

# Factors Affecting Satisfaction Among Diabetic Patients Seeking Orthodontic Treatment in Saudi Arabia

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## ABSTRACT

The objectives of this study were to assess diabetic patients' satisfaction when seeking orthodontic treatment, and to identify the factors and causes that may influence or prohibit their orthodontic treatment. A total of 206 diabetic participants were randomly selected for a cross-sectional study by allocating a satisfaction closed-ended questionnaire. All young and adult patients with three different types of diabetes mellitus, seeking orthodontic care, were included in the study. Comparison between three groups of diabetic patients were performed using chi square statistical analytical method. A significant association was found between diabetes mellitus type and patient satisfaction with access to care provided to them ( $p < 0.0001$ ). In addition, there was a significant association between diabetes mellitus type and the satisfaction level during or after treatment. Generally, the level of satisfaction among Orthodontic diabetic patients in all studied categories was medium, with lower satisfaction level among older age type II diabetic patients than younger age type I diabetic patients. Orthodontists should be aware of the importance of diabetes in relation to the patients' susceptibility to periodontitis, especially if uncontrolled. Periodontal health and proper oral hygiene should be strictly observed during treatment.

**KEY WORDS:** DIABETES MELLITUS, ORTHODONTIC TREATMENT, PATIENT SATISFACTION, TYPES.

## INTRODUCTION

The need for orthodontic care, as one of the most important specialties in current dental practice, centers around fixing malocclusions that have a great social and psychological impacts on the quality of life for both healthy and compromised young people (Littlewood and Mitchell 2019; Baidas et al. 2020). However, as medical science continues to make advances in helping to improve the quality of life for patients with chronic diseases, dentists are seeing an increasing number of medically compromised patients seeking orthodontic treatment (OT) for some types of malocclusions. Thus, it is crucial that orthodontists increase their awareness of basic working knowledge of these diseases with all possible clinical implications on the course of the treatment. This also requires orthodontists to be in close contacts with the physicians who should be regularly informed about the type of planned dental procedures ahead of time (Rizvi et al. 2014; Ahmad et al. 2015). The growing

concern of dentists in attracting new patients and keeping them satisfied with the treatment is the main cause of the emerging and increasing trend to study and identify patient's perceptions towards different dental specialties in general and orthodontic care in particular (Farishta 2015). More importantly in this regard is the medically compromised patients such as the diabetic patients, as diabetes mellitus (DM) is rapidly becoming one of the main health issues in the 21st century (Baidas et al. 2020).

The number of diabetic patients in the Kingdom of Saudi Arabia is increasing rapidly, 18.3% out of the 34.8 million population, according to International Diabetes Federation (IDF), which is around 7 million affected individuals. This number ranks Saudi Arabia as the seventh country globally and the second- highest among Middle Eastern countries (Bergman and Newman 1987). According to the Saudi Ministry of Health (MOH), the number of reported cases of DM in the hospitals and medical centers in (2016) was 485,754, and this number has been increasing to 730,775 in 2018. This is very high increase in just two years (Dawish et al. 2016; Alotaibi 2020). IDF expects that by year 2045, 51% or about 700 million individuals of the whole world

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population will develop diabetic conditions (Alotaibi 2020; Tran et al. 2020).

Diabetes mellitus has four major classifications: Type I resulting from destruction of beta-cells in the islets of Langerhans of the pancreas which occurs early in life, type II DM due to insulin resistance, and III Gestational diabetes mellitus (GDM) arise during pregnancy, and type IV caused by pancreatic disease, hormonal disorders and drugs. It is a chronic disease characterized by an impaired production or utilization of insulin, leading to high amounts of blood glucose causing the blood vessels, nerves, and body organs destruction (Muhamad et al. 2015). The five

classic complications of diabetes are microangiopathy, neuropathy, nephropathy, macrovascular diseases, and wound-healing delay. The World Health Organization (WHO) added periodontal disease as a sixth classic complication in 1993 (Loe 1993). Due to an impaired immune system and Xerostomia, individuals with DM have a higher incidence rate of dental caries, periodontal disease, acetone smell, burning mouth syndrome, candida, and oral infections (Nirmala and Saikrishna 2016; Najeeb et al. 2017). The increased risk of periodontitis in diabetic patients is associated with multiple factors, including the patient's age, the duration of the diabetes, the presence or absence of metabolic controls, and the level of bacterial plaque (Rizvi et al. 2014; Muhamad et al. 2015).

