

**ORIGINAL****Assessing the oral health of in-patients with diabetes using a clinical version of the Diabetes Oral Health Assessment Tool© and its association with dental examinations**

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**Abstract :** **Aims :** To compare assessment of the oral health conditions and behaviors of in-patients with diabetes using a clinical version of the Diabetes Oral Health Assessment Tool (C-DiOHAT©) with dental examinations. **Methods :** A cross-sectional design was used. A nurse assessed 60 in-patients using the C-DiOHAT© (a formatted questionnaire to assess four factors of patients' oral health conditions and behaviors : oral health conditions, oral hygiene behaviors, sharing health information among patients and dental/medical professionals, and perception and knowledge of oral health) while a dentist examined their oral health conditions. **Results :** "Use of supplementary tools (e.g., interdental brush, dental floss)" in the item of C-DiOHAT© was significantly associated with dental examination of "the number of present teeth" and "no recommendation of further dental visit". "Symptoms of gingival swelling" in the item of C-DiOHAT© was also significantly associated with "recommendation of dental visit". "Knowledge of a relationship between periodontal disease and systemic disease including diabetes" was significantly associated with Community Periodontal Index. **Conclusions :** These results suggest that nurses should prioritize these assessment items to most quickly acquire useful information about patients' oral health. It is important to encourage nurses to be interested in patients' oral health by such small pile of clue. *J. Med. Invest.* 66:328-336 August, 2019

**Keywords :** Nurse, Diabetes, Oral Health Conditions and Behaviors, Assess, Dental Examination

**INTRODUCTION**

The increasing number of patients with diabetes is a global burden. It is important to develop strategies to tackle such diabetes-related complications as neuropathy, retinopathy, nephropathy, and cardiovascular disease. Periodontal disease is the "sixth complication of diabetes" (1). It is crucial for diabetes patients to maintain good oral health to prevent oral diseases such as periodontitis and dental caries. Indeed, some studies have examined the frequency of tooth brushing (2) and the use of supplementary tools (e.g., interdental brush, dental floss (3)) among individuals with diabetes. However, to our knowledge, few previous studies have examined oral self-management behavior as a part of diabetes self-management behavior. The Diabetes Oral Health Assessment Tool (DiOHAT©) for nurses (4)—which includes the following four factors : oral health conditions, oral hygiene behaviors, sharing health information among patients and dental / medical professionals, and perception and knowledge of oral health behaviors—was developed for nurses to assess patients' oral health conditions and behaviors. Although diabetes nurse specialists recognized the value of DiOHAT©, its implementation has been considered difficult in clinical

application due to insufficient time, problems with interdisciplinary coordination between nurses and other specialists, etc. (5). Therefore, an assessment sheet based on DiOHAT© served as the clinical assessment sheet for nurses to assess patients' oral health conditions and behaviors. This is the clinical version of the DiOHAT© (C-DiOHAT©). It was an assessment sheet formed as a questionnaire (answering "yes" or "no") with minor change from the items in DiOHAT©.

Hence, the present study aimed to assess the oral health conditions and behaviors of in-patients using C-DiOHAT© and compare them with dental examinations. The present findings may reveal the usefulness of the assessment sheet in collecting evidence on the oral health behaviors of patients with diabetes.

**METHODS***Design*

This study used a cross-sectional design.

*Participants*

Inclusion criteria were the hospital in-patients with diabetes who provided consent to participation in this study and who were treated at the diabetes clinic of a university hospital (which has both medical and dental clinics) and being aged  $\geq 20$  years. Exclusion criteria were impediments to communication, and possibility of change in condition due to participation in this study.

This study was conducted from April 2016 to March 2017.

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### Survey Methods

#### Questionnaire Used by the Nurse

The nurse utilized a questionnaire on participants' characteristics (age ; sex ; type of diabetes ; age at diabetes diagnosis ; complications of diabetes ; current treatment, i.e., oral hypoglycemic agent alone, injection alone, combination therapy ; and hemoglobin A1c (HbA1c) level), and the questionnaire based on the DiOHAT©. Although the DiOHAT© comprises 4 factors and 21 items, it was revised for clinical use in a limited time frame by both nurses and patients as an assessment sheet formed as a questionnaire (answering "yes" or "no"). The following changes were made to items of the DiOHAT© : [1] "tooth brushing around the border between the teeth and marginal gingiva" and "brushing each tooth very carefully" were modified to "brushing each tooth carefully" ; [2] the item "perceptions of one's oral health condition" was deleted because patients with painful (6), stressful, or fearful memories of dental treatment require an intervention program, which was not part of this study ; and [3] the items "presence of dentures (partial or full)", "checking the inside of the patient's mouth", and "counting the patient's total number of teeth (exclusive of dentures, bridges, and implants)" were excluded from the questionnaire. These three items were evaluated by nurses as objective items. They were left out because, in this study, the dentist examined these three aspects during clinical evaluation when checking patients' oral health conditions.

#### Oral Examinations by the Dentist

A dentist carried out the oral examinations in a position convenient to the patient using a disposable dental instrument set (MORITA (Osaka, Japan), comprising a dental explorer, a mirror, and a pair of dental forceps) in the hospital ward under room light and pen light (bright LED model BF-325BP, Panasonic). The dentist examined the number of teeth, presence of dentures, Community Periodontal Index (CPI) (7), and oral conditions.

