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REPORT

Modified diabetes oral health assessment tool（M-DiOHAT©）for nurses and their association with efficacy beliefs and outcome expectancies in patients with diabetes

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Abstract Background：Bidirectional relationships exist between diabetes and periodontal disease. Fostering timely oral health assessments of patients with diabetes, the modified diabetes oral health assessment tool（M-DiOHAT©）for nurses was studied. The DiOHAT© has four factors, namely *oral health conditions*, *oral hygiene behaviors*, *perception and knowledge*, and *health record sharing*. It was modified as the M-DiOHAT© scale. To change people's health behaviors, "efficacy beliefs" and "outcome expectancies" are important. However, no studies have been reported that addressed efficacy beliefs and outcome expectancies of oral health conditions and behaviors of patients with diabetes.
Objective：To clarify the oral health conditions and behaviors of patients with diabetes using the M-DiOHAT©, and to describe their associations with the Self-Efficacy Scale for Self-Care（SESS）/the Outcome Expectancy Scale for Self-Care（OESS）.
Methods：Twenty-eight patients with diabetes participated in the study. Their personal characteristics were determined from the items of self-efficacy for brushing of the teeth（SE-B）, self-efficacy for dental consultations（SE-DC）, OESS that are comprised of three factors, namely, the social outcome expectancy（OE-Social）, oral outcome expectancy（OE-Oral）, and self-evaluative outcome expectancy（OE-Self）, and the M-DiOHAT©.
Results：Forty-three percent of patients had retained their expected number of present teeth, and 68% of them had dental problems. The scores of *health record sharing* were low, and patients who were under 65 years old had fewer "expected number of present teeth," and lower SE-B/*oral health conditions* scores than those patients aged over 65 years. The scores of *oral hygiene behaviors* were significantly correlated with the SE-B scores, SE-DC, OE-Oral, and OE-Self. However, the *oral health conditions* showed no correlation with SE-B, SE-DC, OESS.
Conclusion：The findings suggest that nursing interventions to promote SE-B, SE-DC, and OESS could be effective in enhancing patients' *oral hygiene behaviors*. However, severity of patients' periodontal disease require different types of dental self-efficacy procedures.
Key words：diabetes, nurse, oral health, self-efficacy, DiOHAT©, M-DiOHAT©

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INTRODUCTION

In Japan, approximately 10 million people are currently suspected to have diabetes that is, they have blood hemoglobin A1c (HbA1c) levels of over 6.5% (NGSP) or are currently receiving insulin treatment or oral hypoglycemic medication[1]. Diabetes has many complications ; some are connected to fatal risks, such as myocardial or cerebral infarctions caused by damage to blood vessels, whereas some are associated with the deterioration of quality of life, such as diabetic neuropathy, retinopathy, and nephropathy caused by micro-angiopathy. Periodontal disease is one such complication. It is known that a bidirectional relationship exists between diabetes and periodontal disease[2-4].

The Japanese Clinical Practice Guideline for Diabetes reports that "organized education and support for the self-management of diabetes have been shown to be useful for diabetes management[5,6] (grade A : 100% agreement)[7]." Nurses play important roles in educating patients[8] and supporting patients in diabetes self-management. Nursing support includes medical nutrition therapy, physical activity/exercise, treatment with glucose lowering agents, and body care, such as foot and oral care. To help nurses briefly assess oral health conditions and behaviors of patients with diabetes, the Diabetes Oral Health Assessment Tool (DiOHAT©) for nurses was developed[9]. There are four factors, namely *oral health conditions*, *oral hygiene behaviors*, *perception and knowledge*, and *health record sharing*. In this study, the tool was modified (M-DiOHAT©) for use in a clinical setting.

To support self-management among patients with diabetes, behavioral change is important. Bandura, a psychologist[10], reported that "(a) perceived self-efficacy was a judgment of persons' ability to act or practice ; (b) outcome expectation was a judgment of the likely results such performance will create[10]." According to Bandura, conditional relationships between efficacy beliefs and outcome expectancies affect people's health behaviors[10]. To bring about a change in people's health behaviors, efficacy beliefs and outcome expectancies are important. Some studies have examined self-efficacy in patients with diabetes[11-13]. Regarding periodontal disease, significant associations were found between scores on the Outcome Expectancy Scale for Self-Care (OESS)[14] and the Self-Efficacy Scale for Self-Care (SESS)[15] among patients with periodontal disease. Kakudate et al. reported that SESS has predictive validity for oral health conditions by using a plaque control record[15]. They also reported evaluating psychological conditions of patients with periodontal disease concerning their behavior and affective status using the OESS with SESS[14]. However, no studies have reported the efficacy beliefs and outcome expectancies of oral health conditions and behaviors in patients with diabetes. If M-DiOHAT© has some associations with SESS or OESS, it will be shown that using OESS with SESS has the possibility of promoting oral health conditions and behaviors or M-DiOHAT©.

PURPOSE AND SIGNIFICANCE

This study aimed to clarify the oral health conditions and behaviors of patients with diabetes by using the M-DiOHAT© scale, and to determine their association with the Self-Efficacy Scale for Self-Care (SESS)[15] and the Outcome Expectancy Scale for Self-Care (OESS)[14].

METHODS

Study Design

The design of choice that responded appropriately to the aim of the study was the descriptive correlational design[16].

PARTICIPANTS

The study enrolled patients with diabetes being treated at the diabetes clinic of an educational hospital in western Japan in December 2017. The inclusion criteria were aged ≥ 20 years, having a stable medical condition, having no impediments to communication, and having no possibility of change in condition due to participation in this study as determined by physicians and nurses. Exclusion criteria were severe mental disorders, such as dementia, visual impairment, and impairment of hand

range of motion to emphasize persons' abilities to brush their teeth independently. Participants were recruited at a diabetes clinic. After introducing the researcher, the participants were chosen based on the aforementioned inclusion and exclusion criteria. After the occasion, toothbrush(es) and/or mirrors were provided to patients for participating in the study.

