

ORIGINAL**Effectiveness of a Diabetes Oral Nursing Program Including a Modified Diabetes Oral Health Assessment Tool for Nurses (M-DiOHAT©) : A 12-Month Follow-Up Intervention Study**

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Abstract : Purpose : This study aimed to evaluate the effectiveness of a diabetes oral nursing intervention program for individuals with diabetes. **Methods :** Fifty-six participants with diabetes underwent a diabetes oral nursing intervention program. The program's effect was evaluated through questionnaires and small interviews. The modified diabetes oral health assessment tool (M-DiOHAT©) was used to assess and educate four factors ; oral conditions, behaviors, perceptions and knowledge about diabetes and periodontal disease, and health information-sharing, among participants at baseline, 3, 6, and 12 months later. Primary outcomes included changes in the M-DiOHAT© total scores. Secondary outcomes included scores on the motivation stage of changes in oral health behaviors' scales, dental visits, number of present teeth, hemoglobin A1c (HbA1c), and participants' comments. **Results :** The M-DiOHAT© total score and the motivation stage score significantly improved with the narrative comment of "being motivated to practice oral health behaviors" between the baseline and 12 months later. Eight participants visited the dentist, whereas no differences were observed in the number of present teeth or HbA1c. **Conclusions :** This program improved participants' M-DiOHAT© total score, motivation stage score, and dental visits. These results suggest the program improved oral health perceptions and behaviors among individuals with diabetes. *J. Med. Invest.* 69:86-96, February, 2022

Keywords : Diabetes, nursing intervention, oral health, behaviors, perceptions

INTRODUCTION

The International Diabetes Federation reported that 463 million people aged 20-70 years had diabetes worldwide in 2019 (1). Complications from diabetes severely impact individuals' bodies, mental health, and spirit, threatening both their quality of life and mortality. Therefore, self-management behaviors must be adopted to prevent the onset and exacerbation of complications. Oral functions are a foundational part of self-management behaviors and comprise chewing, swallowing, speech, articulation, and aesthetics to maintain facial appearance. Ensuring proper oral function can also lead to the adoption of self-management behaviors, such as diet therapy, being able to enjoy food, speaking without difficulty, and maintaining the appearance of one's mouth, which can help individuals with diabetes maintain their mental health, self-esteem, and social life. Therefore, practicing good oral behaviors can help improve self-management behaviors for diabetes.

Oral health behaviors (2, 3, 4) aimed at maintaining oral functions and preventing the onset and exacerbation of oral

diseases such as dental caries and periodontal disease. In particular, periodontal disease has been recognized as a complication of diabetes (5) and has a bidirectional relationship with it (6). It deteriorates oral function and negatively impacts individuals with diabetes, hence there is international consensus that individuals with diabetes must protect themselves against periodontal disease (7, 8, 9, 10).

Previous non-interventional studies regarding oral health behaviors on individuals with diabetes have primarily focused on perceptions of oral health (11), behaviors such as dental visits (12, 13, 14, 15) and oral hygiene behaviors (3, 14, 16), educational support (17), mental support (18), and oral conditions (3, 14, 19). To our knowledge, there have only been two previous interventional studies on oral health behaviors of individuals with diabetes, which included education, counseling, and dental examinations for 6 months (20) or 3 months (21). Prior studies on medical staff have focused on their perceptions of providing care to the individuals with diabetes (22), their perceptions of providing education to the individuals with diabetes (23, 24, 25, 26), patient education resources (25, 26), and time constraints (4, 26).

Based on previous studies, two major obstacles toward oral care support for individuals with diabetes caused by nurses were the lack of an educational system for nurses to implement care and insufficient educational materials for nurses to use in providing educational support.

There are also many reports of mental distress associated with the management or treatment of diabetes (27, 28). Hence, nurses need to be capable of recognizing factors that cause

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distress and supporting self-management and oral health behaviors of individuals with diabetes. Consequently, an ideal resolution would be the implementation of behaviors that are less stressful for individuals with diabetes and easier for nurses to administer and monitor.

Thus, an interdisciplinary team comprising medical and dental professionals developed the Diabetes Oral Health Assessment Tool© (DiOHAT©) to help nurses efficiently assess oral health conditions and behaviors (2). Revised for use in a clinical setting, the tool was renamed “the clinical version of DiOHAT©” (C-DiOHAT©) (3), and some items were associated with dental examinations (3). The C-DiOHAT© was modified for use as a questionnaire with a four-point Likert scale and was renamed the Modified DiOHAT© (M-DiOHAT©) (29). Finally, a diabetes oral nursing intervention program, including the M-DiOHAT©, was developed to educate individuals with diabetes about oral health behaviors and promote these behaviors with simple items from the M-DiOHAT© as educational materials.

This study aimed to evaluate the effectiveness of an oral nursing intervention program including the M-DiOHAT© on individuals with diabetes. To the best of the authors’ knowledge, no study of a year-long oral nursing intervention for individuals with diabetes has been conducted in Japan. The study hypotheses were as follows :

H1 : Individuals with diabetes who participate in the oral nursing intervention program including M-DiOHAT© will improve their total M-DiOHAT© scores between the baseline and 12 months post-baseline.

H2 : Individuals with diabetes who participate in the oral nursing intervention program including M-DiOHAT© will improve their scores on the motivation stage of changes in oral health behaviors’ scale, dental visits, number of present teeth, and hemoglobin A1c (HbA1c) between the baseline and 12 months post-baseline.

