the effects of resuming regular dental visits were not possible due to limited sample size and study duration. Separate analyses of people who discontinued regular dental visits were possible with the clear definition of this category.

To assess concerns regarding dental visits, study participants were asked the following question: "Do you feel anxious about visiting dental clinics?". Responses were given on a 5-point scale, with 1 indicating no anxiety, 2 indicating a little anxiety, 3 indicating neutral, 4 indicating anxiety, and 5 indicating high anxiety. Participants with responses of 4 or 5 were categorized as those with concerns regarding dental visits. For simplicity and ease of interpretation of the study results and because of limited sample size, we converted the 5-point scale response into a dichotomized response (ie, having or not having concerns regarding dental visits).

Data on oral health behaviors, including toothbrushing frequency ( $\geq 2$  times/day or  $< 2$  times/day) and interdental cleaning device use (yes or no), were obtained through the questionnaire.

### 2.3 | Oral health examinations

Five calibrated dentists who were blinded to the questionnaire responses conducted the oral health examinations. They determined the number of teeth and the presence of dentures and recorded the probing pocket depth (PPD), gingival recession (GR), and bleeding on probing (BOP) at six sites on every tooth except the third molars. A graduated periodontal probe and a mouth mirror (Williams Colorvue™ Probe and HD Mirrors, Hu-Friedy Mfg. Co., LLC., Chicago, IL, USA) were used under sufficient artificial illumination. Then, clinical attachment loss (CAL) was calculated using the PPD and GR. Based on the Centers for Disease Control and Prevention (CDC) and the American Academy of Periodontology (AAP) case definition (CDC/AAP definition),<sup>14</sup> moderate periodontitis was defined as having  $\geq 2$  interproximal sites with a CAL  $\geq 4$  mm (not on the same tooth) or  $\geq 2$  interproximal sites with a PPD  $\geq 5$  mm (not on the same tooth), and severe periodontitis was defined as having  $\geq 2$  interproximal sites with a CAL  $\geq 6$  mm (not on the same tooth) and  $\geq 1$  interproximal site with a PPD  $\geq 5$  mm. The moderate and severe forms of periodontitis were combined and used as the main outcome. In addition, the periodontal inflamed surface area (PISA) was calculated using the CAL, GR, and BOP. The PISA quantifies the amount of inflamed periodontal tissue in square millimeters.<sup>15</sup>

The prestudy calibration for the PPD and GR was conducted at Kyushu Dental University with volunteer patients. All examiners obtained intraexaminer kappa values  $> 0.8$  for both the PPD and GR. In addition, 4 examiners obtained kappa values  $> 0.8$  compared to the gold standard value based on the results obtained by another examiner (M.U.). For the kappa calculations, PPD and GR values that were exactly equal to or with a difference of within 1 mm indicated agreement.

### 2.4 | Health checkup records inquiries

Data on age, sex, smoking status (currently smoking or not), physician diagnosis of diabetes mellitus, use of insulin or other

glucose-lowering drugs, body mass index (BMI), and serum glycosylated hemoglobin A1c (HbA1c) levels were obtained from the health checkup records. Overweight was defined as a BMI  $\geq 25$  kg/m<sup>2</sup>. Diabetes mellitus (DM) was defined according to the diagnosis made by a physician and/or the self-reported use of insulin or other glucose-lowering drugs and/or an HbA1c  $\geq 6.5\%$ .

### 2.5 | Statistical analyses

First, we described the study population characteristics according to the status of regular dental visits during the COVID-19 pandemic. The Shapiro-Wilk test was used to determine whether the continuous variables were normally distributed. ANOVA, the Kruskal-Wallis test, and the chi-squared test were used, as appropriate. If the overall test was significant, post hoc comparisons were performed.

To assess the effect of the interruption of regular dental visits during the COVID-19 pandemic on periodontal health, subsequent analyses were performed for the study participants who had a habit of attending regular dental visits (ie, the group that did not attend regular dental visits was excluded from the subsequent analyses).