**Table 1. Demographic data and medical information of the participants.**

Variable		N	%
Age group	< 10	2	1.0
	10 - 14	10	4.9
	16 - 20	64	31.1
	21 - 25	36	17.5
	26 - 30	28	13.6
	31 - 35	12	5.8
	36 - 40	11	5.3
	> 40	43	20.9
Gender	Male	80	38.8
	Female	126	61.2
Nationality	Saudi	189	91.7
	Non Saudi	17	8.3
Marital status	Single	117	57.6
	Married	80	39.4
	Divorced	4	2.0
	Separated	2	1.0
Is your diabetes controlled?	Yes	99	48.1
	No	107	51.9
Diabetes type	Type I	109	52.9
	Type II	77	37.4
	Gestational	20	9.7
Medication Type	Pills	52	25.2
	Insulin injection	128	62.1
	Dietary program	25	12.1
	Pills + Insulin injection	1	.5
Other accompanied medical problems	Yes	59	29.8
	No	139	70.2
variable		Median Quartile (25,75)	
How long did you have diabetes?	7	(4,13)	

The emerging trend in the field is to attempt to identify patient's perceptions towards different dental specialty treatment in general and OT in particular. Medically compromised patients, specifically diabetic patients, have been gaining more attention recently, since their numbers are tremendously increasing among younger generations globally, and especially in Saudi Arabia (Alotaibi et al.

2016; Dawish et al. 2016). The aim of this study is to assess the satisfaction levels of diabetic patients' seeking OT and to identify the factors and causes that may influence or prohibit their treatment. To the authors' knowledge, there is no previously performed study with this aim in Saudi Arabia.

## MATERIAL AND METHODS

A total of 206 diabetic patients were randomly selected for a cross-sectional study. The participants in this study included young and adults' diabetic patients with three different diabetes types (I, II, III) who were seeking orthodontic care during 2021 (Muhamad et al. 2015). The data was collected by distributing a close ended questionnaire to all participants in person or through online google site. The participants completed a survey consisted of three parts. The first was the demographic and medical history information, the second consisted of questions about orthodontic treatment data, and the third contained questions intended to assess the satisfaction level of OT. The study was approved by the Institutional Review Board (IRB), King Saud University {E-15-1657}, and the objectives were thoroughly explained to all participants and an informed consent form was obtained. Data was analyzed using Statistical Package for the Social Science (SPSS), software version 21. For data analysis descriptive statistics was applied for all variables. Analytic statistics was applied in the form of chi square to compare between the three groups of diabetic patients (type I, type II, and GDM). Statistical significance was considered at  $P$ -value  $< 0.05$  and Confidence interval of (95%).

## RESULTS AND DISCUSSION

A total of 206 diabetic patients participated in this study consisting of 126 females and 80 males, with a response rate of 80%. Demographic characteristics of the participants were presented in Table 1. The majority of the participants were in the age group of 16-20 years (31.1%). More than half of the participants were females, and the majority were Saudi (91.7%). More than half of the participants stated that their sugar level is under control (51.9%). Moreover, the higher percentage was type I (52.9%), followed by type II (37.4%), while the remaining (9.7%) were gestational type III (GDM). The majority of the participants (62.1%) receive insulin injections as the source of medication to control their glucose level. Less than third of the participants reported other accompanied medical problems (29.8%). The median score of the duration of being diabetic were 7 (Table 1).

The results presented in Table 2 revealed a significant association between DM type and orthodontic data, where the rate of fixed appliance was higher among type I (90.0%), while the rate of removable appliance type was higher among type II (82.4%) ( $p=0.020$ ). Two thirds of the participants (66.5%) stated that their oral health was good, 21.4% stated poor oral health, while only 12.1% of the participants stated an excellent oral health. The evaluation of oral health showed that it was excellent among type III (60%), followed by type II (54%), and the worst oral health was among type I (93.2%) ( $p<0.0001$ ). In regard to previous OT, more than one third (39.8%) of the participants reported having had previous treatment with the majority of the responses were from type I (45.1%,  $p=0.001$ ). On the other hand, 27.2% of the participants reported that they are currently undergoing OT, with the majority were from type II (57.1%,  $p<0.0001$ ).