MATERIALS AND METHODS

Study design and setting

The present research was a mixed-methods design comprising a single-arm quantitative study with small qualitative findings. It was conducted between June 2018 and January 2020 at a Japanese hospital.

Sample and recruitment

Researchers recruited participants from a diabetes outpatient clinic at an education and research hospital, which is an advanced treatment hospital in western Japan. A nonprobability sampling method was used. Inclusion criteria for participant recruitment were : (a) age over 20 years, diagnosed with diabetes, and treated at the outpatient clinic ; and (b) agreement to participate. Exclusion criteria were : (a) having the possibility of changes in physical condition during the time of participating the study, as determined by their diabetes physicians ; (b) having difficulty in expressing their own intentions, making decisions about their own oral health activities, and carrying them out due to mental illness or dementia, as determined by their diabetes physicians ; (c) describing him/herself as being unable to brush his/her own teeth due to an impairment of the upper limbs or fingers ; and (d) describing being unable to read and sign the informed consent document owing to visual impairment. The physicians selected potential participants and introduced them to the researcher. Considering the cooperating hospital’s actual clinical situation, researchers accounted for dropouts when estimating the number of participants. They expected a final sample size of about 60, based on previous oral intervention studies involving a pre- and post-test design (20, 21, 30-32).

A toothbrush (TePe select compact soft™) and a mirror (at

baseline and first follow-up) and two toothbrushes (at second and third follow-ups) were provided as a reward for participation in the study.

The diabetes oral nursing intervention program

This study defined oral health behaviors as consisting of “oral hygiene behaviors” and “dental consultation and treatment behaviors.” Oral hygiene behaviors include keeping the oral cavity clean, observing oral conditions with a mirror, and having positive perceptions and knowledge of oral health behaviors (2, 3, 4). Dental consultation and treatment behaviors include visiting the dentist to maintain oral health and managing medical and dental information for clinic staff with physical or dental information to receive suitable treatment. (2, 3, 4).

The diabetes oral nursing intervention was defined as nursing support for individuals with diabetes to motivate them to manage oral health behaviors independently as diabetes self-management behaviors. Specifically, in this study, a simple question about items of M-DiOHAT© was asked. After that, those items were briefly explained. This simple education was repeated four times at baseline, 3, 6, and 12 months later.

The content of the data collected for the diabetes oral nursing intervention program included : (i) participants’ demographic data, including age, sex, number of present teeth, use of dentures, having the expected number of present teeth by sex and age groups, most recent dental visit, attendance at diabetes educational classes about periodontal disease at the hospital, habit of smoking, and clinical data such as diagnosis, age at diagnosis, duration of diabetes mellitus, complications, therapy, and HbA1c ; (ii) questions of the M-DiOHAT© questionnaire ; (iii) questions about motivation stage of changes in oral health behaviors ; and (iv) education about the M-DiOHAT©. The first author (YK), a nurse and researcher with over five years of clinical experience in the dental ward and hospital clinic and who has received brief clinical training from a dentist and a dental hygienist, conducted all the programs. The data were collected using a questionnaire via private individual face-to-face interviews in order to protect personal information.

(1) Questions of the M-DiOHAT© questionnaire and other items

The questionnaire included objective information about diabetes and oral conditions, subjective information derived from the M-DiOHAT© questionnaire, and the motivation stage of changes in oral health behaviors’ questionnaire. The M-DiOHAT© questionnaire used a four-point Likert scale for responses, with scores ranging from : 1 = “never,” 2 = “occasionally,” 3 = “sometimes,” to 4 = “always.” However, the following items in factor 1 were reverse-scored : “bleeding during toothbrushing,” “gingival swelling,” “awareness of halitosis,” and “having difficulties related to the teeth.” The total possible scores on the M-DiOHAT© questionnaire ranged from 17 to 68. Higher M-DiOHAT© scores indicated better oral health conditions, behaviors, and perceptions (29). By answering the questions, participants could reflect on their oral conditions, behaviors, and perceptions. At the end of each program session, participants were asked about changes in their motivation to improve oral health behaviors, using motivation stage of changes in oral health behaviors’ scale, items from the stages of change model developed by Prochaska *et al.* (33). This model is familiar to many Japanese people because it is often used in medical check-ups. Participants indicated their level of agreement using a five-point Likert scale with scores ranging from 0 = “I am not going to do this in the next six months” (precontemplation), 1 = “I am going to do this in the next six months” (contemplation), 2 = “I am going to do this in the next month” (preparation), 3 = “I have been doing this for less than six months” (action), and 4 = “I have been doing this for over six months” (maintenance). Higher scores indicated increased

motivation to improve oral health behaviors. The participants or researcher completed each questionnaire according to the participants' answers, medical records, or the "Diabetes Coordination Notebook" (34) with permission from the participants. Published by the Japan Association for Diabetes Education and Care (34), the notebook is a personal health record for individuals with diabetes, containing laboratory data (e.g., HbA1c levels) and diabetes complications (e.g., retinopathy or periodontal disease). Participants with diabetes were advised to show the notebook and share their health information with their physicians or dentists (2, 35). The researcher, a nurse, counted the number of present teeth and observed the presence of dentures using a penlight (bright LED model BF-325BP).