DESCRIPTION OF INSTRUMENTS/MEASURES

The following instruments were used to collect data: the Modified Diabetes Oral Health Assessment Tool (M-DiOHAT©) for Nurses and the SESS[15] and OESS[14] of patients with periodontal disease. Data on clinical characteristics, age, sex, clinical diagnosis, treatment of diabetes, duration of diabetes, diabetes complication, HbA1c level, dental checkup in the past month, and attendance at the hospital's diabetes class on periodontal disease were collected. A nurse counted the number of teeth and checked whether the patient had full or partial dentures using a pen light (bright LED model BF-325BP [Panasonic]). The number of teeth by age and sex group was compared with data from the 2016 Survey of Dental Diseases, conducted by the Japanese Ministry of Health, Labour and Welfare (2016 Survey of Dental Diseases)[17].

THE DiOHAT© FOR NURSES

The DiOHAT© for Nurses was developed to elicit data on 4 factors (*oral health conditions* [7 items]; *oral hygiene behaviors* [6 items]; *perception and knowledge* [3 items]; and *health record sharing* [5 items][21 items total])[9]. The tool was used by Certified Nurses in Diabetes Nursing or Certified Nurse Specialists in Chronic Care Nursing, as well as nurses certified by the Japanese Nursing Association. The Cronbach's alpha of the DiOHAT© was 0.932 when developed (participants were diabetes nurse specialists)[9]. Nurses using the original assessment tool found that they wanted to assess patients' oral health conditions and behaviors in a shorter time[18] and gain knowledge about oral assessment[18], therefore, the DiOHAT© was revised for improved clinical use. The first revision, Clinical-DiOHAT© or C-DiOHAT©, was used by nurses in clinical settings along with a simultaneous examination of oral health conditions by a dentist[19]. The findings based on the dentist's and nurse's assessments were compared. It was found that specific assessment items ("symptoms of gingival swelling," and "use of supplementary tools, such as interdental brush, dental floss") were associated with dental examination, suggesting that nurses may be able to obtain useful information using the C-DiOHAT©[19].

In the next stage, the DiOHAT© was revised again. The second revision was the Modified-DiOHAT© or M-DiOHAT© (17 items total), and revisions in the four factors are shown in the following sentences.

Factor 1 (*oral health conditions* [5 items]): The following items were checked by a nurse: "dentures (partial or full)," "counting the total number of the patient's teeth (dentures, bridges, and implants are excluded)," and "checking the inside of the patient's mouth." In addition, the item" presence of difficulties related to the teeth" was included to obtain subjective information from patients.

Factor 2 (*oral health behaviors* [6 items]): "Checking one's mouth with a mirror" was revised as "checking the place where the toothbrush touched the gingival border with a mirror when patients brushed their teeth." One reason for this change was to enhance behavior to prevent periodontal disease, because the rate of nurses' assessment of "brushing around the border of teeth and gingiva" was low[18], even though it was one of the most important items pertaining to the prevention of periodontal disease. Another reason was that checking their mouths with a mirror was difficult for some patients. Many patients asked, "what should I look at? I could not assess anything, but only look." "Regular dental checkup more than once a year" was revised to "regular dental checkup."

Factor 3 (*perception and knowledge* [2 items]): "Knowledge of a relationship between periodontal disease and systemic disease, including diabetes" was revised to "knowledge of a relationship between periodontal disease and diabetes." "Perception of one's oral health status" was originally included in Factor 3. However, it was omitted from the M-DiOHAT©, because the

question about "perception of one's oral health status" in the questionnaire was considered difficult for patients to answer within a short period.

Factor 4 (*health record sharing* [4 items]) : The item "showing self-monitoring blood glucose notebook to the dentist" was excluded because, in Japan, it was only used for medical injection therapy to save the patients' time.

Patient responses to a given statement were scored on a 4-point Likert scale, with values for each response ranging from 1 to 4 (1=never, 2=occasionally, 3=sometimes, 4=always ; except for the *oral health conditions* factor). Regarding *oral health conditions*, except for "biting firmly on molar or dentures," response values ranged from 1 to 4 (1=always, 2=sometimes, 3=occasionally, 4=never). The M-DiOHAT© score for each patient is shown as the sum of the scores for the 17 items. The total possible score ranges from 17 to 68. A higher score indicates that the patient engaged more frequently in self-management behavior or had good oral health conditions for that item. Additionally, to compare these results with those from the 2016 Survey of Dental Diseases[17], a previous study[20], and patients' characteristics, items were dichotomized into binary Yes/No variables. For the majority of times, scores rated as a 1 (*never*) were categorized as *no*, while ratings of 2 (*occasionally*), 3 (*sometimes*), and 4 (*always*) were categorized as *yes*. However, the four items, "bleeding during toothbrushing," "gingival swelling," "awareness of halitosis," and "having difficulties (troubles) related to the teeth" were recorded in a slightly different manner. For these items, ratings of a 4 (*never*) were recoded as *no*, and scores of 1 (*always*), 2 (*sometimes*), and 3 (*occasionally*) were categorized as *yes*. The percentage of the score obtained in each cell was calculated as follows : raw score/maximum possible score×100, where the maximum possible score was 4 (in the item) or the number of items ×4 (in the factor). The score for each item ranged from 1 to 4.

SESS [Self-efficacy for brushing of the teeth (SE-B) and self-efficacy for dentist consultations (SE-DC)][21]. The SESS, a task-specific self-efficacy scale for self-care for patients with periodontal disease, was developed by Kakudate et al[15]. and has been found to have high reliability and validity[15]. It comprises 3 subscales : (a) self-efficacy for dentist consultations (SE-DC ; 5 items)[15, 21], (b) self-efficacy for brushing of the teeth (SE-B ; 5 items)[15, 21, 22], and (c) self-efficacy for dietary habits (SE-DH ; 5 items)[15, 21]. To assess self-efficacy of oral health behavior, SE-B scores based on a scale of self-efficacy for brushing of the teeth were used in other studies[21-23] and SE-DC were used. These studies measured self-efficacy on a Likert scale ranging from 1 (I cannot do it in any way) to 5 (I can do it without fail) (range of total score : 10-50). A higher score indicates that the patient has high self-efficacy. Regarding SESS[15], as the original manuscript was written in Japanese, English expressions were adapted from the same first author's article[21].

