



Awareness of population regarding the effects of diabetes on dental implant treatment in Jeddah, Saudi Arabia

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ABSTRACT

Objective: Diabetes mellitus (DM) has several complications. Delayed wound healing, microvascular disease and an impaired response to infections are complications that can have a direct bearing on dental implant therapy. This paper studies the awareness of the population with regard to the effect of DM on dental implant treatment. **Materials and methods:** A validated, close-ended questionnaire was distributed to 506 randomly selected mall-goers in the city of Jeddah. Responses were coded and entered into spreadsheet software (SPSS, IBM). The frequency distribution of the responses was calculated, and inferences were drawn. **Results:** The study revealed that the majority of the sample were females (62.8%), did not have diabetes (80.4%) and reported a positive family history of diabetes (87.4%). Most of the respondents (56%) believed that uncontrolled diabetes can lead to implant loss and that diabetes affects the healing process (91.6%). Many patients (42%) responded that diabetes could be treated with dental implants if the blood sugar level was controlled. **Conclusion:** The studied sample revealed a satisfactory level of awareness regarding the association of diabetes and oral hygiene in dental implant therapy. However, there is less than adequate knowledge about the effects of diabetes on dental implants, as the majority of the respondents believe that only controlled diabetics can avail dental implant treatment.

1. Introduction

Diabetes mellitus, a condition characterized by increased plasma glucose levels (or hyperglycemia), is a group of metabolic disorders that result either from abnormal insulin secretion, insulin action or both. Currently, approximately 285 million people around the world are affected, and these figures are expected to increase two-fold by 2030 [1]. The burden of diabetes mellitus (DM) in Saudi Arabia is also quite high. According to a report by the Saudi Arabian Ministry of Health, approximately 0.9 million people were diagnosed with diabetes in 1992, but this figure rose to 2.5 million people in 2010, representing a 2.7-fold increase in the incidence rates in less than two decades [2]. It is one of the top ten countries in the world in terms of diabetes prevalence (23.9%) [3]. Poor glycemic control in DM has implications on several organ systems of the body, and over the last few years, special attention is being given to the relationship between diabetes and oral pathologies [4]. Many studies have been conducted to assess oral manifestations of DM, and a recently conducted systematic review summarized these manifestations and their link with DM (Table 1) [5].

Diabetes has been considered a relative contraindication of dental

implant therapy for quite some time now and has grown to become one of the most frequent contraindications to implant treatment [6]. The long-term survival of dental implants depends on successful osseointegration after placement. Any disruption of this process by external factors such as surgical trauma or internal factors such as metabolic disorders may affect the treatment outcomes [7]. Because diabetes is associated with delayed wound healing [8], microvascular disease and an impaired response to infections [9], it is considered risky to opt for dental implant treatment in patients with DM.

Studies have shown that dental implants are growing in popularity among patients as a widely accepted viable treatment option for tooth replacement [10, 11]. A survey conducted on Saudi patients in Riyadh evaluated the level of satisfaction of patients after dental implant treatment and concluded that patients were highly satisfied with this treatment modality and were very likely to recommend it to others [12]. The literature is also abounded with studies reporting the awareness of patients regarding dental implants [13, 14, 15]. However, few studies have been conducted that report the awareness of people regarding the implications of diabetes on dental implant therapy. The present study aims to address this issue and evaluate the knowledge and awareness of

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Table 1

Studies reporting oral manifestations/complications of DM. Adapted from: Mauri-Obradors E, Estrugo-Devesa A, Jané-Salas E, Viñas M, López-López J. Oral manifestations of Diabetes Mellitus. A systematic review. *Med Oral Patol Oral Cir Bucal*. 2017 Sep; 22 (5): e586–e594.