(2) Education about the M-DiOHAT©

The researcher used a leaflet to educate the participants about the M-DiOHAT©. In addition, regarding "Factor 1 : Oral health conditions" and "Factor 2 : Oral hygiene behaviors," photographs of the palatal/lingual/buccal sides of the teeth were presented. A toothbrush, a tuft brush, and an interdental brush were also presented, along with instructions on how to brush each side, emphasis on the fact that brushing should remove dental plaque from the mouth, and examples of good and bad techniques. Participants were then shown two dental education models that displayed the tooth and gum conditions of each stage of periodontal disease (Periodontal disease model, PE-PER010, Nisshin Dental Products Inc., Kyoto, Japan), compared to healthy conditions (Dental study model, P2D-001, Nisshin Dental Products Inc., Kyoto, Japan). The researcher further instructed that participants with diabetes must obtain the following relevant knowledge from their dentists or dental hygienists : how to brush their teeth effectively ; how to use a toothbrush, interdental brush, tuft brush, and dental floss (because oral conditions are different for each person) ; how to enjoy brushing (such as by finding a favorite toothbrush) ; and how to keep their oral organs clean. When participants took the initiative to discuss toothbrushing and teeth, the researcher listened to all their concerns.

Schedule for the program

The request for cooperation was initiated either before or after a consultation. The dates of the intervention were determined based on the participants' schedules, giving top priority to the patients' physical condition and their own convenience, within about one month before or after the target follow-up time. Figure 1 depicts the schedule.

The researcher worked in close cooperation with all clinical nurses and physicians in charge to prevent any unnecessary mental and physical stress for the participants.

Participants' opinions and impressions

The participants were also asked for their opinions and impressions regarding participation in this program at the second and third follow-ups. A researcher recorded these data.

Data analysis

Statistical analysis

Continuous variables were presented as medians and 25th and 75th percentiles because of their skewed distribution ; categorical variables were expressed as counts and proportions. The Friedman test was used to assess changes in M-DiOHAT© scores between the baseline and first, second, and third follow-ups. Significant changes were compared using the Wilcoxon signed-rank tests, and the Bonferroni correction was adapted to preserve the overall type I error levels of 0.05 ($p < 0.05/3$ was regarded as significant). Due to the small sample size, the Mann-Whitney U test (exact test) were used to compare the scores for "Factor 1 : Oral health conditions" between participants, among those who

had not visited the dentist in the past year at baseline, who had visited a dentist by their third follow-up and those who had not visited a dentist by their third follow-up. Higher scores indicated improved oral health conditions.

All the statistical tests were based on two-sided probabilities, and the level of significance was set at $p < 0.05$. All statistical analyses were performed using IBM SPSS version 25.

Qualitative data analysis

The researcher prepared notes on participants' answers at the end of the second and third follow-ups and elaborated the notes at program conclusion. In brief, these notes were converted into simple codes, comparatively analyzed, and categorized by semantic content. To elaborate, first the parts that focused on the thoughts and ideas associated with participation in this study were extracted. Those with similar content were collected, and the common semantic content was condensed to be expressed as a code. Further, subcategories were extracted by repeating the process of categorization, paying attention to the semantic content of the codes, and noting similarities and differences. Finally, the created subcategories were examined for appropriateness, and categories were generated while paying attention to the differences and similarities of the subcategories. Subsequently, comments provided by participants who belonged to the group that had not had a dental visit in the past year at baseline, were compared to the group that did and did not have a dental visit during the 12-month intervention period.

Ethical approval and consent

This study was conducted with the approval of the Clinical Research Ethics Committee of the University Hospital (Approval no. 2982-7) and according to the principles expressed in the Declaration of Helsinki. The participants were assured that their participation was voluntary, that they could withdraw their consent at any point without penalty, and that all data would be kept anonymous and strictly confidential. This study was also registered at the University Hospital Medical Information Network Center before commencing (UMIN test ID : UMIN000028981).

RESULTS

Participants' characteristics at baseline

Analyses included data from 56 participants, who answered all of the M-DiOHAT© questionnaire in the baseline were included in the study, with 19 being excluded due to aforementioned exclusion criteria, transferred, not visiting the hospital, or not having a single tooth (Figure 1). Forty-four (79%) participants had the expected number of teeth according to sex and age group (36), and 39 (70%) had visited the dentist in the last year (Table 1).

Comparison of M-DiOHAT©/motivation scores between the baseline and three follow-ups

Table 2 shows comparisons of M-DiOHAT©/motivation scores between the baseline and follow-ups. The total M-DiOHAT© scores at the third follow-up were significantly higher than the baseline scores ($p < 0.001$). No differences were evident in the total scores for "Factor 1 : Oral health conditions" at baseline and the first, second, and third follow-ups. The item "awareness of halitosis" demonstrated higher scores at the first and second follow-ups than at baseline ($p = 0.003$, $p = 0.004$, respectively). The Bonferroni correction was adapted to preserve the overall type I error levels of 0.05 ($p < 0.05/3$ was regarded as significant). In "Factor 2 : Oral hygiene behaviors," scores for the item "checking where the toothbrush touched (gingival border) with a mirror when brushing teeth" increased significantly during the second