The number of present teeth by age and sex were compared with data from the 2016 Survey of Dental Disease, conducted by the Japanese Ministry of Health, Labor and Welfare (2016 Survey of Dental Diseases).

To assess the periodontal condition simply, the CPI (7) was determined using a disposable probe approved by the World Health Organization (YDM, Tokyo Japan) (after ethylene oxide gas sterilization). The following 10 teeth were the targets of this examination : the upper and lower first and second molars, the right maxillary central incisor, and the left mandibular central incisor (7). The dentist chose the highest applicable code from the following options (7) : 0 – no inflammatory findings in the gingiva ; 1 – bleeding at probing ; 2 – calculus deposition without 4 mm or greater pocket depth ; 3 – 4 to 5 mm pocket depth ; 4 – 6 mm or greater pocket depth. The CPI code was determined as the highest value at the six sites.

The oral conditions were examined and assessed on the following four items (yes, no) : 1 – "good condition ; please continue your current oral care program" (no obvious dental problem was found in the present brief examination) ; 2 – "please brush each tooth more carefully" (the patient was required to brush each tooth more carefully because of his/her poor oral condition) ; 3 – "please get a dental checkup at least once a year" (it was not necessary for the patient to visit the dentist immediately following the current brief examination, but it was recommended that he/she visit the dentist at least once a year) ; and 4 – "we recommend dental visit and further dental examination because treatment is necessary" (the patient had to visit a dentist as soon as possible because the present brief examination was not sufficient to treat their dental problems). During or after oral examinations, if the patients asked questions about their oral conditions and behaviors

to the dentist, he answered them.

#### Statistical Analysis

Continuous variables with a normal distribution are expressed as mean  $\pm$  standard deviation (*SD*) and those with a skewed distribution as median (25<sup>th</sup>, 75<sup>th</sup> percentiles). Categorical variables are expressed as number and proportion (%). The Mann-Whitney U test or Fisher's exact test was used to compare the demographic or clinical characteristics between each item of the C-DiOHAT© (yes or no) where appropriate. The clinical characteristics included periodontal condition (three categories : health (CPI 0), mild (CPI 1–2) or severe (CPI 3–4)), number of present teeth (two categories : having more than the mean number of present teeth by sex and age or not), and recommendation of dental visit (yes or no). The number of present teeth by sex and age group were compared with the 2016 Survey of Dental Diseases (8) (i.e., if the patient had more teeth than the mean number of teeth in the 2016 Survey of Dental Diseases, "yes" was chosen). Logistic regression analysis was used to assess the factors associated with periodontal condition (CPI).

IBM SPSS Statistics versions 23.0 was used for all analyses. The level of statistical significance was set at  $P < 0.05$ .

#### Ethical Approval and Consent

This study was conducted with the approval of the Clinical Research Ethics Committee of Tokushima University Hospital (approval no. 2113). Before acquiring consent to participate in this study, first author explained the contents of the study using documents approved by the ethics committee. Patients who collaborated in this study fully understood its contents and they provided voluntary verbal and written consent to participate in this study.

## RESULTS

Out of 60 participants, two patients only participated in the questionnaire survey (because they did not want their oral cavity examined). Regarding 58 patients, the CPI code was determined for 55 patients, and oral conditions were examined only for 54 patients.

#### Participants' Characteristics

Participants' characteristics are shown in Table 1. A total of 60 patients (male : 32, female : 28) were recruited. Their median age was 58.5 (IQR 43.0 – 66.0) years ; their clinical diagnosis (diabetes type) included type 1 diabetes ( $n = 18$ ), type 2 diabetes ( $n = 35$ ), and others ( $n = 7$ ) ; the median HbA1c was 8.8% (IQR 7.9 – 10.2) ; and the median duration of diabetes mellitus was 9.5 (IQR 1 – 18) years. With regard to their current treatment, 88.4% of patients use injections and with regard to additional complications, 55% of patients have hypertension and 63.3% of patients have dyslipidemia.

Regarding oral conditions, the CPI code for all participants was over 2. No patients were CPI code 0. The patients' data pertaining to the number of present teeth by sex and age group are shown in Table 2. The mean numbers of present teeth by sex and age group as per the 2016 Survey of Dental Diseases are also reported in this table for comparison. In the present study, for most age groups, fewer than 60% of the patients had the mean number of teeth reported in the 2016 Survey of Dental Diseases : 20s (50.0%), 30s (33.3%), 40s (37.5%), 50s (55.6%), 60s (42.1%), 70s (50.0%), and 80s (50.0%).