STUDY	DESIGN	LE	GR	SAMPLE	SEX	MANIFESTATION	ASSOCIATION WITH DM
ARRIETA BLANCO ET.AL., 2003	Transversal	4	C	70 DM 74 Healthy	30M, 40 W 29 M, 45W	Periodontal Disease	Yes
LOPEZ-LOPEZ ET.AL.,2011	Transversal	4	C	50 DM2 50 Healthy	20M, 30W 22M, 28W	Periapical Lesion	Yes
WANG ET.AL. 2011	Longitudinal Prospective 2 years	1B	A	49.334*	-	Periapical Lesion	Yes
FOUAD 2003	Longitudinal Prospective 2 years	1B	A	74* 464**	-	Periapical Lesion	Yes
LIN ET.AL.,1999	Transversal	4	C	24 DM 18 Healthy	10 M, 14W 10M, 8 W	Caries	Yes
PA ET.AL.,2001	Longitudinal Prospective 6–8 years	1B	A	390 DM1 202 Healthy	199M, 191 W 76M, 126W	Root caries	Yes
BHARATEESH ET.AL.,2012	Transversal	4	C	300 DM 300 Healthy	186M, 114W 180M, 120 W	Caries	No
ARRIETA BLANCO ET.AL.,2003	Transversal	4	C	70 DM1,2 70 Healthy	30M, 40 W 29M, 45W	Caries	No
MIRALES ET.AL.,2002	Transversal	4	C	30 DM1 30 Healthy	-	Caries, Mucosal Lesions, PD	No No Yes
KADIR ET.AL.,2002	Transversal	4	C	45 DM1,2 55 Healthy	18M, 27W 26M, 29W	Mucosal Lesion (candida)	Yes
GUGGENHEIMER, 2000	Transversal	4	C	405 DM1, 268 Healthy	-	Mucosal Lesion	Yes
PETROU-AMERIKANOU ET.AL., 1998	Transversal	4	C	135 DM1 353 DM2 274 Healthy	65M, 74W 127M, 225W 110M, 164W	Mucosal Lesion (Lichen Planus)	Yes
CRISTINA DE LIMA ET.AL.,2008	Transversal	4	C	30 DM 30 Healthy	11M, 19W 9M, 21W	Mucosal Lesion	No
SOUSA ET.AL.,2011	Transversal	4	C	96 DM2 100 Healthy	31M, 65W 27M, 73W	Mucosal Lesion	No
BUSATO ET.AL.,2012	Transversal	4	C	51 DM1 51 Healthy	-	Xerostomia	Yes
IVANOSKI ET.AL.,2012	Transversal	4	c	30 DM 30 Healthy	-	Xerostomia	Yes
CARDA ET.AL.,2006	Transversal	4	C	17 DM2 16 Healthy	10M, 7W 8M, 8W	Xerostomia	Yes
CHAVEZ ET.AL.,2001	Longitudinal Prospective 1 year	1B	A	24 DM 15 Healthy	10M, 14 W 9M, 6W	Xerostomia	Yes
STOLBOVA ET.AL., 1999	Transversal	4	C	73 DM2 11 DM1 12 Obese 29 Healthy	26M, 47W 4M, 7W 4M, 8W 6M, 23W	Taste Disturbance	Yes

* Endodontic teeth with DM, ** Endodontic teeth without DM.

patients regarding the effects of diabetes mellitus on dental implant therapy.

2. Materials and Methods

2.1. Study design

This is an observational cross-sectional study that is conducted in Jeddah, Saudi Arabia.

2.2. Questionnaire design

A self-designed, close-ended, and validated questionnaire was made in Arabic, consisting of thirteen questions. The first two questions assessed the demographic data of the sample, while the rest of the questions tested the knowledge of participants about different aspects of diabetes in relation to dental implant therapy. Distributing the questionnaire to two professional colleagues who are experts in the related fields and calculating the Average Congruency Percentage (ACP) was

made for content validity testing. The ACP score of the two reviewers was .96 (96%), which counted this questionnaire valid for application to the present research. The same experts tested and approved the questionnaire for readability, clarity of layout and wording. Test-retest stability testing was conducted to measure the reliability of the questionnaire. Pearson's correlation coefficient (r) was used to measure the stability of responses from a pilot sample of 25 randomly selected dental patients attending the dental general clinics of King Abdul Aziz University Dental Hospital. Data from the pilot study were coded, and Pearson's correlation coefficient was calculated on participants' scores, which showed an overall high reliability ($r = 0.87$).

2.3. Sample selection

The final study sample comprised 500 randomly selected subjects from among a large mall-goers in Jeddah (Red Sea Mall).

Inclusion criteria

- Subjects older than 15 years of age

- Subjects who can read and understand Arabic

Exclusion criteria

- Distinctly abled individuals
- Children younger than 15 years of age

Informed consent was obtained electronically through assigned tablets given to all participants before beginning the questionnaire, and for participants younger than 18 years of age, informed consent was obtained from their parents. The research ethical committee from King Abdulaziz University Faculty of Dentistry (KAUFD) approved the study questionnaire and the consent form. This project follows the principals of the World Medical Association Declaration of Helsinki.

2.4. Data interpretation and analysis

Responses were coded and entered into spreadsheet software (Statistical Package for Social Sciences, SPSS 23.0, IBM). The frequency distribution of the participants' responses was calculated, and the results were drawn.