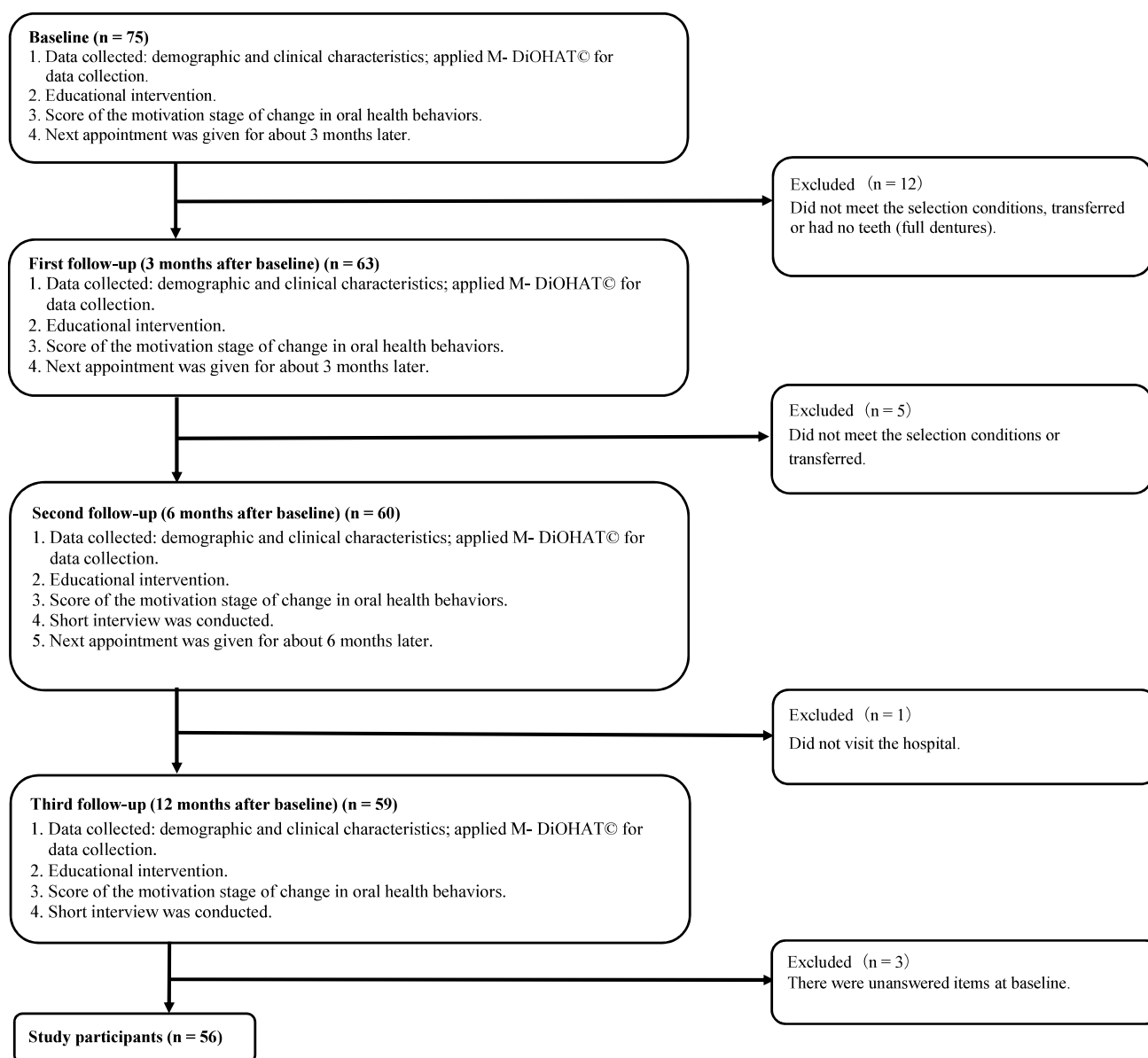


Figure 1. Flow chart showing the study procedure

and third follow-ups ($p = 0.002$, $p < 0.001$, respectively). Scores also increased significantly at the first, second, and third follow-ups for the items “toothbrushing around the border of teeth and gingiva” ($p = 0.003$, $p = 0.007$, $p = 0.006$, respectively), and “toothbrushing carefully tooth by tooth” ($p = 0.003$, $p < 0.001$, $p < 0.001$, respectively). In “Factor 3 : Perceptions and knowledge of oral health behaviors,” all items demonstrated higher scores at the first, second, and third follow-ups than at baseline. In “Factor 4 : Health record sharing,” scores for the item “showing Diabetes Coordination Notebook to the dentist” at the third follow-up were significantly higher than at baseline ($p = 0.001$).

Scores on the motivation stage of changes in oral health behaviors’ scale

First, second, and third follow-up scores were significantly higher than those at baseline ($p = 0.001$, $p < 0.001$, $p < 0.001$, respectively ; Table 2). There were 28 participants (50%) in the

“maintenance” stage (20) at the third follow-up (Table 3).

Number of teeth and HbA1c levels

These measurements did not differ between baseline and the three follow-ups (Table 2).

Dental visits

Eight participants who had not visited dentists in the year preceding the baseline did so following the intervention. Table 4 shows a comparison of participants who completed dentist visits and those who did not, among those who had not visited dentists in the year preceding the baseline. Only the items that were significantly different between these two groups are shown in Table 4. Participants who had not visited dentists reported more oral problems (halitosis, bleeding, and gingival swelling) than participants who had.