#### Nurse Assessment Using the C-DiOHAT©

The findings regarding oral health condition and oral health

**Table 1.** Patients' Characteristics

		Median	IQR	Min	Max
Age (yr)		58.5	43.0 - 66.0	21	81
Duration of diabetes mellitus <sup>1)</sup> (yr)		9.5	1.0 - 18.0	0	36
Age at diagnosis (yr)		44.5	35.0 - 55.0	4	74
HbA1c level (%)		8.8	7.9 - 10.2	5.3	16.7
The number of present teeth <sup>2)</sup>		23.5	17.8 - 27.0	0	32
Community Periodontal Index : CPI <sup>3)</sup>		3.0	2.0 - 3.0	2	4
		n	(%)		
Sex	Male	32	53.3		
	Female	28	46.7		
Clinical diagnosis	Type 1 diabetes mellitus (T1DM)	18	30.0		
	Type 2 diabetes mellitus (T2DM)	35	58.3		
	Other	7	11.7		
Therapy	Oral hypoglycemic agent alone	7	11.7		
	Injections alone	28	46.7		
	Combination therapy	25	41.7		
Complications	Diabetic neuropathy	29	48.3		
	Diabetic retinopathy	21	35.0		
	Angina pectoris, myocardial infarction	7	11.7		
	Cerebral (brain) infarction	9	15.0		
	Diabetic foot ulcers	4	6.7		
	Periodontitis	6	10.0		
	Hypertention	33	55.0		
Denture <sup>2)</sup>	No denture	39	52.7		
	Only partial denture	14	18.9		
	Only full denture	2	2.7		
	Both full and partial denture	3	4.1		
CPI code <sup>3)</sup>	0	0	0		
	1	0	0		
	2	19	34.5		
	3	23	41.8		
	4	13	23.6		

1) There were 14 patients (23%) who were diagnosed for less than 1 year.

2) Only 58 patients agreed to have their total number of teeth and dentures checked.

3) Only 55 patients agreed to have their CPI code checked.

**Table 2.** Peresent teeth by age and sex, compared with data from the 2016 Survey of Dental Diseases, conducted by Japanese Ministry of Health, Labor and Welfare

Age	Total	20-29 yr	30-39 yr	40-49 yr	50-59 yr	60-69 yr	70-79 yr	> 80 yr
Mean number of present teeth <sup>1)</sup> (Total number of the patients in the age group)	20.8 ± 8.2 (n = 58)	26.2 (n = 6)	22.3 (n = 6)	26.3 (n = 8)	22.3 (n = 9)	19.3 (n = 19)	13.3 (n = 8)	14.5 (n = 2)
Number of the patients who have more teeth than 2016 Survey of Dental Disease <sup>2)</sup> (% of the total number in each aged group)	—	3 (50.0%)	2 (33.3%)	3 (37.5%)	5 (55.6%)	8 (42.1%)	4 (50.0%)	1 (50.0%)
Mean number of teeth by sex and age group in the 2016 Survey of Dental Diseases		Age : 20-24 Men ; 29.2 Women ; 28.3	Age : 30-34 Men ; 28.8 Women ; 28.5	Age : 40-44 Men ; 28.0 Women ; 28.0	Age : 50-54 Men ; 25.8 Women ; 26.8	Age : 60-64 Men ; 23.7 Women ; 24.0	Age : 70-74 Men ; 18.6 Women ; 20.7	Age : 80-84 Men ; 15.1 Women ; 15.5
		Age : 25-29 Men ; 29.0 Women ; 28.6	Age : 35-39 Men ; 28.8 Women ; 28.4	Age : 45-49 Men ; 27.6 Women ; 27.6	Age : 55-59 Men ; 24.5 Women ; 25.9	Age : 65-69 Men ; 21.5 Women ; 21.7	Age : 75-79 Men ; 18.5 Women ; 17.6	Age : 85-89 Men ; 12.0 Women ; 9.5

1) Only the patients who agreed to get the data of the total number of teeth were included.

2) The 2016 Survey of Dental Diseases shows the average number of present teeth by sex and age group in individuals. In this comparison, the values corresponding to the number of present teeth were rounding to the nearest whole number, according to the first decimal place. (e.g) If 27.6 was shown in it, it was compared as 27 teeth.

behavior using the C-DiOHAT<sup>®</sup> are shown in Table 3. Only 16 patients (26.7%) could bite firmly with the molars and dentures. Less than approximately 40% of patients were found to engage in oral hygiene behavior, e.g., the number of patients who used supplementary tools (e.g., interdental brush, dental floss) was 23 (39.0%), although 65.0% of them had “experience of receiving instructions for brushing”, and 49 patients (81.7%) had “knowledge of the relationship between periodontal disease and systemic diseases, including diabetes”. Regarding “sharing health information among patients and dental/medical professionals”, the percentage showing their personal health records for diabetes/medications to their dentists was 13.3% and 10.0%, respectively.

*Comparison between the C-DiOHAT<sup>®</sup> and HbA1c Levels*

As is evident from Table 3, the HbA1c level was lower among patients who responded “yes” to the items “experience of receiving instructions for brushing by a dentist” ( $P = 0.001$ ), “dental visits more than once a year” ( $P = 0.048$ ), “checking one’s mouth with a mirror” ( $P = 0.020$ ), “toothbrushing carefully” ( $P = 0.015$ ),

and “notification of dental condition to their primary doctor” ( $P = 0.025$ ) than those who responded “no”.

*Oral Examination by a Dentist*

The CPI code and the number of teeth have already shown in Table 1 and Table 2, respectively. As shown in Table 4, the dentist evaluated 45 patients (83.3%) as needing to brush their teeth more carefully and 36 patients (66.7%) as being recommended dental visits. Some patients asked the dentist about problems with the teeth or dentures, brushing technique, oral health tools (i.e. ; toothbrush, mouthwash, etc.), and so on. Some patients said they would like to treat their teeth, but they could not because of systemic disease.