OESS[14]. The OESS, also developed by Kakudate et al., is used to determine "the beliefs that carrying out a specific behavior will lead to a desired outcome"[14] in patients with periodontal disease. It comprises 3 factors : (a) social outcome expectancy (OE-social ; 5 items) ; (b) oral outcome expectancy (OE-oral ; 4 items) ; and (c) self-evaluative outcome expectancy (OE-self ; 4 items)[14]. It measures outcome expectancy on a Likert scale from 1 (completely disagree) to 5 (completely agree) (the sum of the scores ranges from 13-65). A higher score indicates that the patient has high outcome expectancy.

Regarding SESS and OESS, the percentage of the score obtained in each cell was calculated as follows : raw score/maximum possible score×100, where the maximum possible score was the number of items ×5.

The authors received permission to use the SESS and OESS scales from the developer via e-mail.

STATISTICAL ANALYSIS

Descriptive statistics were performed with participants' demographic characteristics. After applying the Shapiro-Wilk test, the parametric variables were presented as means and standard deviation (SD) and nonparametric variables were presented as medians (interquartile range [IQR]). Spearman's rank correlation coefficient was used to assess the relationships among the scores of the 4 factors of the M-DiOHAT©, SESS

(SE-B, SE-DC), and OESS (OE-Social, OE-Oral, and OE-Self); sub-factors in the M-DiOHAT©; 2 factors of SESS; and 3 factors of OESS. Mann-Whitney U test or Fisher's exact test was used to compare the demographic or clinical characteristics with regard to the scores of the M-DiOHAT©, SESS, or OESS. Furthermore, characteristics (age [under 65 years or over 65 years] and the expected number of present teeth by age and sex group was compared with the data from the 2016 Survey of Dental Diseases conducted by Japanese Ministry of Health, Labour and Welfare [yes or no], and dental checkup in the last month [yes or no]) were compared with the score of sub-factors of M-DiOHAT©. The reference book[24] showed the necessary sample size (n = 29) when the correlation coefficient (r) = 0.50. IBM SPSS version 23.0 was used for the statistical analyses. Statistical significance was set as $P < 0.05$.

ETHICAL CONSIDERATIONS

This study was conducted with the approval of the Clinical Research Ethics Committee of the Tokushima University Hospital (approval no. 2982). In acquiring consent to participate in this research, the authors explained the contents of the research using prepared documents. Participants fully understood the study contents and voluntarily provided verbal and written consent to participate in this research. Participants were informed that they could withdraw their consent at any point during the study, and that their personal data would be kept strictly confidential.

RESULTS

Participant Characteristics

Clinical characteristics of the patients and their oral condition are shown in Table 1. Patients' mean (SD) age was 59.5 (10.5) years; their clinical diagnoses (diabetes type) included type 1 diabetes (n = 7), type 2 diabetes (n = 18), and others (n = 3); those with median HbA1c comprised 6.9% (IQR 6.6-8.6). Thirteen (46%) patients had periodontal disease, and 15 (54%) underwent a dental checkup in the past month. However, only 8 (29%) had attended the hospital's diabetes class on periodontal disease. The median score of M-DiOHAT© was 44.0 (IQR 35.0-49.8), as shown in Table 2. Table 3 shows that there were significant differences between age and bleeding during toothbrushing (subcategory-*oral health conditions* of M-DiOHAT©) ($P = 0.024$); between age and symptoms of gingival swelling (subcategory-*oral health conditions* of M-DiOHAT©) ($P = 0.024$). There were significant differences between number of teeth and being given dentists' instructions for brushing ($P = 0.044$). Significant differences were also found between dental checkup in the last month and awareness of halitosis (subcategory-*oral health conditions* of M-DiOHAT©) ($P = 0.016$), and between dental checkup in the last month and regular dental checkup (subcategory-*oral hygiene behaviors* of M-DiOHAT©) ($P = 0.001$). As Table 4 shows, patients aged under 65 years had a significantly fewer "expected number of present teeth" ($P = 0.001$), lower SE-B scores ($P = 0.027$), and lower *oral health conditions* scores ($P = 0.010$) than patients aged over 65 years. Patients having the expected number of present teeth had significantly higher scores (indicating good conditions) for the subcategory of *oral health conditions* of M-DiOHAT© ($P = 0.040$) than patients who did not have the expected number of present teeth. Furthermore, the patients who had a dental checkup in the last month in which the study was conducted had significantly higher scores of OE-Oral ($P = 0.049$) and of *oral hygiene behaviors* in M-DiOHAT© ($P = 0.004$) than the patients who did not, as indicated in Table 5.

M-DiOHAT©, SE-B, SE-DC, and OESS Scores

M-DiOHAT©. As shown in Table 2, the following items' median scores were low, and the response rates indicating "No" were high: checking where the toothbrush touched the gingival border with a mirror when the patients brushed their teeth; showing personal health record of medicines to the dentist; showing personal health record of diabetes to the dentist; and notifying their primary nurse about their dental condition. Regarding the reliability of the M-DiOHAT© (participants were patients with diabetes), Cronbach's alpha was 0.729 in this study. Cronbach's alphas for subcategories

Table 1. Patients' clinical characteristics and oral conditionsn (n = 28)

	Mean	SD	Min	Max
Age (yr)	59.5	10.5	42	81
Age at diagnosis (yr)	42.1	14.6	11	67
	Median	IQR[1)]	Min	Max
Duration of diabetes mellitus (yr)	12.5	(10.0－25.5)	1	45
HbA1c level (%)	6.9	(6.6 － 8.6)	5.8	13.0
Number of present teeth	23.0	(15.8－26.8)	0	28
				n(%)
Patients	Outpatients / inpatients			24(86%)/4(14%)
Sex	Male/female			13(46%)/15(54%)
Clinical diagnosis	Type1 diabetes mellitus(T1DM)			7(25%)
	Type2 diabetes mellitus(T2DM)			18(64%)
	Other			3(11%)
Therapy	Oral hypoglycemic agent alone			6(21%)
	Injection alone			6(21%)
	Combination therapy			16(57%)
Complications	Diabetic neuropathy			9(32%)
	Diabetic retinopathy			16(57%)
	Diabetic nephropathy			12(43%)
	Angina pectoris, myocardial infarction			6(21%)
	Cerebral (brain) infarction			3(11%)
	Diabetic foot ulcers			3(11%)
	Periodontitis			13(46%)
	Hypertension			16(57%)
	Dyslipidemia			10(36%)
Having the expected number of present teeth based on sex and age group[2)]	Yes			12(43%)
Denture	Yes			13(46%)
Dental checkup in the last month	Yes			15(54%)
Attending diabetes classes about periodontal disease in the hospital	Yes			8(29%)

