

Factors Associated with Oral Health Literacy among Patients with Type 2 Diabetes Mellitus Attending Hospital Universiti Sains Malaysia

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ABSTRACT

Objective: To determine the oral health literacy (OHL) level and its associated factors among patients with type 2 diabetes mellitus attending Hospital Universiti Sains Malaysia (USM). **Material and Methods:** This cross-sectional study involved 135 diabetic patients with a mean age of 62.6 years old (SD=9.05) who attended the Diabetes Outpatient Clinic at Hospital USM, a teaching hospital in the north-eastern corner of Peninsular Malaysia. The Malay version of the Oral Health Literacy Instrument (OHLI-M) was used to assess the level of OHL among respondents. An additional self-administered questionnaire was used to obtain other variables of interest. Systematic random sampling was applied in this study. The data were analyzed using an independent t-test and ANOVA to determine factors associated with oral health literacy among respondents. **Results:** Most respondents have at least one oral health problem (62.2%). The most common problem was cavitated tooth (42.2%). Other problems include toothache (17.8%), mobile tooth (17.8%), and swollen gums (16.3%). OHL level for most respondents (40.7%) was inadequate. The mean total OHLI-M score was 67.9 (SD=17.74). The OHL score was significantly lower in respondents with the following characteristics: female, no formal education or had primary education, unemployed, lower income group, never visited a dentist, and had swollen gums. **Conclusion:** The OHL of most patients with type 2 diabetes mellitus attending the Diabetes Outpatient Clinic, Hospital USM still need to be improved. Oral health problems were common in patients with type 2 diabetes mellitus in this study. This study also highlighted the link between OHL and socio-demographic factors. Improving the OHL of patients may increase their capability to obtain and understand oral health messages needed to take appropriate actions that will eventually prevent oral diseases associated with diabetes mellitus.

Keywords: Diabetes Mellitus; Oral Health; Health Literacy; Health Education.

Introduction

Oral health literacy (OHL) is defined as the degree to which individuals are able to obtain, process, and understand basic health information and services needed to make appropriate oral health decisions [1]. This definition denotes the acquisition of the ability to access information on medical or clinical issues, understand medical information, to interpret and evaluate medical information, make informed decisions on medical issues, and comply with medical advice [2]. In addition, the OHL level influences a patient's consent to treatment procedures and/or compliance to health behaviour recommendations [3]. Hence, OHL was identified as key to promoting oral health and preventing oral health diseases [4].

Studies have shown that poor OHL affects oral health, which can negatively influence the quality of life, and has a significant financial impact on society [3]. Low health literacy is associated with poor health knowledge, unhealthy behaviours, low usage of preventive services, poor health status, and adverse health outcomes [5]. A study by Lee et al. [6] among low-income female clients attending a nutritional program in North Carolina showed that respondents with higher OHL level were more likely to have excellent or very good oral health status than those with lower OHL level. OHL was associated with one's age, sex, educational level, occupation, and marital status [7]. Younger individuals tend to have higher OHL than older individuals, females tend to have higher OHL than males, and patients with low educational level, unemployed, and low-income were more likely to have low OHL [7,8].

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels [9]. Diabetes mellitus is becoming a burden in Malaysia and worldwide as the prevalence escalates. The 2019 National Health and Morbidity Survey (NHMS) in Malaysia showed a prevalence of 18.3% among adults, a 4% increase from 2015, with an estimation of 48.6% undiagnosed cases. Type 2 diabetes mellitus is the most common form of diabetes mellitus, accounting for more than 90% of all cases of adult-onset diabetes mellitus in Malaysia [10]. Worldwide, the prevalence of diabetes for all age groups was estimated at 2.8% in 2000 and 4.4% in 2030, in correspondence with the projected increase from 171 million in 2000 to 366 million in 2030 [11]. A study on diabetes in the Asia and the Pacific region in 2016 reported that more than 60% of patients with diabetes live in the Asia region, with the West Pacific region having more than 138.2 million diabetic patients, and the figure was expected to rise to 201.8 million by 2035 [12].