*Relationship between the Nurse’s Oral Assessment Using the C-DiOHAT<sup>®</sup> and the Dentist’s Oral Examination*

As shown in Table 5, the number of present teeth by sex and age was significantly associated with greater “use of supplementary tools” ( $P = 0.013$ ). In addition, the dentist’s recommendation

**Table 3.** Relationships between nursing assessment with C-DiOHAT<sup>®</sup> and age / HbA1c / sex

Items of assessment	n (%)	Age			HbA1c			Sex			
		Median	IQR <sup>1)</sup>	P-value <sup>2)</sup>	Median	IQR <sup>1)</sup>	P-value <sup>2)</sup>	Men	Women	P-value <sup>3)</sup>	
	60 (100%)	59	43 - 66		8.8	7.9 - 10.2		32 (53.3%)	28 (46.7%)		
<i>Factor 1 : Oral health conditions</i>											
Symptom of gingival swelling	No	21 (35.0%)	59	41 - 66	0.467	8.80	7.80 - 10.55	0.872	11 (34.4%)	10 (35.7%)	1.000
	Yes	39 (65.0%)	58	43 - 71		8.95	7.85 - 9.98		21 (65.6%)	18 (64.3%)	
Bleeding during toothbrushing	No	35 (58.3%)	64	49 - 69	<b>0.002 *</b>	8.80	7.70 - 10.10	0.745	20 (62.5%)	15 (53.6%)	0.331
	Yes	25 (41.7%)	50	35 - 59		8.95	7.95 - 10.28		12 (37.5%)	13 (46.4%)	
Awareness of halitosis	No	37 (61.7%)	63	43 - 67	0.233	8.70	7.90 - 10.55	0.997	23 (71.9%)	14 (50.0%)	0.112
	Yes	23 (38.3%)	53	43 - 64		9.10	7.63 - 9.98		9 (28.1%)	14 (50.0%)	
Biting firmly on molar or dentures	No	44 (73.3%)	59	43 - 66	0.865	8.75	7.70 - 10.05	0.065	24 (75.0%)	20 (71.4%)	0.778
	Yes	16 (26.7%)	59	48 - 71		9.80	8.40 - 10.30		8 (25.0%)	8 (28.6%)	
<i>Factor 2 : Oral hygiene behaviors</i>											
Experience of receiving instructions for brushing	No	21 (35.0%)	55	41 - 64	0.204	10.15	8.80 - 10.90	<b>0.001 **</b>	9 (28.1%)	12 (42.9%)	0.284
	Yes	39 (65.0%)	61	48 - 67		8.30	7.50 - 9.80		23 (71.9%)	16 (57.1%)	
Dental visits more than once a year	No	34 (57.6%)	54	43 - 65	0.354	9.60	8.25 - 10.70	<b>0.048 *</b>	16 (50.0%)	18 (66.7%)	0.290
	Yes	25 (42.4%)	63	41 - 68		8.30	7.60 - 9.75		16 (50.0%)	9 (33.3%)	
Checking one’s mouth with a mirror	No	35 (58.3%)	54	43 - 67	0.757	9.70	8.00 - 10.80	<b>0.020 *</b>	22 (68.8%)	13 (46.4%)	0.116
	Yes	25 (41.7%)	61	42 - 66		8.40	7.75 - 9.10		10 (31.3%)	15 (53.6%)	
Use of supplementary tools (e.g., interdental brush, dental floss) <sup>4)</sup>	No	36 (61.0%)	55	39 - 67	0.490	9.50	8.10 - 10.60	0.096	17 (53.1%)	19 (70.4%)	0.194
	Yes	23 (39.0%)	59	49 - 66		8.40	7.33 - 9.63		15 (46.9%)	8 (29.6%)	
Toothbrushing carefully <sup>5)</sup>	No	38 (63.3%)	63	47 - 67	0.185	9.60	8.20 - 10.70	<b>0.015 *</b>	19 (59.4%)	19 (67.9%)	0.595
	Yes	22 (36.7%)	54	32 - 65		8.20	7.00 - 9.38		13 (40.6%)	9 (32.1%)	
<i>Factor 3 : Perceptions and knowledge of oral health behaviors</i>											
Knowledge of a relationship between periodontal disease and systemic disease including diabetes	No	11 (18.3%)	58	38 - 66	0.825	10.10	8.00 - 10.90	0.410	5 (15.6%)	6 (21.4%)	0.740
	Yes	49 (81.7%)	59	43 - 67		8.80	7.75 - 9.90		27 (84.4%)	22 (78.6%)	
Perceptions of oral care (e.g., brushing teeth, washing denture, gargling) efficacy regardless of timing of care initiation	No	24 (40.0%)	61	37 - 73	0.526	8.70	7.90 - 9.80	0.179	14 (43.8%)	10 (35.7%)	0.603
	Yes	36 (60.0%)	57	44 - 65		9.40	7.78 - 10.63		18 (56.3%)	18 (64.3%)	
<i>Factor 4 : Sharing health information among patients and dental / medical professionals</i>											
Showing personal health record notebook for diabetes to the dentist	No	52 (86.7%)	58	43 - 66	0.382	9.20	7.90 - 10.40	0.135	29 (90.6%)	23 (82.1%)	0.454
	Yes	8 (13.3%)	61	50 - 73		8.20	7.75 - 8.73		3 (9.4%)	5 (17.9%)	
Showing personal health record notebook for medication to the dentist	No	54 (90.0%)	59	45 - 66	0.723	9.10	7.90 - 10.35	0.095	31 (96.9%)	23 (82.1%)	0.088
	Yes	6 (10.0%)	49	32 - 72		7.90	6.93 - 9.05		1 (3.1%)	5 (17.9%)	
Showing self-monitoring blood glucose notebook to the dentist <sup>6)</sup>	No	49 (92.5%)	61	43 - 68	0.609	9.00	7.75 - 10.63	0.697	23 (92.0%)	26 (92.9%)	1.000
	Yes	4 (7.5%)	54	49 - 62		8.80	8.05 - 9.63		2 (8.0%)	2 (7.1%)	
Notification of dental condition to their primary doctor	No	52 (88.1%)	56	39 - 66	0.055	9.20	7.90 - 10.30	<b>0.025 *</b>	29 (90.6%)	23 (85.2%)	0.692
	Yes	7 (11.9%)	67	58 - 76		7.70	7.10 - 8.50		3 (9.4%)	4 (14.8%)	
Notification of dental condition to their primary nurse	No	56 (94.9%)	60	43 - 67	0.903	8.80	7.90 - 10.20	0.081	31 (96.9%)	25 (92.6%)	0.588
	Yes	3 (5.1%)	58	50 - 66		7.10	6.70 - 8.50		1 (3.1%)	2 (7.4%)	