1) IQR : Interquartile range
2) The number of present teeth by age and sex group was compared with the data from the 2016 Survey of Dental Diseases, conducted by Japanese Ministry of Health, Labor and Welfare.

of *oral health conditions*, *oral hygiene behaviors* (6 items), *perception and knowledge*, and *health record sharing* were 0.514, 0.727, 0.586, and 0.758, respectively. Regarding the correlation between factors in the M-DiOHAT©, there was significant correlation between *oral hygiene behaviors* and *perceptions and knowledge* ($r_s = 0.499$), as shown in Table 6.

SE-B, SE-DC in SESS. The median score of SE-B was 19.0 (IQR 14.0-22.0) and that of SE-DC was 19.0 (IQR 9.0-25.0), as shown in Table 2. Regarding SE-B, about 4-14% and 7-25% of patients chose 1 (I cannot do it in any way) or 2 (I cannot do it much) on the Likert scale, respectively. Regarding SE-DC, about 21-32% and 4-11% of patients chose 1 and 2 on the Likert scale, respectively. The score for the item "I have regular checkups even when my mind is not relaxed[21)]" was the highest (32% of patients chose 1, 7% of patients chose 2).

OESS. The median scores of OE-Oral, OE-Self, and OE-Social were 15.5 (IQR 12.0-18.0), 15.5 (IQR 13.0-18.8), and 18.5 (IQR 15.0-21.8), respectively in Table 2. Regarding OE-Oral, about 4-14% of patients chose 1 (completely disagree) or 2 (disagree). Regarding the item "(when I perform good oral self-care,) I can talk more confidently with people[14)]" in OE-Self, 86% chose 5 (completely agree) or 4 (agree). None of the patients chose 1 (completely disagree) with the item. Regarding the item "(when I perform good oral self-care,) I am complimented by my dentist or hygienist[14)]" in OE-Social, about 43% of patients chose 1 (completely disagree) or 2 (disagree). However, none of the patients disagreed with the item "(when I perform good oral self-care,) I feel better talking to people[14)]."

Table 2. Scores on the M-DiOHAT©, SESS, and OESS

		n	Median (%) [1)or2)]	IQR [3)] (%) [1)or2)]
M-DiOHAT© [4)]			44.0(65)	35.0(51)－49.8(73)
Factor 1 : Oral health conditions (5 items)		28	14.5(73)	12.3(61)－17.0(85)
(1)Bleeding during toothbrushing		28	4.0(100)	2.3(56)－ 4.0(100)
(2)Symptoms of gingival swelling		28	4.0(100)	3.0(75)－ 4.0(100)
(3)Awareness of halitosis		28	3.0(75)	2.0(50)－ 4.0(100)
(4)Having difficulties (troubles) related to the teeth		28	2.0(50)	1.0(25)－ 4.0(100)
(5)Biting firmly on molar or dentures		28	4.0(100)	2.3(56)－ 4.0(100)
Factor 2 : Oral hygiene behaviors (6 items)		28	15.0(63)	11.0(46)－18.8(78)
(1)Checking where the toothbrush touched the gingival border using a mirror, when the patients brush their teeth		28	1.0(25)	1.0(25)－ 2.0(50)
(2)Toothbrushing around the border of teeth and gingiva		28	3.0(75)	2.0(50)－ 4.0(100)
(3)Toothbrushing carefully one tooth at a time		28	2.0(50)	2.0(50)－ 4.0(100)
(4)Use of supplementary tools (e.g., interdental brush, dental floss)		28	2.0(50)	1.0(25)－ 3.0(75)
(5)Being given dentists' instructions for brushing		28	2.0(50)	1.0(25)－ 4.0(100)
(6)Regular dental checkup		28	3.0(75)	1.3(31)－ 4.0(100)
Factor 3 : Perceptions and knowledge (2 items)		28	7.0(88)	5.0(63)－ 8.0(100)
(1)Perceptions of oral care efficacy regardless of the timing of care initiation		28	4.0(100)	2.0(50)－ 4.0(100)
(2)Knowledge of the relationship between periodontal disease and diabetes		28	4.0(100)	3.0(75)－ 4.0(100)
Factor 4 : Health record sharing (4 items)		28	7.0(44)	4.0(25)－10.8(67)
(1)Showing personal health record of diabetes to the dentist		28	1.0(25)	1.0(25)－ 3.8(94)
(2)Showing personal health record of medicines to the dentist		28	1.0(25)	1.0(25)－ 2.0(50)
(3)Notifying their primary doctor about their dental condition		28	3.0(75)	1.0(25)－ 4.0(100)
(4)Notifying their primary nurse about their dental condition		28	1.0(25)	1.0(25)－ 1.0(25)
SESS [5)]	Self-efficacy for brushing of the teeth (SE-B) : 5 items	27	19.0(76)	14.0(56)－22.0(88)
	Self-efficacy for dentist consultations (SE-DC) : 5 items	27	19.0(76)	9.0(36)－25.0(100)
OESS [6)]	Oral outcome expectancy (OE-Oral) : 4 items	28	15.5(78)	12.0(60)－18.0(90)
	Self-evaluative outcome expectancy (OE-Self) : 4items	28	15.5(78)	13.0(65)－18.8(94)
	Social outcome expectancy (OE-Social) : 5 items	28	18.5(74)	15.0(60)－21.8(87)

1) Scores on the M-DiOHAT© : "The percentage of the score obtained in the each cell" was calculated as follows : raw score/maximum possible score × 100, where the maximum possible score was 4 (in the item) or the number of items × 4 (in the factor) ; The score for each item ranged from 1 to 4.