The relationship between diabetes mellitus and oral disease has been extensively studied. It is well-established that diabetes mellitus is associated with numerous oral complications. Diabetes has a bidirectional relationship with periodontal disease, and there is strong evidence that treating one condition can positively impact the other [13]. Individuals with diabetes have at least three times greater risk of periodontitis than those without diabetes [14]. On the other hand, studies have shown that patients with well-controlled diabetes have no increased risk of periodontitis than those without diabetes [14,15]. In patients with diabetes, the high plasma glucose level is associated with an increased level of glucose in gingival crevicular fluid, leading to an impaired wound-healing capacity of the periodontal tissues [16]. Besides periodontitis, dry mouth and caries have been reported to be frequent oral complications among diabetes patients [17].

Considering the important link between diabetes mellitus and oral diseases, particularly periodontal disease, patients with diabetes should comply with strict oral hygiene and oral health care to maintain good oral health status. However, the ability to decipher oral health information and act upon it depends very much

on the patient's OHL. Therefore, this study was conducted to assess perceived oral problems and OHL of patients with diabetes mellitus and factors associated with their level of OHL.

Material and Methods

Population and Sample

This cross-sectional study was conducted among patients with type 2 diabetes mellitus attending the Diabetes Outpatient Clinic, Hospital Universiti Sains Malaysia (USM). Diabetic patients who could read and write in Bahasa Malaysia and had no cognitive, vision, or hearing problems were eligible to participate. The sample size was calculated using the single proportion formula with a 95% confidence interval (CI) based on the objective to determine perceived oral problems among patients with diabetes mellitus. The expected proportion was estimated at 11.5%, which was the percentage of diabetic patients in India who reported having dental caries [18]. Sample sizes were calculated for various precision, and a sample size of 107 was chosen with a precision of 0.06 while taking into consideration available resources. Anticipating a 30% of non-response rate, a sample size of 139 was decided for this study. During the period of study, a total of 960 diabetic patients were estimated to attend the clinic. A systematic random sampling method with an interval of 7 was applied for the selection of study participants.

Research Tools

The Malay version of Oral Health Literacy Instrument (OHLI-M), adapted and validated by Ramlay et al. [19], was used to determine the level of OHL among respondents. The OHLI-M has two sections: the reading comprehension section and the numeracy section. The reading comprehension section evaluates the capability of an individual to read and understand the written content of passages on dental caries and periodontal disease. The first passage on dental caries has 13 sentences with 18 words omitted from the sentences, and the second passage on periodontal disease consisted of 14 sentences with 20 omitted words. This section was self-administered and the respondents were asked to choose one of four choices given to complete the sentences [19].

The numeracy section tests the capability of the respondents to understand and interpret numerical messages communicated on a series of printed prompts, including five prescriptions labelling medications commonly prescribed by dentists, one dental appointment card, and one post-extraction instructions. There were 19 items test for this section, and were administered through a structured face-to-face interview. The prompts were shown to the respondents and adequate time was given to the participants to read and understand these prompts. Then, the interviewer will ask questions regarding each item, and the answers given were recorded in a scoring sheet by the interviewer.

For both sections, a score of 1 was given to a correct answer, and a score of 0 was given to incorrect or no answers. In order to get a weighted score from 0 to 50 for each section, the sum of scores was calculated and multiplied by 1.316 (50/38) for the reading comprehension section, while for the numeracy section, the score was multiplied by 2.632 (50/19). The total score for OHLI-M, which may range from 0 to 100, was obtained by summing both weighted scores. A higher score corresponds to a higher OHL level. The OHLI-M score was also categorized into three levels of OHL, namely, inadequate (0-59), marginal (60-74), and adequate (75-100) [19].

Additionally, a structured questionnaire was used to obtain the following variables from the respondents: 1) current oral problems (toothache, cavitated tooth, sore gums, swollen gums, bleeding gums,

gum abscess, loose tooth, bad breath, oral ulcer), 2) perceived current oral health status either very poor, poor, fair, good, and very good, 3) diabetes profile including diseases duration, latest glycated hemoglobin (HbA1c) level to measure the average blood sugar for the past two to three months, medications taken, presence of hypertension and presence of dyslipidaemia, 4) duration since last dental visit, and 5) socio-demographic characteristics, namely age, sex, ethnic group, highest educational level, employment status, and monthly household income. All questions were self-administered except the diabetes profile, which was obtained from the medical record.

Data Collection

Eligible patients who agreed to participate were briefed on the study's importance, objectives, and procedures, and a written informed consent was obtained from each of them. The respondents were then asked to answer the reading comprehension section of the OHLI-M, followed by the administration of the numeracy section by the main author. Adequate time was given for the respondents to read the passages and the prompts, and no time limit was given for them to answer the questions. The questionnaires were collected immediately following completion.