Logistic regression analyses were performed to assess the associations of periodontitis with concerns regarding dental visits, the status of regular dental visits, and other factors among the study participants who had a habit of attending regular dental visits.

We hypothesized that concerns regarding dental visits would indirectly affect periodontal health through the interruption of regular dental visits during the COVID-19 pandemic. We tested this hypothesis by employing mediation analysis, in which concerns regarding dental visits (present or absent) were set as the exposure, periodontitis (present or absent) was set as the outcome, and the status of regular dental visits (continued during the COVID-19 pandemic or not) was set as the mediator. The natural indirect effect (NIE), which is the effect of the exposure through the mediator, the natural direct effect (NDE), which is the effect of the exposure not through the mediator, and the total effect (TE), which is the sum of the NIE and NDE, were estimated. A logistic regression model was fitted for the exposure-mediator and mediator-outcome relationships. The estimates are presented as odds ratios (ORs) with 95% confidence intervals (CIs). We performed bootstrapping based on 1000 replications to derive the CIs. Age, sex, toothbrushing frequency, interdental cleaning device use, smoking status, overweight, and DM were considered potential confounders.

As a sensitivity analysis, another mediation analysis was performed in which the PISA as a continuous variable was set as the outcome instead of the dichotomized periodontitis variable. A logistic regression model was fitted for the exposure-mediator relationship, and a linear regression model was fitted for the mediator-outcome relationship. The estimates are presented as regression coefficients with 95% CIs.

The statistical software STATA version 16.1 (StataCorp, College Station, USA) was used for the analyses. The level of significance (two-tailed) was set at 0.05.

### 3 | RESULTS

#### 3.1 | Study population

Among the 215 individuals who underwent medical checkups and met the inclusion criteria, 199 (92.6%) agreed to participate in our study and completed the examinations. Therefore, the study population was composed of 199 adults (average age = 42.6 years; age range = 19–77 years; 123 men and 76 women). As presented in Table 1, they were categorized into 3 groups: the group that continued regular dental visits ( $n = 77$ ), the group that discontinued regular dental visits ( $n = 31$ ), and the group that did not attend regular dental visits ( $n = 91$ ). The group that continued regular dental visits had a lower prevalence of periodontitis, smaller PISA, and a greater proportion of individuals who used interdental cleaning devices than the other groups. The group that discontinued regular dental visits had higher prevalence of concern regarding dental visits and periodontitis and a larger PISA. The group that did not attend regular dental visits had a lower prevalence of concern regarding dental visits, a larger PISA, and a higher proportion of individuals who did not use interdental cleaning devices. The group that did not attend regular dental visits was excluded from the subsequent analyses.

#### 3.2 | Association of periodontitis with concerns regarding dental visits, regular dental visit status, and other factors among the study participants who had a habit of attending regular dental visits

Among the individuals who had a habit of attending regular dental visits, 31 (28.7%) discontinued regular dental visits, 62 (prevalence rate = 57.4%) had periodontitis, and 37 (prevalence rate = 34.3%) had concerns regarding dental visits. Table 2 shows the results of logistic regression analyses. The discontinuation of regular dental visits during the COVID-19 pandemic was associated with a higher OR for periodontitis (OR = 3.52, 95% CI = 1.36–9.13). Concerns regarding dental visits nearly reached significance (OR = 2.30, 95% CI = 0.99–5.35). Interdental device use was associated with a lower OR for periodontitis (OR = 0.22, 95% CI = 0.09–0.56). Overweight was associated with a higher OR for periodontitis (OR = 5.00, 95% CI = 1.57–15.91). Advancing age and current smoking were not associated with periodontitis among this group (ie, the study participants who had a habit of attending regular dental visits).