2) Scores on the SESS, and OESS "The percentage of the score obtained in the each cell" was calculated as follows : raw score/maximum possible score × 100, where the maximum possible score was the number of items × 5. The score for each item ranged from 1 to 5.

3) IQR : Interquartile range

4) M-DiOHAT© : Modified Diabetes Oral Health Assessment Tool© for Nurses

5) SESS : Self-Efficacy Scale for Self-Care among patients with periodontal disease

6) OESS : Outcome Expectancy Scale for Self-Care among patients with periodontal disease

Relationship Between M-DiOHAT© and SE-B, SE-DC, and OESS Scores

As shown in Table 6, the scores on *oral hygiene behaviors* in M-DiOHAT© were significantly correlated with the SE-B scores (r_s=0.673, P=0.001), SE-DC scores (r_s=0.584, P=0.001), OE-Oral scores (r_s=0.614, P=0.001), and OE-Self scores (r_s=0.406, P=0.032) ; however, *oral health conditions* and *health record sharing* showed no relationship with SE-B, SE-DC, and OESS scores. *Perceptions and knowledge* were correlated with SE-B (r_s=0.519, P=0.001). OE-Social in OESS showed no relationship with M-DiOHAT©. There were significant relationships between SE-B and SE-DC (r_s=0.515, P=0.006)/OE-Self (r_s=0.380, P=0.046) and between SE-DC and OE-Oral (r_s=0.434, P=0.024). There were also significant relationships between OE-Oral and OE-Self (r_s=0.461, P=0.014)/OE-Social (r_s=0.606, P=0.001), and OE-Self and OE-Social (r_s=0.769, P=0.0001).

DISCUSSION

This study found that 43% of patients had the expected number of present teeth and 68% had problems related to the teeth. The scores for *health record sharing* were low, and patients aged under 65 years had fewer "expected number of present teeth" and lower scores for SE-B and *oral health conditions* than patients aged over 65 years. It also found that the scores on *oral*

Table 3. Scores on the M-DiOHAT© and their association with age/having the expected number of teeth based on sex and age group/dental checkup in the last month (n = 28)

M-DiOHAT©[3]	n (%)	Age (yr)			Having the expected number of teeth[1]			Dental checkup in the last month		
		Under65 (yr)	Over65 (yr)	*P*-value[2]	No	Yes	*P*-value[2]	No	Yes	*P*-value[2]
Factor 1 : Oral health conditions (5 items)										
(1)Bleeding during toothbrushing	No[4] 15 (54%)	6	9	**0.024***	7	8	0.276	7	8	1.000
	Yes[5] 13 (46%)	11	2		9	4		6	7	
(2)Symptoms of gingival swelling	No[4] 15 (54%)	6	9	**0.024***	7	8	0.276	6	9	0.705
	Yes[5] 13 (46%)	11	2		9	4		7	6	
(3)Awareness of halitosis	No[4] 9 (32%)	3	6	0.095	4	5	0.432	1	8	**0.016***
	Yes[5] 19 (68%)	14	5		12	7		12	7	
(4)Having difficulties (troubles) related to the teeth	No[4] 9 (32%)	5	4	1.000	4	5	0.432	4	5	1.000
	Yes[5] 19 (68%)	12	7		12	7		9	10	
(5)Biting firmly on molar or dentures	No[6] 3 (11%)	2	1	1.000	2	1	1.000	1	2	1.000
	Yes[7] 25 (89%)	15	10		14	11		12	13	
Factor 2 : Oral hygiene behaviors (6 items)										
(1)Checking where the toothbrush touched the gingival border using a mirror, when the patients brush their teeth	No[6] 19 (68%)	11	8	1.000	10	9	0.687	10	9	0.435
	Yes[7] 9 (32%)	6	3		6	3		3	6	
(2)Toothbrushing around the border of teeth and gingiva	No[6] 4 (14%)	3	1	1.000	2	2	1.000	3	1	0.311
	Yes[7] 24 (86%)	14	10		14	10		10	14	
(3)Toothbrushing carefully one tooth at a time	No[6] 5 (18%)	4	1	0.619	3	2	1.000	1	4	0.333
	Yes[7] 23 (82%)	13	10		13	10		12	11	
(4)Use of supplementary tools (e.g., interdental brush, dental floss)	No[6] 11 (39%)	5	6	0.248	5	6	0.441	6	5	0.700
	Yes[7] 17 (61%)	12	5		11	6		7	10	
(5)Being given dentists' instructions for brushing	No[6] 8 (29%)	4	4	0.671	2	6	**0.044***	6	2	0.096
	Yes[7] 20 (71%)	13	7		14	6		7	13	
(6)Regular dental checkup	No[6] 7 (25%)	4	3	1.000	3	4	0.418	7	0	**0.001***
	Yes[7] 21 (75%)	13	8		13	8		6	15	
Factor 3 : Perceptions and knowledge (2 items)										
(1)Perceptions of oral care efficacy regardless of the timing of care initiation	No[6] 6 (21%)	4	2	1.000	3	3	1.000	3	3	1.000
	Yes[7] 22 (79%)	13	9		13	9		10	12	
(2)Knowledge of the relationship between periodontal disease and diabetes	No[6] 2 (7%)	1	1	1.000	1	1	1.000	1	1	1.000
	Yes[7] 26 (93%)	16	10		15	11		12	14	
Factor 4 : Health record sharing (4 items)										
(1)Showing personal health record of diabetes to the dentist	No[6] 20 (71%)	11	9	0.419	11	9	1.000	9	11	1.000
	Yes[7] 8 (29%)	6	2		5	3		4	4	
(2)Showing personal health record of medicines to the dentist	No[6] 20 (71%)	11	9	0.419	10	10	0.401	11	9	0.221
	Yes[7] 8 (29%)	6	2		6	2		2	6	
(3)Notifying their primary doctor about their dental condition	No[6] 9 (32%)	3	6	0.095	3	6	0.114	7	2	**0.042***
	Yes[7] 19 (68%)	14	5		13	6		6	13	
(4)Notifying their primary nurse about their dental condition	No[6] 22 (79%)	12	10	0.355	12	10	0.673	10	12	1.000
	Yes[7] 6 (21%)	5	1		4	2		3	3	

1) Having the expected number of teeth based on sex and age group was compared with the data from the 2016 Survey of Dental Diseases, conducted by the Japanese Ministry of Health, Labor and Welfare.
2) Fisher's exact test (two-tailed), $^{**}P < 0.01$, $^{*}P < 0.05$
3) M-DiOHAT© : Modified Diabetes Oral Health Assessment Tool© for Nurses
4) No : value for each response "score 4" = never
5) Yes : value for each response "score 1" = always, "score 2" = sometimes, "score 3" = occasionally
6) No : value for each response "score 1" = never
7) Yes : value for each response "score 2" = occasionally, "score 3" = sometimes, "score 4" = always

hygiene behavior in the M-DiOHAT© were significantly correlated with the scores on the SE-B, SE-DC, OE-Oral, and OE-Self. However, the *oral health conditions* showed no correlation with SE-B, SE-DC, and OESS.