1) IQR : interquartile range ; 2) Mann-Whitney test, \*\* $P < 0.01$ , \* $P < 0.05$  ; 3) Fisher’s exact test (two-tailed) ; 4) Participants with more than a tooth (dentulous ;  $n = 59$ ), as they can use supplementary tools if they have one or more teeth ; 5) Patients with edentulous jaw answered questions about brushing dentures ; 6) Only patients who used injected medications.

Table 4. Diagnostics results of dental examinations

Evaluation items	(n = 54)	
	Yes	No
Good condition ; please continue your current oral care program.	9 (16.7%)	45 (83.3%)
Please brush each tooth more carefully.	45 (83.3%)	9 (16.7%)
Please get a dental checkup at least once a year.	18 (33.3%)	36 (66.7%)
We recommend dental visit and further dental examination because treatment is necessary. (Recommendation of dental visit)	36 (66.7%)	18 (33.3%)

Table 5. Relationships between nursing assessment with C-DiOHAT© and oral examinations conducted by a dentist (periodontal disease (CPI), number of present teeth by sex and age group, and recommendation of dental visit)

Items of assessment	Periodontal disease (CPI) <sup>1)</sup>			Number of present teeth by sex and age group <sup>2)</sup>			Recommendation of dental visit			
		Mild (CPI = 1,2) (%)	Severe (CPI = 3,4) (%)	P-value <sup>3)</sup>	No	Yes	P-value <sup>3)</sup>	No	Yes	P-value <sup>3)</sup>
		19 (34.5%)	36 (65.5%)		32 (55.2%)	26 (44.8%)		18 (33.3%)	36 (66.7%)	
<i>Factor 1 : Oral health conditions</i>										
Symptom of gingival swelling	No	8 (42.1%)	12 (33.3%)	0.566	9 (28.1%)	11 (42.3%)	0.282	10 (55.6%)	9 (25.0%)	0.037 *
	Yes	11 (57.9%)	24 (66.7%)		23 (71.9%)	15 (57.7%)		8 (44.4%)	27 (75.0%)	
Bleeding during toothbrushing	No	12 (63.2%)	20 (55.6%)	0.775	19 (59.4%)	14 (53.8%)	0.791	13 (72.5%)	17 (47.2%)	0.145
	Yes	7 (36.8%)	16 (44.4%)		13 (40.6%)	12 (46.2%)		5 (27.8%)	19 (52.8%)	
Awareness of halitosis	No	12 (63.2%)	20 (55.6%)	0.775	21 (65.6%)	14 (53.8%)	0.425	10 (55.6%)	22 (61.1%)	0.773
	Yes	7 (36.8%)	16 (44.4%)		11 (34.4%)	12 (46.2%)		8 (44.4%)	14 (38.9%)	
Biting firmly on molar or dentures	No	16 (84.2%)	25 (69.4%)	0.334	21 (65.6%)	21 (80.8%)	0.246	15 (83.3%)	24 (66.7%)	0.334
	Yes	3 (15.8%)	11 (30.6%)		11 (34.4%)	5 (19.2%)		3 (16.7%)	12 (33.3%)	
<i>Factor 2 : Oral hygiene behaviors</i>										
Experience of receiving instructions for brushing	No	6 (31.6%)	13 (36.1%)	0.775	13 (40.6%)	7 (26.9%)	0.405	3 (16.7%)	16 (44.4%)	0.069
	Yes	13 (68.4%)	23 (63.9%)		19 (59.4%)	19 (73.1%)		15 (83.3%)	20 (55.6%)	
Dental visits more than once a year	No	9 (47.4%)	22 (61.1%)	0.397	21 (67.7%)	12 (46.2%)	0.115	8 (44.4%)	23 (63.9%)	0.245
	Yes	10 (52.6%)	14 (38.9%)		10 (32.3%)	14 (53.8%)		10 (55.6%)	13 (36.1%)	
Checking one's mouth with a mirror	No	12 (63.2%)	21 (58.3%)	0.779	17 (53.1%)	17 (65.4%)	0.426	10 (55.6%)	22 (61.1%)	0.773
	Yes	7 (36.8%)	15 (41.7%)		15 (46.9%)	9 (34.6%)		8 (44.4%)	14 (38.9%)	
Use of supplementary tools (e.g., interdental brush, dental floss) <sup>4)</sup>	No	11 (57.9%)	22 (61.1%)	1.000	24 (77.4%)	11 (42.3%)	<b>0.013 *</b>	7 (38.9%)	26 (72.2%)	<b>0.036 *</b>
	Yes	8 (42.1%)	14 (38.9%)		7 (22.6%)	15 (57.7%)		11 (61.1%)	10 (27.8%)	
Toothbrushing carefully <sup>5)</sup>	No	9 (47.4%)	26 (72.2%)	0.084	22 (68.8%)	14 (53.8%)	0.285	9 (50.0%)	26 (72.2%)	0.136