Table 1. Demographic and clinical characteristics of individuals with diabetes at baseline (n = 56)

	Median	IQR	Min	Max
Age (yr)	58	(43 - 73)	22	85
Age at diagnosis (yr)	41	(26 - 55)	4	72
Duration of diabetes mellitus (yr)	15	(7 - 21)	0	50
HbA1c level (%)	7.0	(6.4 - 7.4)	5.1	11.0
Number of present teeth	27	(22 - 28)	4	32
			n (%)	
Sex	Male/female		25 (45%) / 31 (55%)	
Clinical diagnosis	Type 1 diabetes mellitus (T1DM)		23 (41%)	
	Type 2 diabetes mellitus (T2DM)		29 (52%)	
	Other		3 (5%)	
Therapy	Diet alone		1 (2%)	
	Oral hypoglycemic agent alone		18 (32%)	
	Injection alone		26 (46%)	
	Combination therapy		11 (22%)	
Complications	Diabetic neuropathy		12 (21%)	
	Diabetic retinopathy		11 (20%)	
	Diabetic nephropathy		18 (32%)	
	Angina pectoris, myocardial infarction		11 (20%)	
	Cerebral (brain) infarction		3 (5%)	
	Diabetic foot ulcers		8 (14%)	
	Periodontitis		5 (9%)	
	Hypertension		26 (46%)	
	Dyslipidemia		24 (43%)	
	Having the expected number of present teeth by sex and age groups ¹⁾	Yes		44 (79%)
Denture(s)	Yes		9 (16%)	
Dental visit in the last year	Yes		39 (70%)	
Attending diabetes educational classes about periodontal disease at the hospital	Yes		12 (21%)	
Smoking	Yes		9 (16%)	

IQR : Interquartile range

1) "Having the expected number of present teeth by sex and age group" was compared with the "Mean number of teeth present by sex and age group" data from the 2016 Survey of Dental Diseases, conducted by the Japanese Ministry of Health, Labour and Welfare.

Table 3. Motivation stage of changes in oral health behaviors

	Baseline	1st follow-up	2nd follow-up	3rd follow-up
	n (%)	n (%)	n (%)	n (%)
The motivation stage of change of oral health behaviors				
I am not going to do this in the next six months (precontemplation)	2 (4)	0 (0)	0 (0)	2 (4)
I am going to do this in the next six months (contemplation)	21 (38)	13 (23)	11 (20)	7 (13)
I am going to do this in the next month (preparation)	15 (27)	11 (20)	10 (18)	9 (16)
I have been doing this for less than six months (action)	4 (7)	11 (20)	7 (13)	10 (18)
I have been doing this for over six months (maintenance)	14 (25)	21 (38)	27 (49)	28 (50)
Total	56 (100)	56 (100)	55 (100)	56 (100)

Table 2. Comparison of changes in the scores between the baseline and three follow-ups