In addition, more than two third of the participants were

planning to receive orthodontic treatment in the near future (71.4%), with the majority were from type II DM (51%,  $p<0.0001$ ). Concerning the main reasons behind the lack of previous orthodontic treatment among type I DM patients, the results showed the following responses that are statistically significant: bad experience from previous treatment (93.3%,  $p=0.002$ ), appearance satisfaction (84%,  $p=0.003$ ), associated medical conditions (78.9%,  $p=0.014$ ), financial problems (77.4%,  $p=0.0001$ ), fear of treatment (70.6%,  $p=0.039$ ). On the other hand, "not convinced to receive OT" was the most significant response among type II DM (83.3%,  $p<0.0001$ ). When the responses of all 3 types of DM were assessed in regard to the main reasons for not having orthodontic treatment, the highest percentage of answers referred to the high expenses of treatment (25.7%,  $p<0.0001$ ), followed by the patient's satisfaction with appearance (12.1%,  $p=0.003$ ), and lastly associated medical problems were cited as reasons for not having previous OT (9.2%,  $p=0.014$ ) (Table 2).

The main reasons for seeking orthodontic treatment among type I DM participants, with significant association, were Protrusion of upper and lower teeth ( $p=0.0001$ ), Gummy smile ( $p=0.001$ ), Crowded teeth ( $p=0.002$ ), and to be socially accepted ( $p=0.013$ ). Even though other reasons were mentioned among the groups, they were not of significance such as spaces between teeth, speech problems, TMJ problems, open bite, deep bite, biting and chewing problems (Table 2). According to the survey, significant responses of type I diabetic patients regarding the orthodontist's refusal to perform OT was due to uncontrolled blood sugar levels ( $p=0.0001$ ). On the other hand, the lowest was no OT is required and poor oral hygiene of the patients ( $p=0.009$ ) (Table 2).

Table 3 shows that there is statistically significant association between DM type and patient satisfaction with access to the dental services provided to them. The results revealed strong disagreement among type II DM patients, while the rate of "disagreed" and "neutral" responses were higher among type I DM patients in all questions ( $p<0.0001$ ). This indicates low satisfaction level with adult patients over young patients regarding access to services (Table 3). According to the survey, responses regarding the relation between DM type and satisfaction level of diabetic patients during and after OT revealed significant association as shown in Table 4. A significant higher rate of positive responses was found among type II DM patients for three questions (dietary habits, running blood sugar test, and recurrent candida infection). This is in contrast to type I DM patients where the rate of negative response was higher for the same questions ( $p<0.0001$ ). No significant association was found between the DM type and the experience of fainting in the orthodontic clinic ( $p=0.852$ ). Most of the participants (75%) reported no fainting experience in the orthodontic clinic although their orthodontists didn't perform regular blood glucose level checkup before treatment (64.6%).

More than half of the participants reported that they never been infected with candida infection during treatment (63.3%), and 43.8% of the responses showed that OT



didn't affect their dietary habits, indicating medium level of satisfaction among diabetic patients during treatment. In addition, the result revealed a significant association between diabetes mellitus type during or after treatment, where a significant higher rate of positive response was found among type II patients for four questions (endodontic treatment, having an abscessed tooth, gum problems, and root damage during OT). On the other hand, the rate of

negative response was higher among type I patients for the same four questions ( $p=0.31$ ,  $p<0.0001$ ,  $p=0.005$ , and  $p<0.0001$ , respectively). The rate of positive response was higher among type I patients for the question of "Did you suffer from dental caries during or after OT?" ( $p=0.032$ ). However, no association was found when the participants were asked if they have any pain in their teeth during OT ( $p=0.275$ ).