Statistical Analysis

Data entry and analysis were carried out using IBM SPSS Statistics for Windows (version 24.0, IBM Corp., Armonk, NY, USA). Data checking and cleaning were performed prior to the analysis. Descriptive analysis was used to obtain the mean and standard deviation (SD) of the numerical variables, and the frequency and percentage (%) of the categorical variables. An independent t-test or ANOVA was used to determine the factors associated with OHL among the respondents. A Bonferroni post-hoc test was done following a significant finding using the ANOVA test. The significance level was set at 0.05.

Ethical Approval

This study was approved by the Human Research and Ethics Committee, Universiti Sains Malaysia (USM) on 30th April_2018 (USM/JEPeM/18010053).

Results

A total of 139 patients were invited to participate in this study, and 135 responded, resulting in a 97.1% response rate. The socio-demographic profile of the respondents is shown in Table 1. The age of the respondents ranged from 32 to 89 years old, with a mean age of 62.6 years old (SD=9.05). Most of the respondents were Malay (86.7%). More than one-third (40%) of the respondents attained at least a secondary educational level, and more than half (69.6%) were either unemployed or a pensioner. Nearly half of the respondents were diagnosed with diabetes mellitus for 10 years and above (48.9%), and more than two-thirds (78.5%) have uncontrolled diabetes mellitus (HbA1c \geq 7%). Most respondents also have hypertension (94.1%) and dyslipidemia (89.6%).

The descriptive statistic of OHLI-M is shown in Table 2. The mean OHLI-M score of the respondents was 67.9 (SD=17.74), with the minimum and maximum individual OHLI-M score of 25.6 and 96.2, respectively. The mean reading comprehension score was 34.6 (SD=7.67) with the minimum and maximum individual scores of 17.7 and 50.0, respectively, and mean numeracy score was 30.3 (SD=12.39) with the

minimum and maximum individual scores of 5.3 and 50.0, respectively. Most respondents had inadequate OHL (40.7%), followed by adequate (36.3%) and marginal OHL (23.0%).

Table 1. Socio-demographic data and diabetes profile.

Variables	N (%)
Age group	
≤40 years old	2 (1.5)
41 – 60 years old	50 (37.0)
>60 years old	83 (61.5)
Sex	
Male	56 (41.5)
Female	79 (58.5)
Ethnic group	
Malay	117 (86.7)
Chinese	17 (12.6)
Others	1 (0.7)
Highest educational level	
No formal education	13 (9.6)
Primary education	37 (27.4)
Secondary education	54 (40.0)
Tertiary education	31 (23.0)
Employment status	
Employed	41 (31.4)
Unemployed	50 (37.0)
Retired	44 (32.6)
Monthly household income	
<MYR1000	41 (30.4)
MYR1000-RM1999	42 (31.1)
MYR2000-RM4999	39 (28.9)
≥MYR5000	13 (9.6)
Diabetes duration	
<10 years	69 (51.1)
≥10 years	66 (48.9)
HbA1c level	
<7%	29 (21.5)
≥7%	106 (78.5)
Diabetes medications	
Oral hypoglycemic only	78 (57.8)
Oral hypoglycemic with insulin	6 (4.4)
Insulin only	51 (37.8)
Hypertension	
Yes	127 (94.1)
No	8 (5.9)
Dyslipidaemia	
Yes	121 (89.6)
No	14 (10.4)

Table 2. Level of oral health literacy.

OHLI Score	Level			Mean (SD)	Minimum Score	Maximum Score
	I N (%)	II N (%)	III N (%)			
Total	55 (40.7)	31 (23.0)	49 (36.3)	67.9 (17.74)	25.6	96.2
Reading Comprehension	-	-	-	34.6 (7.67)	17.7	50.0
Numeracy	-	-	-	30.3 (12.39)	5.3	50.0

Level I: Inadequate (<60); Level II: Marginal (60-74); Level III: Adequate (>74).

Results on self-reported oral health status, oral problems, and dental visit status among the respondents are shown in Table 3. Most respondents perceived their oral health status as good (69.6%) or very good (15.6%). More than half (62.2%) of the respondents reported having at least one oral problem. The most common problem was cavitated tooth (42.2%), followed by loose tooth (17.8%), toothache (17.8%), and swollen gums (16.3%). Most (68.2%) of the respondents were not wearing any denture. Most respondents (41.5%) were symptomatic attendees and visited dentists only when they had pain.