M-DiOHAT©

Regarding factor 1 (*oral health conditions*), symptoms of gingival bleeding, swelling, and halitosis were signs of periodontal disease. Referring to the data from the 2016 Survey of Dental Diseases[17], less than 20% of the people aged 40-80 years had "sore, swollen, and bleeding gums". Compared to this data, the oral health conditions of the patients in this study (bleeding during toothbrushing [yes = 46%], and symptom of gingival swelling [yes = 46%]) were not good.

Table 4. The relationships among age and having the expected number of teeth/dental checkup in the last month/score of SESS/OESS/M-DiOHAT©

		Age(yr)			Having the expected number of teeth[1]		
		Under 65(yr)	Over 65(yr)	*P*-value[2]	No	Yes	*P*-value[2]
Having the expected number of present teeth[1]	No	14 (82.4%)	2 (18.2%)	0.001**			
	Yes	3 (17.6%)	9 (81.8%)				
Dental checkup in the last month	No	9 (52.9%)	4 (36.4%)	0.460	7 (43.8%)	6 (50.0%)	
	Yes	8 (47.1%)	7 (63.6%)		9 (56.3%)	6 (50.0%)	
		Median(IQR[3])	Median(IQR[3])	*P*-value[4]	Median(IQR[3])	Median(IQR[3])	*P*-value[4]
SESS[5] Self-efficacy for brushing of the teeth(SE-B) : 5 items		17.0 (12.0−20.5)	22.0 (18.0−24.0)	0.027*	16.0 (11.5−20.8)	20.5 (18.0−23.0)	0.107
Self- efficacy for dentist consultations(SE-DC) : 5 items		18.0 (9.0−23.0)	24.0 (8.0−25.0)	0.228	18.0 (9.0−25.0)	23.0 (8.0−25.0)	0.776
OESS[6] Oral outcome expectancy(OE-Oral) : 4 items		15.0 (12.0−18.0)	16.0 (12.0−20.0)	0.861	16.0 (13.5−18.8)	13.5 (11.3−17.5)	0.387
Self-evaluative outcome expectancy(OE-Self) : 4 items		15.0 (12.0−18.0)	17.0 (14.0−20.0)	0.073	15.5 (12.3−18.0)	15.5 (13.3−19.8)	0.705
Social outcome expectancy(OE-Social) : 5 items		18.0 (14.5−21.5)	21.0 (15.0−22.0)	0.477	18.5 (14.8−21.8)	18.0 (15.0−21.8)	0.827
Total scale(13 items)		46.0 (40.0−56.0)	50.0 (39.0−60.0)	0.451	52.0 (40.3−57.8)	44.0 (39.0−56.5)	0.529
M-DIOHAT©[7] Oral health conditions(5 items)		13.0 (11.0−16.0)	16.0 (14.0−20.0)	0.010*	13.0 (11.0−15.8)	16.0 (14.0−18.0)	0.040*
Oral hygiene behaviors(6 items)		14.0 (11.0−18.0)	16.0 (10.0−19.0)	0.702	15.0 (11.5−18.8)	14.0 (8.5−18.8)	0.470
Perceptions and knowledge(2 items)		7.0 (4.5− 8.0)	7.0 (5.0− 8.0)	0.800	7.5 (4.5− 8.0)	5.5 (5.0− 8.0)	0.404
Health record sharing(4 items)		7.0 (5.5−12.0)	4.0 (4.0−10.0)	0.079	7.0 (5.0−12.5)	6.0 (4.0− 9.5)	0.333
Total(17 items)		41.0 (36.0−49.5)	46.0 (34.0−53.0)	0.635	46.5 (38.3−49.8)	42.0 (33.3−51.8)	0.723

1) Having the expected number of present teeth were compared by the number of present teeth by age and sex group was compared with the data from the 2016, Survey of Dental Diseases, conducted by Japanese Ministry of Health, Labor and Welfare
2) Fisher's exact test(two-tailed), $^*P < 0.05$
3) IQR : Interquartile range
4) Mann-Whitney U test, $^*P < 0.05$
5) SESS : Self-Efficacy Scale for Self-Care(SESS)among patients with periodontal disease
6) OESS : Outcome Expectancy Scale for Self-Care among patients with periodontal disease
7) M-DiOHAT© : Modified Diabetes Oral Health Assessment Tool© for Nurses

Table 5. The relationships between dental checkup in the last month and SESS/OESS/M-DiOHAT©

		Dental checkup in the last month		
		No	Yes	
		Median(IQR[1])	Median(IQR[1])	*P*-value[2]
SESS[3]	SE-B(5 items)	17.0(14.0−19.5)	21.0(13.0−23.0)	0.195
	SE-DC(5 items)	18.0(8.3−23.0)	23.0(9.0−25.0)	0.346
OESS[4]	OE-Oral(4 items)	14.0(10.0−16.0)	16.0(12.0−20.0)	0.049*
	OE-Self(4 items)	15.0(12.5−18.5)	16.0(13.0−19.0)	0.901
	OE-Social(5 items)	19.0(15.5−21.5)	18.0(13.0−22.0)	0.741
	Total scale(13 items)	46.0(40.0−56.0)	50.0(39.0−60.0)	0.532
M-DIOHAT©[5]	Oral health conditions(5 items)	14.0(12.5−16.0)	15.0(11.0−18.0)	0.592
	Oral hygiene behaviors(6 items)	11.0(9.5−14.0)	18.0(15.0−20.0)	0.004*
	Perceptions and knowledge(2 items)	6.0(4.5− 8.0)	7.0(5.0− 8.0)	0.498
	Health record sharing(4 items)	5.0(4.0− 9.0)	7.0(5.0−13.0)	0.166
	Total(17 items)	39.0(33.5−42.0)	49.0(45.0−51.0)	0.020*

1) IQR : Interquartile range
2) Mann-Whitney U test, $^*P < 0.05$
3) SESS : Self-Efficacy Scale for Self-Care among patients with periodontal disease
4) OESS : Outcome Expectancy Scale for Self-Care among patients with periodontal disease
5) M-DiOHAT© : Modified Diabetes Oral Health Assessment Tool© for Nurses

Oral health conditions did not correlate with SE-B, SE-DC, and OESS scores in this study. There are some possible reasons.