Table 2. The relation between DM type and orthodontic data

Variable		Diabetes Mellitus				P- value
		Type I	Type II	Type III	Total	
Type of orthodontic appliance	Fixed	72(90.0%)	7(8.8%)	1(1.3%)	80(63.5%)	0.020*
	Removable	3(17.6%)	14(82.4%)	0	17(13.5%)	
	Combined	23(79.3%)	5(17.2%)	1(3.4%)	29(23.0%)	
Evaluation of oral health?	Excellent	9(36%)	1(4.0%)	15(60%)	25(12.1%)	0.0001**
	Good	59(43.1%)	74(54.0%)	4(2.9%)	137(66.5%)	
	Poor	41(93.2%)	2(4.3%)	1(2.3%)	44(21.4%)	
Receiving any previous orthodontic treatment	Yes	37(45.1%)	28(34.1%)	17(20.7%)	82(39.8%)	0.001*
	No	72(58.1%)	49(39.5%)	3(2.4%)	124(60.2%)	
Current orthodontic treatment	Yes	8(14.3%)	32(57.1%)	16(28.6%)	56(27.2%)	0.0001
	No	101(67%)	45(30%)	4(2.7%)	150(72.8%)	
Planning for orthodontic treatment for future	Yes	34(36.7%)	75(51.0%)	18(12.2%)	147(71.4%)	0.0001
	No	55(93.2%)	2(3.4%)	2(3.4%)	59(28.6%)	
Do you think you need orthodontic treatment?	Yes	50(34.5%)	76(52.4%)	19(13.1%)	145(70.4%)	0.0001
	No	39(96.7%)	1(1.6%)	1(1.6%)	61(29.6%)	
If no orthodontic treatment was done this is because?	Satisfied with your appearance	21(84.0%)	3(12%)	1(4%)	25(12.1%)	0.003
	No orthodontic problem	8(44.4%)	10(55.6%)	0	18(8.7%)	0.934
	Parents disagreement	1(100%)	0	0	1(0.5%)	0.392
	Not convinced to have ortho tx.	3(16.7%)	15(83.3%)	0	18(8.7%)	0.0001
	Afraid to have treatment	24(70.6%)	8(23.5%)	2(5.9%)	34(16.3%)	0.039
	Your medical condition	15(78.9%)	4(21.1%)	0	19(9.2%)	0.014
	Doctor refused to treat	2(28.6%)	5(71.4%)	0	7(3.4%)	0.553
	Bad experience from previous tx	14(93.3%)	1(6.7%)	0	15(7.3%)	0.002
	-ve impact of friends for ortho. Tx.	2(100%)	0	0	2(1%)	0.225
	Financial problems	41(77.4%)	11(20.8%)	1(1.9%)	53(25.7%)	0.0001
Doctor refused to treat.	Other	1(50%)	1(50%)	0	2(1%)	0.884
	Your uncontrolled diabetes condition	26(100%)	0	0	26(12.6%)	0.0001
	Chronic Gingival inflammatory	12(100%)	0	0	12(5.8%)	0.002
	Repeated ulcers and fungi	2(100%)	0	0	2(1%)	0.225
	I'm not interested of treatment	5(100%)	0	0	5(2.4%)	0.63
	No orthodontic problem	9(100%)	0	0	9(4.4%)	0.009
	Severe decayed teeth	5(100%)	0	0	5(2.4%)	0.225
	Cannot afford Tx. fees	5(83.3%)	1(16.7%)	0	6(2.9%)	0.133
	Sensitivity of used materials	0	0	0	0	
	Pregnant	1(100%)	0	0	1(0.5%)	0.392
	Cannot maintain good OH	13(86.7%)	2(13.3%)	0	15(7.3%)	0.009
	Medically compromised patient	4(100%)	0	0	4(2%)	0.084
	Lack of experience	19(100%)	0	0	19(9.2%)	0.0001
	Other	1(33.3%)	2(66.7%)	0	3(1.5%)	0.796
	Did not follow the doctor instructions	2(100%)	0	0	2(1%)	0.225
If you have orthodontic treatment answer the following questions:	Crowded teeth	29(76.3%)	8(21.1%)	1	38(18.4%)	0.002
	Pronunciation and speech problems	7(77.8%)	2(22.2%)	0	9(4.4%)	0.111
	Protruded lower teeth	19(95.0%)	1(5%)	0	20(9.7%)	0.0001
	Space between teeth	16(47.1%)	18(52.9%)	0	34(16.5%)	0.711
	Protruded upper teeth	37(100%)	0	0	37(18%)	0.0001
	TMJ pain and clicking	4(50%)	4(50%)	0	8(3.9%)	0.768
	gummy smile	13(100%)	0	0	13(6.3%)	0.001
	Being teased by your colleagues	9(75%)	3(25%)	0	12(5.8%)	0.088
	Open bite	7(26.9%)	19(73.1%)	0	26(12.6%)	0.181
	To be socially accepted	12(85.7%)	2(14.3%)	0	14(6.8%)	0.013
	Deep bite	1(100%)	0	0	1(0.5%)	0.392
	A transfer from another dentist	2(100%)	0	0	2(1%)	0.225
	Other	0	0	1(100%)	1(0.5%)	0.095
	biting and chewing Problems	9(52.9%)	8(47.1%)	0	17(8.3%)	0.528