3. Results

The surveyed sample showed that the majority of the participants (62.8%, 314 subjects) were females, while 37.2%, 186 subjects were males, as shown in the Fig. 1. The demographic details and frequency distribution of participants' responses are recorded in Table 2. Most of the respondents were between the ages of 21 and 40 years, while only (8.8%) were 15–20 years of age. Respondents in the 41–70 year age group were (28.8%) of the entire sample.

The frequency distribution of the sample in regard to their diabetes status and family history of diabetes are shown in Figs. 2 and 3. The majority of the respondents in the surveyed sample were non-diabetics (80.4%). Very few were not sure about their status as diabetics or not (4.4%), and the rest (15.2%) were known diabetics. When asked the diabetics about their control of diabetes, (8.6%) reported having controlled diabetes, while (6.4%) had uncontrolled diabetes. When we asked the participants about their family history of diabetes, (87.4%) reported a positive family history of diabetes, while (10.8%) reported a negative history. Very few of the participants (1.8%) were unaware about their relatives being diabetics or not.

Most of the respondents (63.6%) believed that telling their dentist

about their diabetic condition would affect the implant treatment plan, while (23.6%) believed it would not affect the treatment plan. The rest of the participants (12.8%) did not know if diabetes had any negative effect on their implant treatment plan. Most of the participants knew that diabetes affects the health of oral tissues around implants (85%), very few did not think it is relevant (5.2%), while some of them did not know if it is relevant (9.8%). A percentage of (17.2%) of participants who responded in the affirmative regarding the effect of diabetes on oral health tissues around implants did not know how diabetes adversely affects oral health tissues. When asked about the effect of diabetes on wound healing during dental implant surgery, (66.4%) of participants thought that diabetes reduces the body's immunity and causes delay in wound healing, while the rest (16.4%) thought that diabetes attracts oral microbes that later cause oral diseases.

The responses to the risks of uncontrolled diabetes and bad oral hygiene on dental implants were close to even distribution among participants, with implant loss and dry mouth answers receiving the most responses (56% and 46.4%, respectively). A small percentage (2%) of the respondents thought that there are no sequelae of untreated gum disease around implants, while the majority of them believed that it will lead to future gingival recession around implants, bone loss and implant loss (86.6%). The rest of the respondents (9%) thought that bleeding would eventually stop even without treatment.

When asked about whether they think that diabetes affects the healing process of implant surgery, a vast majority of the participants (91.6%) replied positively, while (5.6%) responded that they did not think so. Very few participants (2.8%) did not know if it did or did not. Most of the participants (42%) thought that diabetics could be treated with dental implants if their blood sugar was controlled, while (11.6%) thought that diabetics should not be treated with dental implants at all. The majority of the respondents never received any tips or information regarding the connection between diabetes and dental implant treatment (69%); nonetheless, the majority of participants (75.6%) believed that a combination of regular dental visits and home care regimen is the most important to maintain good oral health around implants.

4. Discussion

The present study examines the awareness of people in Jeddah regarding the implications of diabetes on dental implant therapy. It was divided into three domains pertaining to a) demographic data, b) diabetes prevalence and associated family history, and c) implications of diabetes on dental implant therapy.

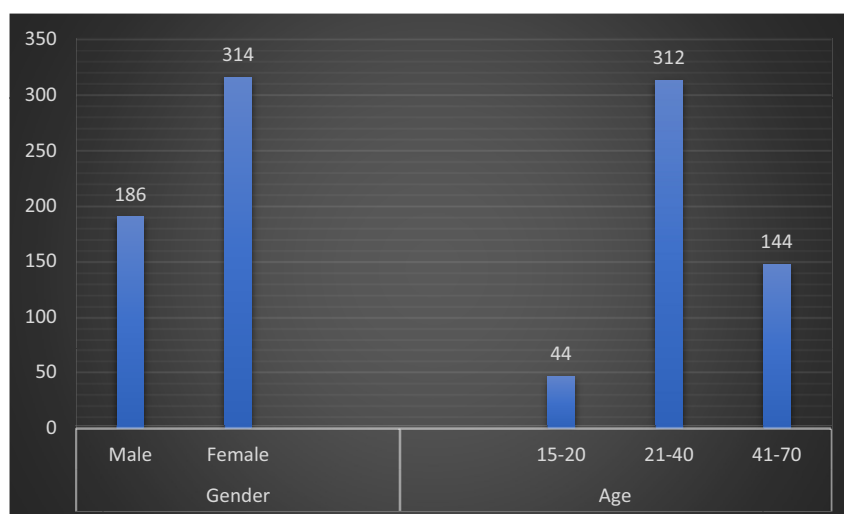


Fig. 1. Demographic Information of Study Sample. Age and gender of participants of the study illustrated. Note the majority were females. In regards to age groups, most participants were between 21–40 years of age among all participants (males and females).