First, oral health conditions are caused by many factors. In this study, 68% of patients had difficulties (troubles) related to their teeth. With respect to dental problems, many patients were likely to have caries and periodontal disease. Caries are caused by complex factors (individual factors, bacterial flora, lifestyle, diet, and so on[25]. Periodontal disease is caused by lack of balance between microbial infection and host immune response[26]. Therefore, it seems that oral health conditions are influenced by complex factors and not simply related to self-efficacy.

Table 6. The relationships among M-DIOHAT©, SESS and OESS, and among sub-factors in the M-DiOHAT©/SESS/OESS

		M-DiOHAT©[1]				SESS[2]			OESS[3]			
		Oral health conditions (5 items)	Oral hygiene behaviors (6 items)	Perceptions and knowledge (2 items)	Health record sharing (4 items)	Total (17 items)	SE-B (5 items)	SE-DC (5 items)	OE-Oral (4 items)	OE-Self (4 items)	OE-Social (5 items)	Total scale (13 items)
SESS[2]	Self-efficacy for brushing of the teeth (SE-B) (5 items)	0. 341	**0. 673****	**0. 519****	0. 204	**0. 684****	1. 000					
	Self-efficacy for dentist consultations (SE-DC) (5 items)	0. 110	**0. 584****	0. 368	−0. 003	0. 373	**0. 515****	1. 000				
OESS[3]	Oral outcome expectancy (OE-Oral) (4 items)	0. 164	**0. 614****	0. 211	0. 227	**0. 534****	0. 301	**0. 434***	1. 000			
	Self-evaluative outcome expectancy (OE-Self) (4 items)	0. 160	**0. 406***	0. 367	0. 060	**0. 438***	**0. 380***	0. 366	**0. 461***	1. 000		
	Social outcome expectancy (OE-Social) (5 items)	0. 284	0. 310	0. 136	−0. 006	0. 318	0. 190	0. 245	**0. 606****	**0. 769****	1. 000	
	Total scale (13 items)	0. 209	**0. 509****	0. 253	0. 084	**0. 469***	0. 283	0. 379	**0. 848****	**0. 790****	**0. 894****	1. 000
M-DIOHAT©[1]	Oral health conditions (5 items)	1. 000										
	Oral hygiene behaviors (6 items)	0. 016	1. 000									
	Perceptions and knowledge (2 items)	0. 042	**0. 499****	1. 000								
	Health record sharing (4 items)	−0. 020	0. 265	0. 259	1. 000							
	Total (17 items)	0. 361	**0. 736****	**0. 578****	**0. 676****	1. 000						

Spearman's rank correlation coefficient (r_s) : $^{**}P < 0.01$, $^{*}P < 0.05$

1) M-DiOHAT© : Modified Diabetes Oral Health Assessment Tool© for Nurses

2) SESS : Self-Efficacy Scale for Self-Care among patients with periodontal disease

3) OESS : Outcome Expectancy Scale for Self-Care among patients with periodontal disease

Another reason for the lack of an association between oral health conditions and SE-B/SE-DC/OESS scores could have been that it seems difficult for patients who have poor oral health conditions to have oral self-efficacy and outcome expectancy. This is backed up by the fact that some patients had severe periodontal disease (although the dentists did not examine this, it was evident that there were numerous reports of few teeth or edentulous).

Such patients also require dental visits to treat their teeth or manage their dentures, such as to "get new dentures" or "learn how to use dentures". Additional professional dental treatment, such as removal of calculus, occlusal adjustment, or fixation of mobile teeth, may become necessary because oral health conditions may not improve by self-care alone. It was apparent that patients with severe periodontal disease required a different type of dental self-efficacy. Therefore, it is necessary to use different procedure of oral self-efficacy and outcome expectancy depending on the patient's oral health conditions. Although Kakudate et al[15]. did not investigate the association between the stage of periodontal disease and self-efficacy, it was noted that patients' self-efficacy may vary in cases of mild and severe periodontal disease. An assessment tool is needed for use with diverse patient populations in a short period of time. These are some of the future challenges in the field.

Furthermore, the Cronbach's alpha of factor 1 (*oral health conditions*) was 0. 51. However, since the Cronbach's alpha values exceeded 0. 50, an acceptable[27, 28], but low level of internal consistency was verified[27, 28]. It had been reported that low Cronbach's alpha value might be due to "a low number of questions, poor interrelatedness between items, or heterogeneous construct[29]". Generally, in dental science, these items are considered suitable for assessing periodontal conditions. This should be researched further in the future.

Regarding factor 2 (*oral hygiene behaviors*), 75% of patients in this study visited dentists regularly, and 54% had a dental checkup in the last month. According to data from the National Health and Nutrition Survey in Japan[1], less than 60% of the people visited dentists annually. It seems that having high SE-B, SE-DC, and OESS scores led to good oral hygiene behaviors. It was suggested that patients who scored high on oral hygiene behavior in M-DiOHAT© had the highest possibility of obtaining high scores on the SE-B, SE-DC, and OESS. It was found that participants who scored high on the SESS had a greater improvement of the plaque control record than those who scored low on the SESS[15]. This means that SESS can predict the brushing effect[15]. Thus, patients with high scores might have high efficacy beliefs and high outcome expectancies. In other words,

the M-DiOHAT© scale seems to provide a way to determine efficacy beliefs and outcome expectancies, in addition to briefly examining oral health conditions and oral hygiene behaviors.