#### 3.3 | Interrelationships among concerns regarding dental visits, the status of regular dental visits, and periodontal health

Table 3 shows the results of the mediation analysis. The discontinuation of regular dental visits significantly mediated the association between concerns regarding dental visits and periodontitis (NIE:

OR = 1.68, 95% CI = 1.02–2.79, proportion mediated [PM] = 64.3%). The NDE and TE of concerns regarding dental visits on periodontitis were represented by ORs of 1.61 (95% CI = 0.60–4.34) and 2.72 (95% CI = 1.05–7.02), respectively. We could not construct a multivariable model including DM due to the very low and biased prevalence of DM (0% in the non-periodontitis group and 4.8% in the periodontitis group: Table 2). Therefore, the model was adjusted for potential confounders except for DM (ie, age, sex, toothbrushing frequency, interdental cleaning device use, smoking status, and overweight). We also performed a mediation analysis excluding the individuals with DM ( $n$  of analyzed population = 105) and obtained similar results (Table S1). In a sensitivity analysis using PISA as the outcome variable (Table S2), the NIE of concerns regarding dental visits was represented by a regression coefficient of 36.7 (95% CI = 4.0–102.3, PM = 48.5%). These results are consistent with those of the main analysis that used the dichotomized periodontitis variable as the outcome.

### 4 | DISCUSSION

In this cross-sectional study involving Japanese men and women, we investigated the interrelationships among concerns regarding dental visits, the status of regular dental visits, and periodontal health during the COVID-19 pandemic. Among the study participants who had a habit of attending regular dental visits, 28.7% discontinued regular dental visits during the COVID-19 pandemic. The discontinuation of regular dental visit was associated with a higher prevalence of periodontitis and a greater degree of periodontal inflammation, as indicated by a higher PISA. We also found that individuals with concerns regarding dental visits were more likely to discontinue regular dental visits. Our mediation analysis revealed that concerns regarding dental visits indirectly affected periodontal health through the interruption of regular dental visits during the COVID-19 pandemic.

The lack of dental care utilization and oral health problems during the COVID-19 pandemic in Japan have been reported recently. A cross-sectional study based on Internet survey data demonstrated that deteriorated socioeconomic conditions due to the COVID-19 pandemic were associated with dental pain and that association was mediated by the postponement of dental visits.<sup>16</sup> The findings of our study are in agreement with those recent findings.

Periodontitis is an inflammatory disease caused by bacteria in dental plaque, which is a biofilm that accumulates on teeth adjacent to the gingiva. Sufficient plaque removal on a regular basis by dental professionals has been demonstrated to be an effective means of maintaining good periodontal health.<sup>10,11</sup> Additionally, proper self-care skills are obtained through toothbrushing instruction (TBI) during the dental visit. Combined professional and self-performed plaque control is effective for controlling gingivitis.<sup>17</sup> Overall, one potential reason for the higher prevalence of periodontitis among study participants who discontinued regular dental visits was the loss of the opportunity to receive professional plaque control and TBI.

TABLE 1 Characteristics of the study population according to the status of regular dental visits during the COVID-19 pandemic (N = 199)