	Baseline			1st follow-up (3 months after baseline)			2nd follow-up (6 months after baseline)			3rd follow-up (12 months after baseline)			p-value ¹⁾	Base-1st follow-up ²⁾	Base-2nd follow-up ³⁾	Base-3rd follow-up ⁴⁾	p-value ⁵⁾
	n	Median	IQR	n	Median	IQR	n	Median	IQR	n	Median	IQR					
<i>The total scores of M-DiOHAT© scale</i>																	
Factor 1: Oral health conditions	56	42.0	38.0-47.0	55	46.0	41.0-52.0	54	48.0	42.8-52.3	55	51.0	45.0-55.0	<0.001	<0.001	<0.001	<0.001	<0.001
Bleeding during toothbrushing	56	16.0	14.3-18.0	56	17.0	14.0-19.0	56	16.5	14.0-18.8	55	17.0	14.0-19.0	0.247				
Gingival swelling	56	3.0	2.0-4.0	56	4.0	2.0-4.0	56	4.0	2.0-4.0	56	4.0	2.0-4.0	0.239				
Awareness of halitosis	56	4.0	3.0-4.0	56	4.0	3.0-4.0	56	4.0	2.0-4.0	56	4.0	3.0-4.0	0.480				
Having difficulties related to the teeth	56	3.0	2.0-4.0	56	3.5	2.0-4.0	56	3.5	2.0-4.0	56	3.0	2.3-4.0	0.011	0.003	0.004	0.018	
Biting firmly on molar or dentures	56	3.0	1.3-4.0	56	4.0	2.0-4.0	56	4.0	2.0-4.0	55	4.0	3.0-4.0	0.463				
Biting firmly on molar or dentures	56	4.0	4.0-4.0	56	4.0	3.3-4.0	56	4.0	3.3-4.0	56	4.0	4.0-4.0	0.330				
<i>Factor 2: Oral hygiene behaviors</i>																	
Checking where the toothbrush touched (gingival border) with a mirror when brushing teeth	56	1.0	1.0-2.0	56	2.0	1.0-3.0	55	2.0	1.0-4.0	56	3.0	1.3-4.0	<0.001	0.050	0.002	<0.001	<0.001
Toothbrushing around the border of teeth and gingiva	56	4.0	3.0-4.0	56	4.0	4.0-4.0	56	4.0	4.0-4.0	56	4.0	3.3-4.0	0.001	0.003	0.007	0.006	
Toothbrushing carefully tooth by tooth	56	2.0	1.0-4.0	56	3.0	2.0-4.0	56	3.5	2.0-4.0	56	3.0	3.0-4.0	<0.001	0.003	<0.001	<0.001	
Use of supplementary tools (e.g., interdental brush, dental floss)	56	2.0	1.0-4.0	56	3.0	1.0-4.0	55	3.0	1.0-4.0	56	3.0	1.0-4.0	0.084				
Regular dental checkup	56	2.0	1.0-4.0	55	3.0	1.0-4.0	56	2.5	1.0-4.0	56	2.5	1.0-4.0	0.783				
Experience being given dentist's instructions for brushing	56	2.0	1.0-3.8	56	3.0	1.0-4.0	56	3.0	2.0-4.0	56	3.0	2.0-4.0	0.122				
<i>Factor 3: Perceptions and knowledge of oral health behaviors</i>																	
Perceptions of oral care efficacy regardless of the timing of care initiation	56	6.0	5.0-8.0	56	8.0	6.0-8.0	56	8.0	7.0-8.0	56	8.0	7.0-8.0	<0.001	0.001	<0.001	<0.001	<0.001
Knowledge of a relationship between periodontal disease and diabetes	56	3.0	2.0-4.0	56	4.0	3.0-4.0	56	4.0	3.3-4.0	56	4.0	3.3-4.0	<0.001	0.002	<0.001	0.018	
Knowledge of a relationship between periodontal disease and diabetes	56	3.0	2.0-4.0	56	4.0	3.0-4.0	56	4.0	4.0-4.0	56	4.0	4.0-4.0	<0.001	0.002	<0.001	<0.001	<0.001
<i>Factor 4: Health record sharing</i>																	
Showing Diabetes Coordination Notebook to the dentist	56	5.0	4.0-7.8	56	5.0	4.0-9.0	56	7.0	4.0-9.0	56	7.0	5.0-10.0	0.003	0.752	0.051	<0.001	<0.001
Showing personal health record of medications to the dentist	56	1.0	1.0-1.0	56	1.0	1.0-2.5	56	1.0	1.0-2.0	56	1.5	1.0-4.0	<0.001	0.142	0.026	0.001	
Telling their primary doctor about the dental condition	56	1.0	1.0-2.8	56	1.0	1.0-3.5	56	1.0	1.0-4.0	56	1.0	1.0-4.0	0.045	0.975	0.294	0.019	
Telling their primary nurse about the dental condition	56	1.0	1.0-2.8	56	1.0	1.0-2.8	56	1.0	1.0-3.8	56	2.0	1.0-4.0	0.013	0.919	0.223	0.013	
Telling their primary nurse about the dental condition	56	1.0	1.0-1.0	56	1.0	1.0-1.0	56	1.0	1.0-1.0	56	1.0	1.0-1.0	0.602				
Scores of motivation stage of changes in oral health behaviors scale																	
Number of present teeth	56	2.0	1.0-3.8	56	3.0	2.0-4.0	55	3.0	2.0-4.0	56	3.5	2.0-4.0	<0.001	0.001	<0.001	<0.001	<0.001
HbA1c (%)	56	28	22-28	56	28	22-28	56	27	22-28	56	27	22-28	0.208				
HbA1c (%)	56	7.0	6.4-7.4	56	7.1	6.4-7.5	56	7.1	6.4-7.7	56	7.0	6.6-7.8	0.164				

IQR : Interquartile range.

1) Friedman test was used (asymptotic significance probability).

2) Base-1st follow-up : Comparison between baseline and the first follow-up

3) Base-2nd follow-up : Comparison between baseline and the second follow-up

4) Base-3rd follow-up : Comparison between baseline and the third follow-up

5) Wilcoxon signed-rank tests were used to compare the scores between the baseline and the first, second, or third follow-up, and the Bonferroni correction was adapted to preserve the overall type I error levels of 0.05 (p < 0.05/3 was regarded as significant).

Participants' comments

Participants' comments were organized into six categories: "being motivated to practice oral health behaviors by participating in this study," "already knowing and performing oral health behaviors," "there are reasons why I don't want to

and can't visit the dentist," "having dental problems," "needing information to maintain good oral health," and "knowing the importance of the body" (Table 5).

Participants who had not visited dentists prior to the study but had done so during the study provided the following reasons for their behavior change: tooth pain, swelling, and need for

Table 4. Comparison of individuals who had visited a dentist by 3rd follow-up and those who had not among individuals who had not visited a dentist in a year at baseline

Time	Oral health conditions ²⁾	Dental visit			No (n = 9)			p -value ¹⁾
		Yes (n = 8)		No (n = 9)				
		Mediam	IQR		Mediam	IQR		
			25%	75%		25%	75%	
Baseline	Awareness of halitosis	4.0	3.0	4.0	2.0	1.5	2.5	0.011
2nd follow-up	Awareness of halitosis	4.0	4.0	4.0	2.0	1.5	3.0	0.001
3rd follow-up	Bleeding during toothbrushing	4.0	4.0	4.0	3.0	2.5	4.0	0.045
3rd follow-up	Gingival swelling	4.0	4.0	4.0	2.0	2.0	3.0	0.002
ΔHbA1c ³⁾		0.30	-0.53	0.58	0.30	-0.25	0.60	0.772

IQR : Interquartile range

Only the items that were significantly different between these two groups are shown.

1) Mann-Whitney U test (exact test) was used.

2) These are items from "Factor 1 : Oral health conditions" in the score of M-DiOHAT©. A higher score means better oral health conditions.