Generally, most of the cases reported equal percentage concerning “no root damage during OT”, and “no abscessed teeth” (60.5%). Furthermore, 38.9% of the responses revealed “no root canal treatment” during OT, while 67.9% of cases reported that having toothache, 53.8% suffering from dental caries, and 45.4% reported gum problems during and after OT. Most of the responses were from type I DM, indicating medium level of satisfaction during or after

treatment (Table 4). Furthermore, the results revealed no significance among different types of DM after treatment completion, even though the rate of approval was higher among type I patients ( $p > 0.05$ ) indicating medium level of satisfaction after treatment among diabetic groups as shown in Table 5. According to the survey, more than third of the participants (39.8%) reported OT discontinuation, where more than half of them reported that it was their decision (54.9%) as presented in Table 6.

**Table 3. The relation between DM type and participants' satisfaction level (Measuring patient satisfaction with access to services provided to them).**

Variable		Diabetes Mellitus				P value
		Type I	Type II	GDM	Total	
Q1- Was it easy to get an appointment?	Strongly disagree	2(3.8%)	44(83.0%)	7(13.2%)	53(28.2%)	0.0001
	Disagree	24(52.2%)	22(47.8%)	0	46(24.3%)	
	Neutral	33(89.2%)	2(5.4%)	2(5.4%)	37(19.7%)	
	Agree	16(80.0%)	3(15.0%)	1(5%)	20(10.6%)	
	Strongly Agree	29(90.6%)	3(9.4%)	0	32(17%)	
Q2- Were you giving a clear direction to the clinic?	Strongly disagree	2(3.4%)	55(94.8%)	1(1.7%)	58(32.8%)	0.0001
	Disagree	44(80.0%)	11(20%)	0	55(31.1%)	
	Neutral	20(90.9%)	0	2(9.1%)	22(12.4%)	
	Agree	18(78.3%)	4(17.4%)	1(4.3%)	23(13%)	
	Strongly Agree	16(84.2%)	3(15.8%)	0	19(10.7%)	
Q4- Have you been greeted and welcomed with a good manner & offered appointment time that was convenient to you?	Strongly disagree	2(5.1%)	37(94.9%)	0	39(23.4%)	0.0001
	Disagree	37(68.5%)	17(31.5%)	0	54(32.3%)	
	Neutral	36(97.3%)	1(2.7%)	0	37(22.2%)	
	Agree	11(61.1%)	4(22.2%)	3(16.7%)	18(10.8%)	
	Strongly Agree	15(78.9%)	4(21.1%)	0	19(11.4%)	
Q6- Did you receive your treatment in right time?	Strongly disagree	1(3.2%)	30(96.8%)	0	31(19.6%)	0.0001
	Disagree	33(66%)	17(34%)	0	50(31.6%)	
	Neutral	28(96.6%)	1(3.4%)	0	29(18.4%)	
	Agree	19(86.4%)	2(9.1%)	1(4.5%)	22(13.9%)	
	Strongly Agree	19(73.1%)	6(23.1%)	1(3.8%)	26(16.3%)	
Q7- Did your doctor allocate enough time to listen to your problems and personal health, answer all your questions and explain to you what you need to know?	Strongly disagree	3(8.8%)	31(91.2%)	0	34(20.9%)	0.0001
	Disagree	22(52.4%)	20(47.6%)	0	42(25.8%)	
	Neutral	33(97.1%)	1(2.9%)	0	34(20.9%)	
	Agree	21(80.8%)	2(7.7%)	3(11.5%)	26(16.0%)	
	Strongly Agree	22(81.3%)	5(18.5%)	0	27(16.6%)	
Q8- Did your doctor explain the treatment options, the risks and side effects resulting from your treatment clearly?	Strongly disagree	2(6.1%)	31(93.9%)	0	33(21.4%)	0.0001
	Disagree	28(68.3%)	13(31.7%)	0	41(26.6%)	
	Neutral	31(96.9%)	1(3.1%)	0	32(20.8%)	
	Agree	22(81.5%)	2(7.4%)	3(11.1%)	27(17.3%)	
	Strongly Agree	16(76.2%)	5(23.8%)	0	21(13.6%)	
Q12- Have you given the opportunity to choose the type of treatment?	Strongly disagree	3(9.7%)	28(90.3%)	0	31(20.3%)	0.0001
	Disagree	21(58.3%)	15(41.7%)	0	36(23.8%)	
	Neutral	41(97.6%)	1(2.4%)	0	42(27.8%)	
	Agree	23(88.3%)	2(7.7%)	1(3.8%)	26(17.2%)	
	Strongly Agree	11(68.8%)	3(18.8%)	2(12.5%)	16(10.6%)	
Q13- Did you feel comfortable during the duration of treatment?	Strongly disagree	2(7.1%)	26(92.9%)	0	28(18.9%)	0.0001
	Disagree	22(62.9%)	13(37.1%)	0	35(23.6%)	
	Neutral	36(94.7%)	2(5.3%)	0	38(25.7%)	
	Agree	24(85.7%)	2(7.1%)	2(7.1%)	28(18.9%)	
	Strongly Agree	15(78.9%)	4(21.1%)	0	19(12.8%)	
Q14- Are you confident with the treatment provided to you & satisfied with your doctor?	Strongly disagree	2(5.9%)	32(94.1%)	0	34(22.3%)	0.0001
	Disagree	31(75.6%)	10(24.4%)	0	41(27.2%)	
	Neutral	32(97%)	1(3%)	0	33(21.9%)	
	Agree	20(87.0%)	2(8.7%)	1(4.3%)	23(15.2%)	
	Strongly Agree	14(70%)	5(25%)	1(5%)	20(13.2%)	
Q15- Was treatment fee reasonable and acceptable to you?	Strongly disagree	2(6.7%)	28(93.3%)	0	30(19.9%)	0.0001
	Disagree	15(46.9%)	14(43.8%)	3(9.4%)	32(21.2%)	
	Neutral	38(95%)	2(5%)	0	40(26.3%)	
	Agree	22(91.7%)	2(8.3%)	0	24(15.9%)	
	Strongly Agree	22(88%)	3(12%)	0	25(16.6%)	