Variables	Regular dental visits				p-value*
	Yes		No		
	Discontinued regular dental visits during the COVID-19 pandemic				
	Yes		No		
	Group that discontinued regular dental visits		Group that did not attend regular dental visits		
Total	N = 77	N = 31	N = 91	N = 91	
Had concerns regarding dental visits, n (%)	54 (27.1%)	17 (22.1%)	20 (64.5%)	17 (18.7%)	<0.01
Periodontitis, n (%)	118 (59.3%)	38 (49.4%)	24 (77.4%)	56 (61.5%)	0.02
Severe periodontitis, n (%)	15 (7.5%)	4 (5.2%)	1 (3.2%)	10 (11.0%)	0.22
PISA (mm <sup>2</sup> ), median (IQR)	64.6 (16.5–163.7)	50.8 (2.0–126.1) <sup>a</sup>	76.4 (43.4–130.0) <sup>b</sup>	67.6 (26.2–212.1) <sup>b</sup>	0.03
Average PPD (mm), median (IQR)	2.3 (1.9–2.5)	2.3 (1.9–2.5)	2.3 (1.8–2.4)	2.3 (2.0–2.5)	0.36
Average CAL (mm), median (IQR)	2.4 (2.1–2.6)	2.4 (2.1–2.6)	2.4 (1.9–2.6)	2.4 (2.1–2.7)	0.83
BOP (%), median (IQR)	4.8 (2.4–10.1)	4.2 (2.4–8.9)	4.8 (2.4–7.7)	5.4 (2.4–14.3)	0.35
Number of teeth, median (IQR)	28 (27–28)	28 (27–28)	28 (27–28)	28 (27–28)	0.63
Denture use, n (%)	1 (0.5%)	0 (0%)	1 (3.2%)	0 (0%)	0.07
Toothbrushing ≥2 times/day, n (%)	178 (89.4%)	70 (90.9%)	28 (90.3%)	80 (87.9%)	0.81
Interdental cleaning device use, n (%)	92 (46.7%)	49 (65.3%)	19 (61.3%)	24 (26.4%)	<0.01
Age, mean (s.d.)	42.6 (10.4)	43.9 (10.4)	43.3 (9.7)	41.4 (10.5)	0.28
Sex (male), n (%)	123 (61.8%)	45 (58.4%)	15 (48.4%)	63 (69.2%)	0.09
Current smoker, n (%)	26 (13.2%)	7 (9.2%)	2 (6.5%)	17 (18.9%)	0.09
Overweight, n (%)	56 (28.6%)	17 (22.4%)	7 (23.3%)	32 (35.6%)	0.14
Diabetes mellitus, n (%)	10 (5.1%)	3 (3.9%)	0 (0%)	7 (7.8%)	0.20

Abbreviations: BOP, bleeding on probing; CAL, clinical attachment level; IQR, interquartile range; PISA, periodontal inflamed surface area; PPD, probing pocket depth; SD, standard deviation. Underlined text indicates data with significant adjusted standardized residuals.

Different letters; a and b indicate statistically significant differences between groups.

\*p-value for the comparison among groups.

Variables	Outcome = Periodontitis (1 = Present, 0 = Absent)	
	OR	95% CI
Attended regular dental visits during the COVID-19 pandemic (1 = Discontinued, 0 = Continued)	3.52	1.36-9.13
Concerns regarding dental visits (1 = Yes, 0 = No)	2.30	0.99-5.35
Toothbrushing $\geq 2$ times/day (1 = Yes, 0 = No)	0.31	0.06-1.52
Interdental cleaning device use (1 = Yes, 0 = No)	0.22	0.09-0.56
Age (per one increase)	1.01	0.97-1.05
Sex (1 = male, 0 = female)	1.48	0.69-3.19
Current smoking (1 = Yes, 0 = No)	0.90	0.23-3.55
Overweight (1 = Present, 0 = Absent)	5.00	1.57-15.91
Diabetes mellitus (1 = Present, 0 = Absent) <sup>*</sup>	-	

Abbreviations: CI, confidence interval; OR, odds ratio.

<sup>\*</sup>All the study participants with diabetes mellitus ( $n = 3$ ) had periodontitis. The OR could not be estimated.

**TABLE 3** Mediation of the association between concerns regarding dental visits and periodontitis by the status of regular dental visits during the COVID-19 pandemic ( $N = 108$ )

Exposure = Concerns regarding dental visits (1 = Yes, 0 = No)	Outcome = Periodontitis (1 = Yes, 0 = No)	
	Mediator = Status of regular dental visits during the COVID-19 pandemic (1 = Discontinued, 0 = Continued)	
	OR <sup>*</sup>	95% CI
Natural indirect effect	1.68	1.02-2.79
Natural direct effect	1.61	0.60-4.34
Total effect	2.72	1.05-7.02
Proportion mediated	64.3%	

Abbreviations: CI, confidence interval; OR, odds ratio.