3) ΔHbA1c : (HbA1c at 3rd follow-up) - (HbA1c at baseline)

Table 5. Participants' comments on study participation

(n = 56)

Categories	Subcategories	Code
Being motivated to practice oral health behaviors by participating in this study	I increased motivation for oral health.	I learned.
		I was inspired.
	I started to do what I learned.	I visited a dentist.
		I became more conscious of brushing my teeth.
		I was glad I visited the dentist.
Already knowing and performing oral health behaviors	Already performing oral health behavior, already able to implement oral health behavior.	I'm already getting dental instructions regarding brushing my teeth.
		I'm already getting dental treatment regarding brushing my teeth.
		Careful brushing of teeth (brushing method, toothbrush, toothpaste, timing [time for brushing teeth] , time [duration of brushing teeth]).
		When I visited the dentist, I show the Diabetes Coordination Notebook to the dentist.
		I have diabetes, so I am careful with my teeth too.
	Already knowing oral health behavior.	I feel the connection between my oral organs and my body.
		I know the relationship between diabetes and periodontal disease.
There are reasons why I don't want to and can't visit the dentist.	I want to go to the dentist, but I can't.	I think about going to the dentist, but I can't. Factors like time, cost, timing, distance.
		I can't visit the dentist because of poor physical conditions.
	I can't think of visiting dentist, there are barriers to visiting dentist.	I felt like I was being frowned upon by the dentist because of my illness.
		I have bad dental memories, I have an aversion to dentists.
		Dental treatment is not expected to be effective.
Having dental problems	I have some difficulties regarding my teeth.	I can't chew food.
		I have a toothache.
		I have a difficulty speaking.
		I feel depressed because my dentures don't fit.
Needing information to maintain good oral health	I need better information regarding my teeth.	I need information.
		I want to be able to care for my teeth as soon as possible.
		I share good information with my friends and members of the patient group.
Knowing the importance of the body	I want to take care of my teeth.	I think teeth are important.
		I should have worked or paid attention to caring for my teeth sooner.
	I want to take care of my body.	I want to take care of my body.

prosthetic treatment due to removal of prosthesis materials. Their comments were “the dentist looked at my Diabetes Coordination Notebook carefully,” “after receiving guidance from my dentist, I became more conscious of brushing my teeth,” “I started visiting the dentist on a regular basis,” “the dentist shows me parts of my teeth that I am not able to brush myself,” and “the dentist worked on my teeth so that I would not feel any pain.” In contrast, those who still did not visit dentists commented “I don’t feel the need to go to the dentist,” “I thought of trying to do something, but I could not do it,” “I know that it is important for me to visit the dentist,” “I do not like going to the dentist because I hate dentists and I have bad experiences with them,” “I feel reluctant to be treated by a dentist because I have had some complications,” and “because physical treatment is a priority, and teeth are an afterthought.”

DISCUSSION

In the diabetes oral nursing intervention program including M-DiOHAT[©], simple oral health assessment and education was repeated at baseline, 3, 6, and 12 months later. It improved participants’ total M-DiOHAT[©] scores, oral health perceptions, and behaviors as measured by three factors from the M-DiOHAT[©], motivation stage of changes in oral health behaviors’ scores, and dental visits. These findings were also supported by participants’ qualitative comments, such as “being motivated to practice oral health behaviors by participating in this study,” and “having practiced oral health behaviors.” However, no differences were observed in the number of present teeth or HbA1c levels. The reason was that the participants’ diabetic conditions were well controlled by the diabetologists. There were no dental interventions in this study. Hence, we speculate that the nursing interventions on oral health behaviors and perceptions did not result in additional changes in the HbA1c levels.

M-DiOHAT[©] scores

Bleeding (37, 38), swelling (37, 38), and tooth movement are useful symptoms that may indicate periodontal disease. The reasons given for why no changes occurred in scores for “Factor 1 : Oral health conditions” were : most participants’ oral health conditions were good when the mean number of present teeth were compared by sex and age group (36), and it might be difficult to improve the symptoms of serious periodontal disease without dental treatment. This is consistent with participants’ narratives of “having dental problems.” Regarding “awareness of halitosis,” the main component of halitosis (39) was volatile sulfur compounds produced by anaerobic oral bacteria (40). This correlated with the bleeding index (41), probing depth (41), and plaque index (42). Improving oral health behaviors and cleanliness may be moderately related to removing plaque and improving awareness of halitosis. The behaviors of “checking where the toothbrush touched (gingival border) with a mirror when brushing teeth,” which enables confirmation of where the toothbrush is cleaning and may prevent periodontal disease ; “showing Diabetes Coordination Notebook to the dentist ;” and “experience in being given dentists’ instructions for brushing,” may not have been easy to practice, and may have taken time to be incorporated into daily schedules. Toothbrushing habits can be changed in small increments, and such small steps may help individuals become accustomed to the importance and practice of oral self-care. The scores for “Factor 3 : Perceptions and knowledge of oral health behaviors” were high, possibly due to enhanced knowledge and motivation, which notably increased from the first follow-up. These results confirm those of Ghaffari’s study (43). Since scores for “Factor 4 : Health record sharing” were low, consistent with a

previous study (3), awareness of sharing physical and dental care information remains important. This is supported by the qualitative data category of “need for information in order to maintain good oral health,” indicating that individuals need dental care information and assistance from professionals to maintain good health. Nurses are crucial in supporting good oral care and encouraging healthy behaviors (44) ; however, they should bear in mind the comprehensive diabetes treatment and consider the stress levels of individuals with diabetes (45, 46).