Table 2
Frequency distribution of participant responses.

QUESTION	RESPONSE	FREQUENCY	PERCENTAGE
GENDER	Male	186	37.20%
	Female	314	62.80%
AGE	15–20	44	8.80%
	21–40	312	62.40%
	41–70	144	28.80%
DO YOU HAVE DIABETES	Yes, controlled	43	8.60%
	Yes, uncontrolled	33	6.40%
	No	402	80.40%
DO YOU HAVE ANY RELATIVES WHO HAVE DIABETES	I Don't know	22	4.40%
	Yes	437	87.40%
	No	54	10.80%
DO YOU THINK TELLING YOUR DENTIST THAT YOU HAVE DIABETES AFFECTS YOUR TREATMENT WITH IMPLANT?	I don't know	9	1.80%
	Yes	318	63.60%
	No	118	23.60%
DO YOU THINK DIABETES AFFECTS THE HEALTH OF ORAL TISSUES AROUND IMPLANTS?	Don't know	64	12.80%
	Yes	425	85%
	No	26	5.20%
IF YOU CHOSE “YES” FOR THE PREVIOUS QUESTION, THEN WHAT DO YOU THINK IS THE REASON FOR THIS?	Don't know	49	9.80%
	Don't know	86	17.20%
	Reduces body's immunity to fight infection and delays wound healing	332	66.40%
THE RISK OF UNCONTROLLED DIABETES AND BAD ORAL HYGIENE ON IMPLANT THERAPY CAN CAUSE THE FOLLOWING? (YOU CAN SELECT MORE THAN ONE)	Attracts microbes that cause diseases	82	16.40%
	Gum bleeding, redness, swelling	214	42.80%
	Bad breath	193	38.60%
	Dry mouth	232	46.40%
	Oral infection	204	40.80%
	Implant Loss	280	56%
WHAT DO YOU THINK WILL HAPPEN IF GUM DISEASE AROUND IMPLANTS IS LEFT UNTREATED?	Nothing	10	2%
	Bleeding gums will eventually stop	51	9%
	Gum recession, bone loss, Implant loss	433	86.60%
HAVE YOU EVER RECEIVED TIPS ABOUT DIABETES EFFECT ON DENTAL IMPLANTS SUCCESS?	Yes	155	31%
	No	345	69%
WHAT IS THE MOST IMPORTANT PART FOR HAVING GOOD ORAL HEALTH AROUND IMPLANTS?	Regular check-ups with the dentist	80	16%
	Home care hygiene	42	8.40%
	Both	378	75.60%
DO YOU THINK DIABETES AFFECTS THE HEALING PROCESS OF IMPLANT SURGERY?	Yes	458	91.60%
	No	28	5.60%
	I don't know	14	2.80%
DO YOU THINK DIABETIC PATIENTS CAN HAVE DENTAL IMPLANTS?	Yes	85	17%
	No	58	11.60%
	I don't know	147	29.40%
	Only if diabetes is controlled	210	42%

4.1. The diabetic participants in the study

Only 15.2% of participants in the present study were diabetics, while the rest were either non-diabetic or they had no idea about their diabetes status. Bahijri et al. (2016) also reported a similar percentage (15.7%) of diabetic people among a sample of 1420 individuals in Jeddah [16]. However, Alqurashi et al. (2009) [17] reported a prevalence of 30%, almost double that of our study. Based on the systematic review conducted by Al-Otaibi et al. (2017)², who reported that the nationwide prevalence rate of diabetes increased from 23.7% between 1995 and 2000 to 25.4% between 2007 and 2009, it is evident that diabetes prevalence is growing in Saudi Arabia, and with it, there is a growing need to evaluate diabetes-related oral health awareness among the Saudi population. Nonetheless, the results of this paper revealed some important information pertaining to awareness among the population.

4.2. Family history of diabetes in the study

Despite the low diabetes prevalence in our sample, the majority of the participants (87.4%) showed a positive family history, which may indicate an anomaly in our findings, as research has established a strong familial correlation of diabetes. Abbasi et al. (2011) [18] and Hemminki et al. (2010) [19] reported that a positive family history of diabetes is associated with a two- to thirty-fold increase in the risk of Type II diabetes mellitus. This implies that with such a high percentage of diabetic probands among the families of the participants, there is a likelihood of

pre-diabetics and diabetics in the sample that was not accounted for due to lack of diabetes screening in our research. This establishes a need for future researchers to incorporate diabetes screening as part of their study to conclusively establish the number of diabetic individuals among the participants for demographic knowledge.