Table 3. Self-reported oral health problems and dental visit.

Variables	N (%)
Self-perceived oral health status	
Very good	21 (15.6)
Good	94 (69.6)
Moderate	20 (14.8)
Poor	0 (0.0)
Very poor	0 (0.0)
Presence of oral health problem	
No	51 (37.8)
Yes	84 (62.2)
Oral health problems (multiple answers are allowed)	
Toothache	24 (17.8)
Cavitated tooth	57 (42.2)
Sore gums	15 (11.1)
Swollen gums	22 (16.3)
Bleeding gums	17 (12.6)
Gum abscess	0 (0.0)
Loose tooth	24 (17.8)
Bad breath	3 (2.2)
Oral ulcer	5 (3.7)
Denture wearing	
No denture	92 (68.2)
Partial denture	23 (17.0)
Full denture	20 (14.8)
Last dental visit	
Last 12 months	27 (20.0)
Last 1 to 2 years	34 (25.2)
Only when in pain	56 (41.5)
Never been for dental visit	18 (13.3)

Table 4 and Table 5 show the results of a comparison of OHLI-M mean scores based on characteristics of the respondents. The OHL was found to be significantly associated with the respondents' sex, educational status, employment status, monthly household income, dental visit, and the presence of swollen gums.

Male respondents had a significantly higher mean OHLI-M score compared to female respondents. The mean of OHLI-M score was significantly higher in respondents with tertiary education than respondents with secondary educational level and no formal education or who had primary education. The mean of OHLI-M scores between respondents with secondary education and those without formal/primary education was not significantly different.

Retired respondents had significantly higher mean OHLI-M scores than unemployed respondents. However, no statistically significant difference was observed in mean OHLI-M score between the employed and the unemployed group, and between the employed and retiree group.

The mean OHLI-M score among respondents with household monthly income of MYR5000 and above was significantly higher compared to respondents with monthly income below MYR5000: MYR2000-RM4999, RM1000-RM1999 and below MYR1000. Other income group comparisons were not significant.

A statistically significant difference in OHLI-M score was observed between respondents who had their dental visit within the last 12 months and respondents who had never been to a dentist. The OHLI-M score was also significantly higher among respondents who visited the dentist within the past 1 to 2 years than respondents who had never visited a dentist. Comparisons between other dental visit patterns were not significantly different. Additionally, the mean of OHLI-M score was significantly higher among respondents without swollen gums compared to those with swollen gums.

Table 4. Association between oral health literacy and socio-demographic and diabetes profile.

Variables	Mean (SD)	t-statistics ^a (df)	p-value
Sex			
Male	69.9 (15.76)	2.84 (133)	0.005 ^c
Female	61.3 (18.29)		
Age group (year)			
≤40 years old	65.6 (15.00)	0.30 (2.132) ^b	0.740
41 – 60 years old	66.4 (19.03)		
>60 years old	63.9 (17.11)		
Ethnic group			
Malay	65.0 (17.88)	0.29 (133)	0.805
Others	63.8 (17.27)		
Highest educational level			
No formal/primary education	56.2 (18.51)	14.98 (2.132) ^b	0.001 ^d
Secondary education	66.7 (15.18)		
Tertiary education	75.7 (13.72)		
Employment status			
Employed	65.8 (18.76)	5.79 (2.132) ^b	0.040 ^e
Unemployed	59.0 (18.82)		
Retired	70.9 (13.05)		
Monthly household income group			
<MYR1000	53.1 (17.68)	14.63 (3.131) ^b	0.001 ^f
MYR1000-RM1999	64.6 (14.89)		
MYR2000-RM4999	73.3 (13.33)		
≥MYR5000	77.6 (16.41)		
Diabetes duration			
<10 years	66.2 (15.78)	0.91 (124.78)	0.366
≥10 years	63.5 (19.60)		

Mean (SD) is referring to mean and standard deviation for group comparison; ^aIndependent t-test; ^bOne-way ANOVA; ^cThe mean OHLI-M score was significantly different between male and female respondents (p=0.005); ^dThe mean OHLI-M score was significantly different between respondents with tertiary education and respondents with secondary education and no formal/primary education (p=0.001); ^eThe mean OHLI-M score was significantly different between retired and unemployed respondents (p=0.040); ^fThe mean OHLI-M score was significantly different between respondents with income <MYR1000 and respondents with other income groups (p= 0.001)

Table 5. Association between oral health literacy and self-reported oral health problems and dental visit.