The motivation stage of changes in oral health behaviors’ scores

Although there are several studies on the stages of change in health behaviors (47, 48), as far as the authors know, no research has investigated stages of change in oral health behaviors. The number of participants in the “maintenance” stage increased in the third follow-up, suggesting that the intervention was effective (33, 49). Motivation was only assessed at the program’s conclusion ; however, moving forward, support for participants during the “precontemplation” (33) or “contemplation” (33) stages must also be developed to encourage them toward change adoption.

Dental visits

Participants with more oral problems probably did not visit the dentist because : (i) they disliked or feared dental visits ; or (ii) they were inconvenienced or financially constrained for dental visits because they have to regularly meet with their diabetologists, ophthalmologists, and other physicians ; or (iii) their physical conditions were not good. The health check-up rate in Japan was 71.4% in 2018 (50), whereas the dental examination rate was only 52.9% in 2016 (51). Dental visits by individuals over 44 years have decreased (52), even in the United States (53). Previous research has found that intensive oral-health-related behavior modification interventions improved oral health behaviors (54). The increased costs associated with dental visits, especially in individuals with diabetes, have led to these individuals neglecting or avoiding dental visits (55). Furthermore, reasons such as fear of pain during dental treatment, the possibility of worsening teeth conditions due to physical illness and the difficulty of treatment, and negative attitudes toward dental care providers were also considered to be obstacles to receiving dental care. Therefore, the results of this study are valuable because they offer insights for motivating individuals to visit dentists. Researchers also developed an educational leaflet in collaboration with a nurse and dentist. Collaborating with dental professionals (56) to promote higher standards for oral care is important, as many individuals need health information. Nurses should also acknowledge and appreciate the efforts of individuals with diabetes to visit dentists. Even if individuals with diabetes do not have dental problems, gingival recessions may still occur due to aging ; hence, they must understand the importance of regular dental visits. For this purpose, simple education was repeatedly provided in this program. Several participants stated that the program motivated them to practice oral health behaviors. Therefore, implementing such an approach might be effective in motivating those with diabetes to practice good oral health behaviors. Nurses can play a significant role in encouraging and supporting individuals to obtain better medical and dental care with the right information.

Implications for nursing practice

Oral cavity support for individuals with diabetes, particularly educational support, includes knowledge of : (i) symptoms, prevention, and treatment of periodontal disease, (ii) the relationship between periodontal disease and systemic diseases such as diabetes, and (iii) the necessity of managing physical and dental

information (3). Educating individuals about technical skills is also important. Furthermore, nurses must be aware that individuals can only visit the dentist when their commitments and finances allow. Therefore, nurses must observe oral health behaviors over time, estimate illness trajectories, and support and encourage changes in oral health behaviors.

Limitations of the study

This study has several limitations. First, a single-arm design without a control group was used, preventing between-subjects comparisons. Second, participants may have intrinsically developed a high interest in oral care or maintaining good oral conditions, which this study did not account for. Third, the total number of participants in the study was small. In particular, the number of participants with “periodontal disease” in their medical records written by the physicians or in their Diabetes Coordination Notebook were limited. The study participants were patients from the outpatient clinic of the hospital. In this study, the dentist did not diagnose periodontal disease. Therefore, the statistical power might not be enough. Fourth, the outcome indices were subjective, as they contained information from participants’ self-examinations, restricting objective comparisons. Fifth, the qualitative data were transcribed by the researcher without a recording device, as the researcher listened to participants talk about their teeth and dental experiences. This might have compromised the completeness and accuracy of qualitative data.

Recommendations for future research

The effects of educational interventions are important and need to be further examined through comparison with a control group. It might be important to create an oral health program based on the motivation stage to changes in oral health behavior, especially to support individuals in the stages of “precontemplation” (33) or “contemplation” (33), as well as individuals with serious levels of diabetes and periodontal disease. Research should also be conducted to investigate the roles of nurses in oral care, while considering changes in oral health behaviors and potential collaborations with dental professionals. Finally, future research should consider cooperation with clinical nurses to share evidence from clinical studies and discuss nursing education interventions to support oral health behaviors in individuals with diabetes. It is essential to modify the current program for easy implementation by nurses to aid larger cohorts of individuals with diabetes in performing oral health behaviors. It is also necessary to implement the study results (43, 57) as applications for nursing practice.

This form of care will be more widespread with advances in diabetes oral nursing care practice and research. For this purpose, researchers believe that the first step is to record the various interventions implemented by nurses. As the results of this study indicate that participants’ health perceptions and behaviors need to be incorporated into interventions, future research should aim to clarify the specific items to be included.

CONCLUSION

This study established that the diabetes oral nursing intervention program including simple and easy assessment and education by M-DiOHAT©, which was repeated at baseline and 3, 6, and 12 months later, effectively increased (i) the total M-DiOHAT© score, (ii) motivation stage of changes in oral health behaviors’ score, and (iii) the number of individuals who visited the dentist, with the narrative comment of “being motivated to practice oral health behaviors by participating in this study.” This suggests that the program improves oral health

behaviors and perceptions of individuals with diabetes.

CONFLICT OF INTERESTS

Authors declare that there is no conflict of interest for this study.

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