	Yes	10 (52.6%)	10 (27.8%)		10 (31.3%)	12 (46.2%)		9 (50.0%)	10 (27.8%)	
<i>Factor 3 : Perceptions and knowledge of oral health behaviors</i>										
Knowledge of a relationship between periodontal disease and systemic disease including diabetes	No	6 (31.6%)	3 (8.3%)	<b>0.051</b>	3 (9.4%)	6 (23.1%)	0.274	4 (22.2%)	5 (13.9%)	0.461
	Yes	13 (68.4%)	33 (91.7%)		29 (90.6%)	20 (76.9%)		14 (77.8%)	31 (86.1%)	
Perceptions of oral care (e.g., brushing teeth, washing denture, gargling) efficacy regardless of timing of care initiation	No	9 (47.4%)	14 (38.9%)	0.577	15 (46.9%)	8 (30.8%)	0.283	6 (33.3%)	15 (41.7%)	0.768
	Yes	10 (52.6%)	22 (61.1%)		17 (53.1%)	18 (69.2%)		12 (66.7%)	21 (58.3%)	
<i>Factor 4 : Sharing health information among patients and dental / medical professionals</i>										
Showing personal health record notebook for diabetes to the dentist	No	19 (100.0%)	31 (86.1%)	0.152	26 (81.3%)	25 (96.2%)	0.116	17 (94.4%)	31 (86.1%)	0.651
	Yes	0 (0.0%)	5 (13.9%)		6 (18.8%)	1 (3.8%)		1 (5.6%)	5 (13.9%)	
Showing personal health record notebook for medication to the dentist	No	17 (89.5%)	33 (91.7%)	1.000	28 (87.5%)	24 (92.3%)	0.681	16 (88.9%)	32 (88.9%)	1.000
	Yes	2 (10.5%)	3 (8.3%)		4 (12.5%)	2 (7.7%)		2 (11.1%)	4 (11.1%)	
Showing self-monitoring blood glucose notebook to the dentist <sup>6)</sup>	No	18 (94.7%)	29 (96.7%)	1.000	25 (89.3%)	23 (100.0%)	0.242	17 (100.0%)	28 (90.3%)	0.543
	Yes	1 (5.3%)	1 (3.3%)		3 (10.7%)	0 (0.0%)		0 (0.0%)	3 (9.7%)	
Notification of dental condition to their primary doctor	No	18 (100.0%)	31 (86.1%)	0.157	26 (83.9%)	25 (96.2%)	0.205	15 (83.3%)	33 (94.3%)	0.323
	Yes	0 (0.0%)	5 (13.9%)		5 (16.1%)	1 (3.8%)		3 (16.7%)	2 (5.7%)	
Notification of dental condition to their primary nurse	No	18 (100.0%)	34 (94.4%)	0.547	31 (100.0%)	24 (92.3%)	0.204	17 (94.4%)	34 (97.1%)	1.000
	Yes	0 (0.0%)	2 (5.6%)		0 (0.0%)	2 (7.7%)		1 (5.6%)	1 (2.9%)	

1) Only 55 patients agreed to offer the CPI code data. CPI code 1 or 2 meant mild periodontal disease, CPI code 3 or 4 meant severe periodontal disease ; 2) 58 patients who agreed to offer the data of the number of present teeth. 3) Fisher's exact test (two-tailed), \*\* $P < 0.01$ , \* $P < 0.05$  ; 4) Participants with more than a tooth, as they can use supplementary tools if they have one or more teeth. (dentulous patients : Shapiro-Wilk test ;  $P = 0.014$ ) ; 5) Patients with edentulous jaw answered questions about dentures brushing ; 6) Only patients who used injected medications.

of dental visit was significantly associated with “no use of supplementary tools” ( $P = 0.036$ ) and “symptoms of gingival swelling” ( $P = 0.037$ ). CPI code was significantly associated with “knowledge of a relationship between periodontal disease and systemic disease including diabetes” ( $P = 0.021$ ) in Table 6.

DISCUSSION

In the present study, the oral health of in-patients with diabetes was assessed by a nurse using the C-DiOHAT<sup>®</sup> and by a dentist conducting the oral examination. Patients’ awareness of the symptoms of gingival swelling was also significantly associated with recommendation of dental visit. Use of supplementary tools (e.g., interdental brush, dental floss) was significantly associated with the number of present teeth and no recommendation of further dental visit.