Variables	Mean (SD)	t-statistics ^a (df)	p-value
Last dental visit			
Last 12 months	75.3 (12.89)	7.38 (3.131) ^b	0.001 ^c
Last 1 to 2 years	65.7 (16.29)		
Only when in pain	63.5 (18.68)		
Never been for dental visit	51.9 (14.94)		
Presence of oral health problem			
No	61.7 (19.61)	-1.64 (133)	0.103
Yes	66.8 (16.31)		

Toothache			
Yes	64.4 (18.23)	0.14 (133)	0.888
No	65.0 (17.71)		
Cavitated tooth			
Yes	65.6 (18.11)	0.59 (133)	0.555
No	63.8 (17.32)		
Sore gums			
Yes	65.5 (17.13)	-0.14 (133)	0.886
No	64.8 (17.88)		
Swollen gums			
Yes	55.9 (18.20)	2.66 (133)	0.009 ^d
No	66.6 (18.20)		
Bleeding gums			
Yes	65.9 (10.65)	-0.39 (32.54)	0.694
No	64.7 (18.57)		
Loose teeth			
Yes	60.8 (17.06)	1.25 (133)	0.215
No	65.8 (17.83)		

Mean (SD) is referring to mean and standard deviation for group comparison; ^aIndependent t-test; ^bOne-way ANOVA; ^cThe mean OHLI-M score was significantly different between respondents who never visited dentist and respondents who visited dentists within past 12 months and 1-2 years ago ($p=0.001$); ^dThe mean OHLI-M score was significantly different between respondents with and without swollen gums ($p=0.009$).

Discussion

The impact of diabetes mellitus on periodontal disease has been extensively described, and current scientific evidence supports the adverse effects of periodontal disease on glycemic control and diabetes-related complications [16]. Given the bidirectional relationship between diabetes and periodontitis, with each having negative impacts on the other, prevention and control of periodontal disease is considered an integral part of diabetes control [13].

Only about one-third (36.3%) of patients with diabetes mellitus had adequate OHL, while the rest had either inadequate or only marginal OHL. This finding was lower than that reported in a previous local study by Fabillah et al. [20] among carers of special needs children in Kuala Terengganu, Malaysia, which showed that 52.5% of carers had adequate OHL. A higher proportion of respondents with adequate OHL was reported in studies among patients attending dental clinics. A study in Belarus by Blizniuk et al. [21] showed that 68.7% of the patients had adequate OHL. A much higher proportion of patients with adequate OHL (89.0%) was reported in Canada [22]. Periodontal disease and diabetes are highly prevalent in Malaysia [10,23]. Our findings found that a high percentage of patients with diabetes mellitus had inadequate or marginal OHL underline the urgent need for strategies to increase the patients' OHL as poor control of periodontal disease may contribute to the spiralling increase of diabetes mellitus complications that will present significant public health challenges for healthcare providers, patients, and their families [24].

A lower total OHLI-M score (Mean=67.9, SD=17.74) was also found among our respondents compared to that reported by Sabbahi et al. [22] at 87.2 (SD=10.2) and Blizniuk et al. [25] at 77.2 (SD=14.5) in another study among dental patients in Belarus. Higher OHL level among patients attending dental clinics highlights OHL as an important determinant of oral health care seeking behaviour [4]. In the studies by Sabbahi et al. [22] and Blizniuk et al. [25], the dental visit interval for most study participants was at least once a year, while in our study, most respondents visited dentists only when in pain.

Most respondents in this study (62.2%) reported having at least one oral problem. Besides the symptoms of periodontal diseases, symptoms related with dental caries were also commonly reported, even more common than the symptoms of periodontal diseases. At the same time, there is good evidence to show

that periodontitis is more prevalent among diabetic patients than nondiabetic people [14]. A high prevalence of dental caries among diabetic patients has also been reported [17]. The increased likelihood of developing new and recurrent dental caries could be attributed to salivary secretion dysfunction, which is a common complication of diabetes mellitus and its medications [17]. Xerostomia is the subjective sensation of oral dryness due to is qualitative or quantitative reduction or absence of saliva in the mouth [26]. Saliva plays an important role in maintaining the health of oral tissues. Rich in calcium and phosphates, saliva facilitates the remineralization of early carious lesions [26]. The development of dental caries in diabetic patients with xerostomia can be rampant and severe and, if left untreated, can result in infection of the dental pulp and tooth abscess [27].