4.3. Diabetics' status and informing the dentist

Patients must be aware that they need to inform the dentist about their diabetes status as part of their medical history because the dentist might need to alter the treatment plan on the basis of current diabetes control and the presence/absence of systemic complications [20]. In our present study, (63.6%) were aware that informing the dentist that they are diabetics has some bearing on the treatment plan in regard to dental implant placement. There are varied reports from other parts of the world in relation to whether patients inform the dentist about their diabetic status. A study conducted in India revealed that 64.8% of the participants reportedly told their dentist about their diabetes status [21]. In contrast, a study conducted in the UK revealed that 56.9% of the participants never mentioned their diabetes status to the dentist [22]. Similarly, another study in the UK reported that only 30.2% of the participants' dentists knew about their diabetes status [23]. A survey conducted in Sweden on randomly selected Type II diabetes patients revealed that 48% of these patients had been taking treatment without disclosing their diabetes status and without the dentist ever enquiring about it [24]. The last two studies bring forth alarming revelations as they demonstrate not only the

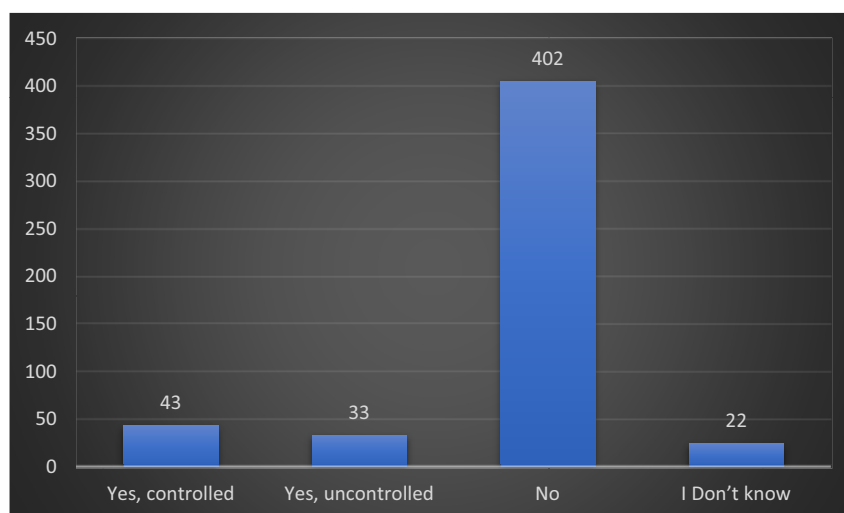


Fig. 2. Frequency Distribution of Study Sample on the Basis of Diabetes Status. Participants status of diabetes including controlled and uncontrolled diabetics, non diabetics, and unaware of they were diabetic or not.

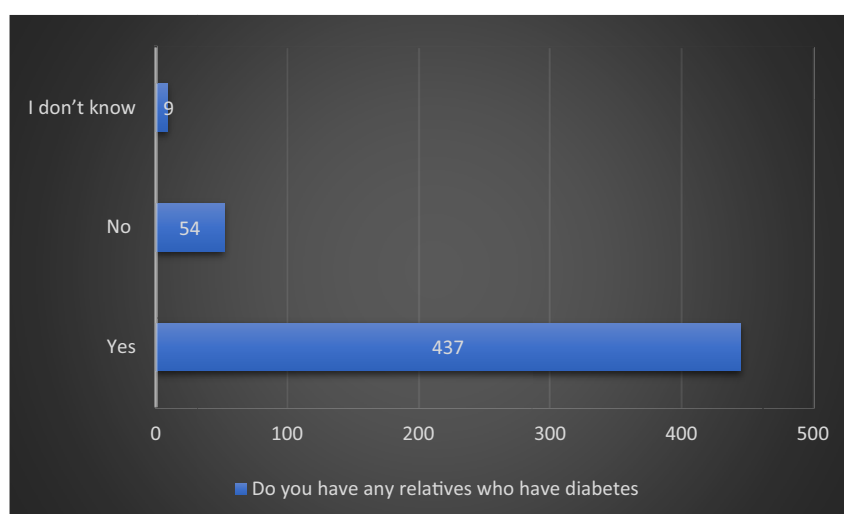


Fig. 3. Frequency Distribution of Study Sample on the Basis of Family History of Diabetes. Note the majority of participants were having positive family history of diabetes.

lack of awareness among patients to inform their dentist about their diabetes history but also the incompetence of the dentists in taking a thorough history of the patient before formulating treatment plans. More research needs to be conducted to determine why dentists are skipping the important step of taking a detailed medical history of the patient and to find ways to effectively incorporate history taking into general dental practice. These studies also demonstrate the growing need for primary health care providers to educate their patients that they need to inform their dentists about their diabetes status.