Periodontal diseases are classified as gingivitis and periodontitis. The major symptoms of gingivitis are redness, swelling, and bleeding. The item of “patients’ awareness of the symptoms of gingival swelling” in C-DiOHAT<sup>®</sup> may be a useful predictor of oral health condition.

To prevent periodontal disease (9), both oral self-care (daily

self-performed oral health (e.g., toothbrushing, flossing, using interdental brush)) and oral professional care (regular professional removal of the microbial biofilm) are important.

Regarding oral self-care, 39.2% of the respondents performed interdental cleaning with supplementary tools (8). Flossing in addition to brushing has also been reported to reduce interproximal gingivitis (10). Even when compared with the results of previous research (11–13), the implementation rate found in this study (39%) does not seem low. It stands to reason that the patients who use supplementary tools have more teeth and fewer dental problems. Therefore, these results suggest that the item of “use of supplementary tools” in C-DiOHAT<sup>®</sup> may be a useful predictor of oral health condition.

Regarding oral professional care, 52.9% of the participants had undergone a dental examination in the past year (14). Targets is 65% by 2022 (15). The present result was 42%. It was suggested that patients with diabetes have to visit physicians to treat diabetes once every 1–3 months, as well as make special visits in cases of diabetes complications or other diseases. Therefore, it might be difficult to visit dentists. To encourage patients to visit medical and dental clinics regularly, the diabetes information-sharing notebook (16) has been published by

Table 6. Logistic regression analysis for periodontal condition (CPI)

Independent variable <sup>1)</sup>		OR <sup>2)</sup>	95%CI <sup>3)</sup>		P value <sup>4)</sup>
Symptom of gingival swelling	0 : No	1.44	0.41	5.01	0.57
	1 : Yes				
Bleeding during toothbrushing	0 : No	3.71	0.83	16.64	0.09
	1 : Yes				
Awareness of halitosis	0 : No	2.81	0.68	11.67	0.15
	1 : Yes				
Biting firmly on molar or dentures	0 : No	2.93	0.61	14.09	0.18
	1 : Yes				
Experience of receiving instructions for brushing	0 : No	0.53	0.14	2.00	0.35
	1 : Yes				
Dental visits more than once a year	0 : No	0.36	0.10	1.34	0.13
	1 : Yes				
Checking one’s mouth with a mirror	0 : No	1.65	0.45	6.01	0.45
	1 : Yes				
Use of supplementary tools (e.g., interdental brush, dental floss) <sup>5)</sup>	0 : No	0.57	0.16	2.06	0.39
	1 : Yes				
Toothbrushing carefully <sup>6)</sup>	0 : No	0.36	0.10	1.37	0.13
	1 : Yes				
Knowledge of a relationship between periodontal disease and systemic disease including diabetes	0 : I don’t know.	7.61	1.35	42.86	0.02 *
	1 : I know.				
Perceptions of oral care (e.g., brushing teeth, washing denture, gargling) efficacy regardless of timing of care initiation	0 : I don’t know.	1.80	0.51	6.33	0.36
	1 : I know.				
Showing personal health record notebook for diabetes to the dentist <sup>7)</sup>	0 : No	—			
	1 : Yes				
Showing personal health record notebook for medication to the dentist	0 : No	1.39	0.18	10.89	0.75
	1 : Yes				
Showing self-monitoring blood glucose notebook to the dentist <sup>8)</sup>	0 : No	0.56	0.03	10.81	0.70
	1 : Yes				
Notification of dental condition to their primary doctor <sup>7)</sup>	0 : No	—			
	1 : Yes				
Notification of dental condition to their primary nurse <sup>7)</sup>	0 : No	—			
	1 : Yes				

1) Independent variables are dummy ; 2) OR : odds ratio ; 3) 95%CI : 95% confidence interval. 4) Dependent variable : Community Periodontal Index (CPI) : 0 : CPI = 1 or 2, 1 : CPI = 3 or 4 ; Age and gender were adjusted ; \* $P < 0.05$  ; 5) Participants with more than a tooth, as they can use supplementary tools if they have one or more teeth. ; 6) Patients with edentulous jaw answered questions about dentures brushing ; 7) In this variable, it was not applicable to calculate OR ; 8) Only patients who used injected medications.

the Japan Association for Diabetes Education and Care since 2010. It is expected to help the diabetes cure/care team members develop interdisciplinary relationships. In a previous study (17), 35.1% of the patients provided their dentist with clinical data pertaining to their HbA1c level, and 43.9% reported their ongoing medical treatment. It is suggested that patients may not manage their physical information appropriately. There is a high risk of incomplete healing of wounds or infection during dental treatment when the patient has hyperglycemia (18). After dental treatment, the patient might be unable to eat meals at the usual time (because of the use of anesthesia for dental treatment) and thereby become hypoglycemic. Furthermore, if patients cannot chew foods easily because of dental problems, they will have to consume only soft meals (19) and soft drinks (20), which may lead to hyperglycemia through an increase in food intake (19). These days, medical professionals share patients' information with each other as part of their medical team (21, 22). Person-centered care for the self-management of diabetes (23) is important. It is suggested that educational programs for patients are recommended so that patients can manage their own medical and dental information, understand their disease (including its stages and trajectory), and engage in self-management behavior.