Scientific evidence regarding the association between OHL and oral conditions is weak, as there has been conflicting study results [28]. In this study, OHL was found to be significantly associated with swollen gums, a symptom of periodontal diseases. Our findings corroborated the report by Baskaradoss [29] that patients with limited OHL were more likely to have poorer periodontal health. The association with other reported oral problems was not apparent. In addition, the OHL of the respondents of this study was also found to be associated with a dental visit. Higher OHLI-M score were seen in respondents with favourable dental visit behaviour. This is in agreement with the findings of Ramlay et al. [19] among adult outpatients attending a health clinic in Malaysia, Sabbahi et al. [22] among patients attending a dental clinic in Canada, and Blizniuk et al. [25] among dental patients attending a clinic in the Republic of Belarus, which showed significantly lower OHL scores in participants with longer interval since last dental visit.

Besides adding to the growing body of evidence that suggests OHL as an important determinant of oral health outcomes and oral health care behaviours, our findings also showed that OHL level vary by socio-demographic factors, namely sex, educational status, employment status, and household income. In this study, male respondents had higher OHLI-M scores than female respondents. This finding was consistent with a study done by Mahmud et al. [7] on Bangladeshi adults attending the Outpatient Dental Department of Ibrahim General Hospital-Mirpur where they found that 17 out of 32 respondents (53%) had fair OHL levels as compared to female respondents, 22 out of 68 respondents (32%) had fair OHL level. Education level was significantly associated with the OHL of our respondents; diabetic patients with higher education level had higher OHL levels. Our finding was in agreement with previous studies that consistently demonstrated the positive association between the OHL and education level, supporting the importance of education in understanding and valuing OHL [6,7]. Employment status and household income were also significantly associated with the OHL of our respondents. Unemployed and lower-income respondents had lower OHL levels. These findings are also consistent with reports of studies conducted among other populations [7,8].

The findings of the current study provide a vital piece of information on the OHL and self-reported oral problems of diabetic patients, as well as factors associated with the patients' OHL. This information is important for health care providers in identifying the group of diabetic patients with low OHL and planning the appropriate interventions to improve their communication to help patients better understand oral health messages. An important strategy for improving OHL is to avoid the use of complicated terminology or jargon. Instead, use simple language in both verbal and written communications to minimize the risk of misunderstanding. Additionally, it is important that patient education materials are written at a level that is readable for individuals with low reading skills, which is no higher than the grade 6 reading level, and are suitable for the given patient population [30]. This will ensure that patients can gain access to the information they need, understand, and use it to make appropriate health decisions that will improve, promote, and




maintain good oral health. Apart from that, visual aids in health education materials may benefit persons with low-literacy levels by improving health literacy outcomes, comprehension towards information given to them and benefits in medication adherence [31].

This study has several limitations. The findings of this study can only be inferred from diabetic patients attending Hospital USM, Kelantan, a state where Malay is the predominant ethnic group, as reflected by the ethnic composition of the respondents. The Chinese, the second largest ethnic group in the country, were under-represented, as well as the Indians and other ethnic groups. A larger study involving a more racially or ethnically diverse sample should be considered. Apart from that, for oral health problems, this study did not clinically evaluate the presence of periodontal disease but use self-reported oral health problems questionnaires to identify the oral health problems faced by the respondents. Patient Report Outcome Measures (PROMs) are identifiable, valid and reliable instruments that evaluate a patient's health condition, as reported directly by the patient [32]. However, the presence of periodontal diseases among diabetes patients should be clinically evaluated in the future research as diabetes has a bidirectional relationship with periodontal disease [13].

Conclusion

The OHL of most patients with type 2 diabetes mellitus attending the Diabetes Outpatient Clinic, Hospital USM was inadequate or only marginal. The OHL was found to be significantly lower in patients with the following characteristics: females, no formal education or had primary education, unemployed, lower income group, never been for a dental visit and had swollen gums. Efforts must be taken to ensure the effective delivery of oral health messages at the appropriate literacy level. Patients with diabetes mellitus must be able to access, understand and use the information written on oral health-related materials to improve, promote, and maintain good oral health. Finally, having adequate OHL may help achieve the general goals of diabetes treatment which are preventing disease complications, decreasing mortality, and maintaining a good quality of life.

Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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