4.4. Awareness of participants about diabetes effect on dental implants

In the present study (85%) of participants were aware that diabetes has a bearing on the dental tissues around implants creating diseases. These findings are higher than those reported in other studies, such as those conducted by Allen et al. (2008) in Ireland, where they reported that only 33% of the diabetic participants were aware of the increased risk of periodontal disease in diabetes, whereas 84%, 98% and 99% of them were aware of the increased risk of heart disease, eye diseases and circulatory problems, respectively [25]. Similar low awareness was

reported in a study conducted on a Jordanian population by Al Habashneh et al. (2010), who reported that only 48% of the surveyed sample was aware that diabetic patients were more prone to oral diseases [26]. Another study conducted in the UAE on 200 participants revealed that 60%, 54% and 42% of the respondents were aware of the increased risk of periodontal disease, dental caries and oral infections, respectively [27]. In comparison with the above studies, our present study displays a satisfactory level of self-reported awareness among the respondents with respect to the risk of oral diseases in diabetics. This is especially important given that periodontitis is described as the sixth complication of DM and that there exists a bidirectional relationship between diabetes and periodontitis [28]. It has been reported that periodontal risk becomes threefold in adults with uncontrolled or poorly controlled diabetes compared to non-diabetics [29], and untreated periodontitis also worsens the glycemic control of a patient by inducing inflammation that can contribute to insulin resistance [30].

In our present study, almost all participants (91.6%) replied affirmatively when asked if DM affects the healing process. This is an important finding because awareness of people towards healing in diabetes affects their treatment choices and efforts for glycemic control.

Diabetes has been frequently reported in the literature to be associated with bone metabolic and osteopathic changes [26, 27]. These findings, coupled with animal studies showing negative effects of hyperglycemia, not only on bone formation but also on bone strength and fracture healing [28, 29] and decreased levels of implant osseointegration, suggest that diabetes is a cause of concern for patients who seek dental implant therapy [30, 31]. It is then necessary that these patients be aware of the implications of diabetes on the outcomes of implant therapy. A percentage of (42%) of participants in our study believed that diabetic patients could be treated with dental implants only if they had good glycemic control. This is not true, however, as on the basis of available literature, there is no clear data that contraindicates implant therapy in patients who lack good glycemic control [32, 33]. Previous studies assessing implant stability over the first four to six months after placement in type 2 diabetic patients with HbA1c levels as high as 12% reported high implant survival rates regardless of the patient's glycemic status [33, 34, 35]. It is important to mention that these same studies reported an initial decreased implant stability in patients with HbA1c levels higher than 8% and delayed osseointegration compared to non-diabetic or well-controlled diabetic patients, which hints at achieving better glycemic control. Patients must be aware that diabetes is not an absolute contraindication for dental implants and that a good implant survival rate can be achieved in diabetic patients.

4.5. Sources of diabetes associated oral health information among participants

Studies conducted around the globe report different sources of diabetes-associated oral health information. Bahammam (2015) reported that 55.3% of patients received diabetes-related information from family members or from friends, while 50.9% of patients received it from health care professionals [36]. Television and print media accounted for only 29.5% of awareness. In our present study, only 31% of participants had received information about the effect of DM on the success of dental implants. This highlights a large information and communication gap between health care professionals, media and the general population. Similar results have been shown by Broder et al. that health care providers do not acknowledge the relationship between diabetes and oral health nor do they incorporate oral health diseases into diabetes screening/treatment [37]. It is important that dental care providers specifically ask about diabetes when taking medical history. Moreover, health care professionals need to be trained on providing information about the deleterious effect of DM on oral health tissues.

4.6. Study limitation

A limitation of our research was that the responses showed awareness but did not correlate the level of awareness and participant characteristics. We did not have an avenue for screening diabetics. This was because our research was not conducted in a clinical setting, it was self-funded and researchers did not have the resources for screening patients.

5. Conclusion

The findings of our research show that there is adequate knowledge among the population regarding the association of diabetes and oral hygiene in dental implant therapy. Participants believed that diabetic patients could only receive dental implant therapy if they maintained good glycemic control. Recent evidence proves the contrary, and there is a need for health care providers to educate diabetic patients about the possibilities of dental implant therapy regardless of glycemic control. Our study also reported that participants did not receive information about diabetes and dental implant therapy from external sources. There is also the need to direct health care professionals to increase awareness and knowledge among patients as well as policy makers to invest in media to engage and educate the population about the diabetes-dental implant

treatment option.