<sup>\*</sup>Adjusted for age, sex, toothbrushing frequency, interdental cleaning device use, smoking status, and overweight.

The percentage of individuals who discontinued regular dental visits in our study was 28.7% during the period from March 1, to November 10, 2020, which was higher than that in the Internet survey conducted by the Japanese Association of Private Dental Schools (21.4% during the period from February to August 2020).<sup>13</sup> Differences in study population characteristics and the period in which the study was conducted may have contributed to this difference in the result. Other studies based on Internet surveys have been conducted in Japan. A study by Koyama et al.<sup>18</sup> reported that 17.2% of the study participants canceled dental visits during the period from April 7, to May 10, 2020. A study by Matsuyama et al.<sup>16</sup> reported that 13.9% of study participants postponed dental visits between April and May 2020. The researchers did not classify dental visits (regular or episodic dental visits) in these studies.

**TABLE 2** Association of periodontitis with concerns regarding dental visits, the status of regular dental visits, and other factors among the study participants who had a habit of attending regular dental visits ( $N = 108$ )

A study by Koyama et al.<sup>18</sup> reported that 24.1% of the study participants felt marked anxiety regarding dental visits. In our study, 27.1% of the total study population ( $N = 199$ ) had concerns regarding dental visits. We observed a significant association between concerns regarding dental visits and the discontinuation of regular dental visits, which suggests that concerns regarding dental visits are a barrier to the utilization of dental services. Unfortunately, we did not obtain data regarding the factors that could relate to anxiety, such as psychological health and socioeconomic status (SES). Further studies exploring the factors related to concerns regarding dental visits will be important. The results may help create strategies to reduce anxiety and promote safe dental service use during the COVID-19 pandemic.

We observed the discontinuation of regular dental visits during the period from March 1, to November 10, 2020. However, a significant change in periodontal tissues may not occur in such a short observation period (8 months). As shown in Table 1, when the analysis was restricted to the severe form of periodontitis, no association was found between discontinuation of regular dental visits and periodontitis prevalence. Therefore, the current findings may be mainly due to slight aggravation of periodontal health. The effect of a longer interruption of regular dental visits during the COVID-19 pandemic on periodontal health should be investigated in future studies.

The prevalence of periodontitis in this study population was 59.3%, which was higher than that reported in the Japan National Survey for Clinical Dental Status, Survey of Dental Diseases (SDD) 2016 (ie, 49.4%). A periodontal assessment involving examinations of six sites on all teeth (full-mouth periodontal examination [FMPE]) was performed in our study. On the other hand, a partial-mouth periodontal examination was performed in the SDD, which could have contributed to the difference in periodontitis prevalence between our study and the national survey.

Advanced age and current smoking were not associated with periodontitis among the study participants who had a habit of attending regular dental visits. The exact reason was unclear, but we can speculate several reasons. First, we restricted the analyzed



population to those who had a habit of attending regular dental visits. The effects of age and smoking on periodontal health may be decreased due to continuous periodontal maintenance. Second, the age range was limited because the analyzed population consisted of mainly middle-aged workers. Third, we could only categorize the participants as current smoker or not based on the available data. We did not find any association between smoking status and periodontitis, potentially due to absence of data on the history, duration, and amount of smoking.

This study was conducted in one municipal office in Fukuoka Prefecture, Japan. The total number of people with COVID-19 (from March 1, 2020, to November 10, 2020) in Fukuoka Prefecture was 5307.<sup>19</sup> From April 7, 2020, to May 14, 2020, Fukuoka was under a state of emergency in relation to COVID-19. From August 5, 2020, to October 8, 2020, Fukuoka was affected by the "Fukuoka Corona Alert." Prefectural residents were requested to adopt thorough measures to prevent infections and refrain from using restaurants with close contact among diners, restaurants that serve alcohol, and karaoke locations in which no infection prevention measures were being implemented. The closure of dental clinics was not mandated. It is not clear whether current findings can be applied to other areas in Japan. Further studies are needed to test the generalizability of our results because the study population mainly consisted of white-collar workers. Future studies are needed to determine whether the current study results are applicable to a broader population.