However, on the M-DiOHAT© scale, most patients scored low on factor 4 (*health record sharing*), which might explain a lack of correlation with SE-B, SE-D, and OESS scores. Patient education on the importance of self-management—including sharing information with medical and dental professionals—should be promoted. Many patients with diabetes have (or will have) diabetes complications, which can affect their quality of life and longevity. Regarding the weak relationship between *oral hygiene behavior* in M-DiOHAT© and OE-Self, patients may not expect the following outcome : "(when patients perform good oral self-care) living an orderly life, becoming confident in oneself, having more pride in one's teeth, and talking more confidently with people[14]". There was no relationship between *oral hygiene behavior* in M-DiOHAT© and OE-Social. Similarly, patients may not expect the following social outcome : "(when patients perform good oral self-care,) being praised by one's dentist or dental hygienist, saving dental treatment expense, talking with people more willingly, becoming more confident when meeting people, and supporting the people who can live more healthy life[14]." Therefore, nurses should inform patients about the health and social benefits of oral health behavior.

Self-efficacy is one of the most important concepts in supporting patients with chronic illness. Many patients with diabetes face behavioral changes. Miller[30] reported that to assess patients and their family members' readiness to learn, their self-efficacy must be determined. Self-efficacy involves confidence in the ability to perform a behavior, and has a high positive influence on health-promoting behavior changes in people with chronic illness[30]. Therefore, self-efficacy is often used as an important predictor for patients with diabetes to be examined for behavioral changes or health promotion efforts[31, 32]. In a previous study, Kakudate et al.[14] found a significant relationship between SESS and OESS and reported their possible use to evaluate the oral health of patients with periodontal disease. This study found a similar correlation in patients with diabetes, suggesting that the M-DiOHAT© can be used effectively by nurses to promote patients' oral hygiene behaviors.

Factor 3 (*perceptions and knowledge*) included two items ; Cronbach's alpha was 0.586. This might be because there were only two items. It has been reported that questionnaires with fewer items have lower Cronbach's alpha values[29, 33]. It was also found that *perceptions and knowledge* were correlated with SE-B scores. Patients' efficacy in brushing might cause good "perceptions and knowledge". Conversely, good "perceptions and knowledge" might lead to "patients' efficacy of brushing." Most patients were found to have adequate knowledge about oral health. These results may affect the relationship between "oral health behavior in M-DiOHAT©" and SE-B, SE-DC, and OE-Oral scores. *Perceptions and knowledge* did not correlate with their SE-DC and OESS scores. It seems that patients visited dentists when they had poor oral health conditions or experienced problems, and the dentists said that these were worsened by diabetes. It might be important for patients that their knowledge is related to their behaviors. However, it is more important for dental or medical professionals to provide the patients with knowledge so that patients have hope of improving their oral health amid their illness (diabetes, periodontal disease), and because patients can intend to practice oral hygiene behaviors.

Patients with diabetes have many daily regimens, such as diet, exercise, self-monitoring blood glucose, taking medicine or insulin injection, washing feet. They may have diabetes complications requiring visits not only to their primary physician for diabetes treatment but also an ophthalmologist, circulation physician, or nephrologist. Although these patients might be too busy to physically visit multiple physician, many participants in this study reported that they visited a dentist during the previous month. Therefore, nurses should recognize and commend the patients for their efforts. It is also important to support patients to make the regimen more effective. While all patients may know that daily toothbrushing is an important oral health behavior, some patients may not be able to follow this suggestion.

Nurses should help these patients to brush their teeth by themselves and encourage them to visit a dentist regularly. It is the nurses' role to encourage patients not to give up on medical/dental professionals' treatment of their oral health conditions, as other physical conditions could worsen. In addition, nurses are required to be knowledgeable, educate patients about addressing dental problems, such as periodontal disease, dentures, and nurses are also required to share the information with dental professionals.

LIMITATIONS

The findings of this study may contribute to promoting improved oral health conditions and oral hygiene behaviors for patients with diabetes. However, this study has some limitations. First, the small sample size and the selection of patients from only one educational hospital, which has both medical and dental departments, limit the generalizability of the findings. Moreover, patients who consented to participate in this survey might have had higher-than-average interest in oral care and comparatively good oral health conditions. Thus, future studies with larger samples should be conducted in local general hospitals, which do not have a dental division, to clarify the relationships among the scores of the M-DiOHAT©, SESS, and OESS. Second, the cross-sectional design of this study precludes causal inference. A longitudinal intervention study is needed to confirm the effect of assessing and educating patients on oral health conditions and behaviors using the M-DiOHAT© on their self-efficacy beliefs and outcome expectancy.

CONCLUSION

The scores on *oral hygiene behaviors* in the M-DiOHAT© were significantly correlated with self-efficacy for brushing of the teeth, self-efficacy for dentist consultations, oral outcome expectancy, and self-evaluative outcome expectancy. The factor of "*oral hygiene behaviors*" could predict improvement in self-efficacy of oral health behavior in a short time. Therefore, supporting the promotion of these aspects may be effective for improving patients' oral hygiene behaviors. However, patients with poor oral health conditions may have difficulty achieving self-efficacy and outcome expectancies. It appears that patients with severe periodontal disease require a different type of dental self-efficacy. Therefore, it is necessary to use different types of oral self-efficacy and outcome expectancy depending on the patients' oral health conditions.

RECOMMENDATIONS FOR NURSING EDUCATION

It is necessary for nursing education to teach students to the importance of supporting patients' promotion of self-efficacy and outcome expectancy regarding oral care.

IMPLICATIONS FOR PRACTICE

The study's initial step was to investigate the diabetic clinic's tendencies for one month, and to determine the directions for future studies. One of the most important nursing research roles is providing evidence for clinical practice. The presentation of M-DiOHAT© has some offers. One of them is to grow nurses' interests in patients' oral care. Furthermore, the use of M-DiOHAT© will result in nurses' time reduction in acquiring patients' oral information. Finally, the results of this study demonstrate the one of the ways of nursing care to promote patients' oral health behaviors.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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