Declarations

Author contribution statement

Ahmad Alemhadi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

- [1] R.S. Leite, N.M. Marlow, J.K. Fernandes, Oral health and type 2 diabetes, *Am. J. Med. Sci.* 345 (4) (2013) 271–273.
- [2] A. Al Otaibi, L. Perry, L. Gholizadeh, A. Al Ganmi, Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: an overview, *J. Int. Oral Health* 7 (4) (2017) 211–218.
- [3] Aguirre Florencia, Alex Brown, Cho Nam Ho, Dahlquist Gisela, Sheree Dodd, Trisha Dunning, et al., *IDF Diabetes Atlas*, sixth ed., International Diabetes Federation, Basel, Switzerland, 2013.
- [4] A.M. Valero, J.C.F. Garcia, A.H. Ballester, C.L. Rueda, Effects of diabetes on the osseointegration of dental implants, *Med. Oral Patol. Oral Cir. Bucal* 12 (2007) e38–e43.
- [5] E. Mauri-Obradors, A. Estrugo-Devesa, E. Jané-Salas, M. Viñas, J. López-López, Oral manifestations of diabetes mellitus. A systematic review, *Med. Oral Patol. Oral Cir. Bucal* 22 (5) (2017) e586–e594.
- [6] R. Okazaki, M. Miura, M. Toriumi, M. Taguchi, Y. Hirota, S. Fukumoto, T. Fujita, K. Tanaka, A. Takeuchi, Short-term treatment with troglitazone decreases bone turnover in patients with type 2 diabetes mellitus, *Endocr. J.* 46 (1999) 795–801.
- [7] B.R. Chrcanovic, T. Albrektsson, A. Wennerberg, Diabetes and oral implant failure: a systematic review, *J. Dent. Res.* 93 (9) (2014) 859–867.
- [8] B.R. Rothwell, E.L. Richard, Diabetes mellitus: medical and dental considerations, *Spec. Care Dent.* 4 (1984) 58–65.
- [9] M.M. McMahon, B.R. Bistrian, Host defenses and susceptibility in patients with diabetes mellitus, *Infect. Dis. Clin. N. Am.* 9 (1995) 1–9.
- [10] I. Naert, G. Koutsikakis, J. Duyck, M. Quirynen, R. Jacobs, D. van Steenberghe, Biologic outcome of implant-supported restorations in the treatment of partial edentulism. Part I: a longitudinal clinical evaluation, *Clin. Oral Implant. Res.* 13 (4) (2002) 381–389.
- [11] A.L. Grogono, D.M. Lancaster, I.M. Finger, Dental implants: a survey of patients' attitudes, *J. Prosthet. Dent.* 62 (5) (1989) 573–576.
- [12] K. Al-Hamdan, Patients' satisfaction with dental implants in Riyadh, Saudi Arabia, *Saudi Dent. J.* 19 (2) (2007) 6–11.
- [13] A. Al-Musawi, P. Sharma, M. Maslamani, M. Dashti, Public awareness and perception of dental implants in randomly selected sample in Kuwait, *J. Med. Imp. Surg.* 2 (2017) 116.
- [14] J. Rustemeyer, A. Bremerich, Patients' knowledge and expectations regarding dental implants: assessment by questionnaire, *Int. J. Oral Maxillofac. Implant.* 36 (9) (2007) 814–817.
- [15] S. Al-Johani, H.A. Al Zoman, M. Al Juhaini, M. Al Refeai, Dental patients' awareness and knowledge in using dental implants as an option in replacing missing teeth: a survey in Riyadh, Saudi Arabia, *Saudi Dent. J.* 22 (4) (2010) 183–188.
- [16] S.M. Bahjri, H.A. Jambi, R.M. Al Raddadi, G. Ferns, J. Tuomilehto, The prevalence of diabetes and prediabetes in the adult population of Jeddah, Saudi Arabia - a community-based survey, in: N.C. Barengo (Ed.), *PLoS One* 11 (2016) e0152559.
- [17] K.A. Alqurashi, K.S. Aljabri, S.A. Bokhari, Prevalence of diabetes mellitus in a Saudi community, *Ann. Saudi Med.* 31 (1) (2011) 19–23.
- [18] A. Abbasi, E. Corpeleijn, Y.T. van der Schouw, R.P. Stolk, A.M. Spijkerman, A.D. van der, et al., Maternal and paternal transmission of type 2 diabetes: influence of diet, lifestyle, and adiposity, *J. Intern. Med.* 270 (2011) 388–396.
- [19] K. Hemminki, X. Li, K. Sundquist, J. Sundquist, Familial risks for type 2 diabetes in Sweden, *Diabetes Care* 33 (2010) 293–297.
- [20] A.T. Vernillo, Dental considerations for the treatment of patients with diabetes mellitus, *J. Am. Dent. Assoc.* 134 (1) (2003) 24S–33S.