One of the strengths of this study is that we used data from a detailed periodontal assessment involving FMPE, which is considered the gold standard for the diagnosis of periodontitis in population-based studies.<sup>20</sup> In this study, we used the CDC/AAP periodontitis case definition, which was specifically designed for population-based surveillance.<sup>14</sup> It is the most frequently used definition and is considered the most appropriate definition for an epidemiological setting.<sup>21</sup> A case definition has been proposed by the European Federation of Periodontology (EFP) and the AAP (EFP/AAP definition).<sup>22</sup> Information on tooth loss due to periodontitis and complex factors is required to conclusively determine the stage of periodontitis in the EFP/AAP definition. Therefore, we did not use the EFP/AAP definition in this study.

This study has several limitations. First, the study had an observational and cross-sectional design, limiting our ability to establish temporality. Obtaining periodontal health data immediately before the COVID-19 pandemic and identifying variables based on changes in periodontal health would be an ideal study design. However, because data on periodontal health before the COVID-19 pandemic are lacking, such an approach is not possible. Although we obtained novel findings based on medication analysis, further studies with a longitudinal design must be conducted to validate the results of the current study. Second, as with any multivariable analysis, residual confounding can occur due to unmeasured variables, such as SES, psychological stress, and systemic conditions/diseases other than overweight and DM. Finally, this study focused on regular dental visits. We did not examine how episodic dental care users were affected during the COVID-19 pandemic.

In summary, within the aforementioned limitations, our study of Japanese office workers demonstrates that individuals who discontinued regular dental visits during the COVID-19 pandemic due to concerns regarding dental visits had relatively poor periodontal health.

## ACKNOWLEDGEMENTS

The authors thank the staff and participants of the study and give special thanks to Drs. Masaki Morishita, Kousuke Muraoka, and Ryota Kifune, who were affiliated with the Division of Clinical Education Development and Research, Department of Oral Function, Kyushu Dental University, Kitakyushu, Japan, at the time the study was conducted and performed the periodontal examinations. This work was supported by grants from Kyushu Dental University (Promotion Program for Strategic Research 2019).

## CONFLICT OF INTEREST

The authors have no conflicts of interest to report.

## DATA AVAILABILITY STATEMENT

The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to ethical and legal restrictions imposed by the Ethics Committee of Kyushu Dental University.

## ORCID

Masanori Iwasaki  <https://orcid.org/0000-0002-5739-2936>

Michihiko Usui  <https://orcid.org/0000-0002-5208-1848>

Keisuke Nakashima  <https://orcid.org/0000-0003-3243-8122>

## REFERENCES

- Pihlstrom BL, Michalowicz BS, Johnson NW. Periodontal diseases. *Lancet*. 2005;366:1809-1820.
- The Ministry of Health, Labour, and Welfare. Survey of dental diseases. 2016. <https://www.mhlw.go.jp/toukei/list/dl/62-28-02.pdf> (accessed 15 May 2021)
- The 80/20 Foundation. Reasons for permanent tooth extractions in Japan: the second survey. [in Japanese]. Available at [https://www.8020zaidan.or.jp/pdf/Tooth-extraction\\_investigation-report-2nd.pdf](https://www.8020zaidan.or.jp/pdf/Tooth-extraction_investigation-report-2nd.pdf) (accessed 15 May 2021)
- Graziani F, Gennai S, Solini A, Petrini M. A systematic review and meta-analysis of epidemiologic observational evidence on the effect of periodontitis on diabetes: an update of the EFP-AAP review. *J Clin Periodontol*. 2018;45:167-187.
- Schenkein HA, Loos BG. Inflammatory mechanisms linking periodontal diseases to cardiovascular diseases. *J Clin Periodontol*. 2013;40:S51-S69.
- Borgnakke WS, Ylostalo PV, Taylor GW, Genco RJ. Effect of periodontal disease on diabetes: systematic review of epidemiologic observational evidence. *J Periodontol*. 2013;84:S135-S152.
- Deschamps-Lenhardt S, Martin-Cabezas R, Hannedouche T, Huck O. Association between periodontitis and chronic kidney disease: systematic review and meta-analysis. *Oral Dis*. 2019;25:385-402.
- Sato M, Iwasaki M, Yoshihara A, Miyazaki H. Association between periodontitis and medical expenditure in older adults: a 33-month follow-up study. *Geriatr Gerontol Int*. 2016;16:856-864.
- Saremi A, Nelson RG, Tulloch-Reid M, et al. Periodontal disease and mortality in type 2 diabetes. *Diabetes Care*. 2005;28:27-32.