Regarding knowledge of periodontal disease and systemic diseases such as diabetes, it was reported that "people with diabetes have inadequate oral health knowledge, poor oral health attitudes, and fewer dental visits (24)". The patients' knowledge was higher in the present study (81.7%) than the other (30% (25), 32% (12)). Therefore, when patients with severe oral problems visit dentists, the dentists might explain to them that their oral condition could worsen owing to diabetes and encourage them to develop their knowledge about their condition. Patients will be prepared for disease complications if nurses educate them early. As for oral care, nurses should discuss how they can help patients avoid getting worse and what they can do to improve patients' oral self-management. In a previous study (4,5), several nurses reported that they wished to conduct quick oral assessments because in real clinical settings they have to educate patients about several other aspects of the disease. Not surprisingly, the present study found significant relationships between the items of C-DiOHAT<sup>©</sup> ("use of supplementary tools") and the dentist's examination ("number of present teeth by sex and age" and "dentist's recommendation of dental examination"). The item "experience receiving instructions for brushing" had a significant relationship with HbA1c levels. These results suggest that nurses could utilize assessment items of the C-DiOHAT<sup>©</sup> to effectively acquire useful information about patients' oral health conditions and behaviors. The authors think that the role of the nurse in oral care is to help the patients in their daily care and self-management.

On the other hand, the salivary multi-test system (26, 27) was developed to assess oral health. One (28) such test requires that patients not eat or drink and not engage in oral cleaning for at least 2 hours before the examination. These requirements may be difficult for patients with diabetes, who tend to feel thirsty and who need to keep drinking fluids to prevent cerebral complications. Therefore, assessment items of the C-DiOHAT<sup>©</sup> seem useful in assessing patients' oral health conditions in a short time frame in clinical settings.

CPI was significantly influenced by the duration of diabetes, fasting blood glucose levels, and HbA1c levels (2). In the present study, participants were in-patients receiving serious medical care. Naturally enough, all patients may have periodontal disease (the CPI codes of all patients exceeded 2.0), and the ratios of mild to severe periodontal disease were one (34.5%) to two (65.5%). These things may be one of the reasons that there was

no association between the CPI code and each assessment item of the C-DiOHAT<sup>©</sup> except for "knowledge of a relationship between periodontal disease and systemic disease including diabetes". Furthermore, these things may be a reasons that the patients who had more "knowledge of a relationship between periodontal disease and systemic disease" had higher CPI code. However, further research should consider when the patients got the "knowledge of a relationship between periodontal disease and systemic disease including diabetes".

Regarding oral care by nurses (29–34), it has been pointed out that nurses lack knowledge of oral health care (35). And nurses need to know that many patients want to get knowledge about oral health. They also acknowledge the importance of interprofessional and collaborative education between medicine/nursing and dentistry (30). The need for dental hygiene registration by nurses was also reported (36). It is important to encourage nurses to be interested in patients' oral health conditions and behaviors.

## STUDY LIMITATIONS

Several limitations of this study should be acknowledged. First, this survey was conducted with a small number of in-patients in one university hospital with medical and dental clinics. Therefore, the study's statistical power might be limited. Second, the patients who consented to participate in the study may have had high interest in oral care. Thus, the representativeness of the sample may be questioned, the findings cannot be generalized. Third, only the CPI code was used to examine the severity of periodontal disease, and X-rays were not used to diagnose the same accurately. Fourth, the CPI code for all participants was over 2. Further research should include participants of every level of periodontal disease. Fifth, "checking the inside of the patient's mouth", which is the items of DiOHAT<sup>©</sup>, was excluded from the questionnaire. However, further research should consider which information regarding the oral cavity nurses need to be able to observe. Finally, further research should also consider when the patients got the "knowledge of a relationship between periodontal disease and systemic disease including diabetes".

## CONCLUSION

According to the dentist's oral examination, the CPI code for all the in-patients was over 2, indicating that all of them may have had a periodontal disease. Further, the patients who had the present number of teeth by sex and age use more supplementary tools (e.g., interdental brush, dental floss) for oral care than those who did not. Thus, patients who used supplementary tools were less likely to require further dental examination than those who did not. Similarly, patients who visited dentists once a year had more teeth and a lower HbA1c level than patients who did not. The dentist's recommendation of further dental examination (need for dental treatment) was related to the patient's awareness of the symptoms of gingival swelling, and use of supplementary tools. However, the patients who had "knowledge of a relationship between periodontal disease and systemic disease including diabetes" were significantly higher CPI code. Regarding this, further research should also consider when the patients got the knowledge.

The following assessment items of the C-DiOHAT<sup>©</sup> were closely related to the dentist's oral examinations: "use of supplementary tools", "symptom of gingival swelling", and "knowledge of a relationship between periodontal disease and systemic disease including diabetes". These results suggest that nurses

should prioritize these assessment items to most quickly acquire useful information about patients' oral health conditions and behaviors. It is important to encourage nurses to be interested in patients' oral health conditions and behaviors by such small pile of clue.

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## AUTHOR CONTRIBUTIONS

YK contributed to the study design, creation of the questionnaire, data collection, analysis, writing and approving the paper. ES contributed to data collection, analysis, and final approval of the paper. MS contributed to the study design, creation of the questionnaire, analysis, and final approval of the paper. MM contributed to the study design, analysis and final approval of the paper. DH, HU, and SK contributed to the analysis and final approval of the paper.

## COMPLIANCE WITH ETHICAL STANDARDS

## CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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