- [21] S.M. Shanmukappa, P. Nadig, Puttannavar, Z. Ambareen, T.M. Gowda, D.S. Mehta, Knowledge, attitude, and awareness among diabetic patients in Davangere about the association between Diabetes and Periodontal Disease, *J. Int. Soc. Prev. Community Dent.* 7 (6) (2017) 381–388.
- [22] A. Lindenmeyer, V. Bowyer, J. Roscoe, J. Dale, P. Sutcliffe, Oral health awareness and care preferences in patients with diabetes: a qualitative study, *Fam. Pract.* 30 (1) (2013) 113–118.
- [23] V. Bowyer, P. Sutcliffe, R. Ireland, A. Lindenmeyer, R. Gadsby, M. Graveney, J. Sturt, J. Dale, Oral health awareness in adult patients with diabetes: a questionnaire study, *Br. Dent. J.* 211 (6) (2011) e12.
- [24] G.E. Sandberg, H.E. Sundberg, K.F. Wikblad, A controlled study of oral self-care and self-perceived oral health in type 2 diabetic patients, *Acta Odontol. Scand.* 59 (1) (2001) 28–33.
- [25] E.M. Allen, H.M. Ziada, D. O'Halloran, V. Clerehugh, P.F. Allen, Attitudes, awareness and oral health-related quality of life in patients with diabetes, *J. Oral Rehabil.* 35 (3) (2008) 218–223.
- [26] R. Al Habashneh, Y. Khader, M.M. Hammad, M. Almuradi, Knowledge and awareness about diabetes and periodontal health among Jordanians, *J. Diabet. Complicat.* 24 (6) (2010) 409–414.
- [27] A.H. Eldarrat, Diabetic patients: their knowledge and perception of oral health, *Libyan J. Med.* 6 (2011).
- [28] H. Loe, Periodontal disease. The sixth complication of diabetes mellitus, *Diabetes Care* 16 (1) (1993) 329–334.
- [29] B.L. Mealey, T.W. Oates, Diabetes mellitus and periodontal diseases, *J. Periodontol.* 77 (2006) 1289–1303.
- [30] P. Stanko, L. Izakovicova Holla, Bidirectional association between diabetes mellitus and inflammatory periodontal disease: a review, *Biomed. Pap. Med. Fac. Univ. Palacky Olomouc Czech Repub.* 158 (1) (2014) 35–38.
- [31] M. Inaba, Y. Nishizawa, K. Mita, et al., Poor glycemic control impairs the response of biochemical parameters of bone formation and resorption to exogenous 1,25-dihydroxyvitamin D3 in patients with type 2 diabetes, *Osteoporos. Int.* 9 (1999) 525–553.
- [32] S.P. Engebretson, J. Hey-Hadavi, F.J. Ehrhardt, et al., Gingival crevicular fluid levels of interleukin-1b and glycemic control in patients with chronic periodontitis and type 2 diabetes, *J. Periodontol.* 75 (2004) 1203–1208.
- [33] R.K. Dubey, D.K. Gupta, A.K. Singh, Dental implant survival in diabetic patients: review and recommendations, *Natl. J. Maxillofac. Surg.* 4 (2) (2013) 142–150.
- [34] S.A. Kemink, A.R. Hermus, L.M. Swinkels, J.A. Lutterman, A.G. Smals, Osteopenia in insulin-dependent diabetes mellitus; prevalence and aspects of pathophysiology, *J. Endocrinol. Investig.* 23 (2000) 295–303.
- [35] J.C. Krakauer, M.J. McKenna, N.F. Buderer, D.S. Rao, F.W. Whitehouse, A.M. Parfitt, Bone loss and bone turnover in diabetes, *Diabetes* 44 (1995) 775–782.
- [36] M.A. Bahammam, Periodontal health and diabetes awareness among Saudi diabetes patients, *Patient Prefer. Adherence* 9 (2015) 225–233.
- [37] H.L. Broder, D. Tormeti, A.L. Kurtz, D. Baah-Odoom, R.M. Hill, S.M. Hirsch, S.A. Hewlett, J.K. Nimako-Boateng, J.Y. Rodriguez, L. Sischo, Type II diabetes and oral health: perceptions among adults with diabetes and oral/health care providers in Ghana, *Community Dent. Health* 31 (3) (2014) 158–162.