10. Axelsson P, Nyström B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *J Clin Periodontol*. 2004;31:749-757.
11. Lee HK, Choi SH, Won KC, et al. The effect of intensive oral hygiene care on gingivitis and periodontal destruction in type 2 diabetic patients. *Yonsei Med J*. 2009;50:529-536.
12. Makiyama K, Kawashima T, Nomura S, et al. Trends in healthcare access in Japan during the first wave of the COVID-19 pandemic, up to June 2020. *Int J Environ Res Public Health*. 2021;18:3271.
13. The Japanese Association of Private Dental Schools. Awareness survey on dental practice and dentist: the fifth survey. Available at <https://www.shikadaikyo.or.jp/wp-content/uploads/pdf/ishikichousa-5.pdf> (accessed 15 May 2021)
14. Eke PI, Page RC, Wei L, Thornton-Evans G, Genco RJ. Update of the case definitions for population-based surveillance of periodontitis. *J Periodontol*. 2012;83:1449-1454.
15. Nesse W, Abbas F, van der Ploeg I, Spijkervet FKL, Dijkstra PU, Vissink A. Periodontal inflamed surface area: quantifying inflammatory burden. *J Clin Periodontol*. 2008;35:668-673.
16. Matsuyama Y, Aida J, Takeuchi K, Koyama S, Tabuchi T. Dental pain and worsened socioeconomic conditions due to the COVID-19 pandemic. *J Dent Res*. 2021;100(6):591-598.
17. Figuero E, Nóbrega DF, García-Gargallo M, Tenuta LM, Herrera D, Carvalho JC. Mechanical and chemical plaque control in the simultaneous management of gingivitis and caries: a systematic review. *J Clin Periodontol*. 2017;44:S116-S134.
18. Koyama S, Takeuchi K. Dental visit behavior of patients during the COVID-19 pandemic: which people exhibit the most anxiety? [in Japanese]. *J Dent Hlth*. 2020;70:168-174.
19. Fukuoka Prefecture Novel Coronavirus Infection Portal. [in Japanese] Available at: <https://www.pref.fukuoka.lg.jp/contents/covid-19-portal.html> (accessed 15 May 2021)
20. Eke PI, Dye BA, Wei L, et al. Self-reported measures for surveillance of periodontitis. *J Dent Res*. 2013;92:1041-1047.
21. Holtfreter B, Albandar JM, Dietrich T, et al. Standards for reporting chronic periodontitis prevalence and severity in epidemiologic studies: Proposed standards from the Joint EU/USA Periodontal Epidemiology Working Group. *J Clin Periodontol*. 2015;42:407-412.
22. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *J Periodontol*. 2018;89:S159-S172.

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

**How to cite this article:** Iwasaki M, Usui M, Ariyoshi W, et al. Interruption of regular dental visits during the COVID-19 pandemic due to concerns regarding dental visits was associated with periodontitis in Japanese office workers. *J Periodont Res*. 2021;56:1091-1098. <https://doi.org/10.1111/jre.12923>