The result showed that the main reasons for discontinuing OT, with significant association to Diabetes Mellitus type, were due to bad oral hygiene and treatment expenses (23.2%), followed by teeth mobility and transportation difficulty (15.9%), and lastly were due to relocation to different place (9.8%), and painful procedure (8.5%). In addition, the main reasons of the participants not advising

others to undergo orthodontic treatment were “painful treatment” (11.2%,  $p=0.0001$ ), less satisfaction about treatment results (9.2%,  $p=0.0001$ ), and due to difficulty of maintaining good oral hygiene with fixed orthodontic appliances (8.7%,  $p=0.001$ ) (Table 6). Majority of the responses were among type I DM patients.

**Table 4. The relation between DM type and participants' satisfaction level (Measuring the satisfaction of diabetics during and after OT).**

Variable		Diabetes Mellitus				P value
		Type I	Type II	GDM	Total	
Did your orthodontic treatment affect your dietary habits?	Yes	21(45.7%)	24(52.2%)	1(2.2%)	46(35.4%)	0.0001
	No	53(93%)	4(7%)	0	57(43.8%)	
	Not a concern	24(88.9%)	1(3.7%)	2(7.4%)	27(20.8%)	
Did your orthodontists do regular blood glucose level test before treatment?	Yes	4(14.3%)	23(82.1%)	1(3.6%)	28(22.0%)	0.0001
	No	81(98.8%)	1(1.2%)	0	82(64.6%)	
	Not a concern	13(76.5%)	2(11.8%)	2(11.8%)	17(13.4%)	
Have you ever fainted in the orthodontic clinic?	Yes	2(13.3%)	13(86.7%)	0	15(11.7%)	0.852
	No	90(93.8%)	5(5.2%)	1(1%)	96(75.0%)	
	Not a concern	6(35.3%)	9(52.9%)	2(11.8%)	17(13.3%)	
Have you ever been infected with candida infection or ulcers during treatment?	Yes	8(28.6%)	20(71.4%)	0	28(21.9%)	0.0001
	No	74(91.4%)	6(7.4%)	1(1.2%)	81(63.3%)	
	Not a concern	16(84.2%)	1(5.3%)	2(10.5%)	19(14.8%)	
Did you have any pain in your teeth.	Yes	61(68.5%)	27(30.3%)	1(1.1%)	89(67.9%)	0.275
	No	22(91.7%)	2(8.3%)	0	24(18.3%)	
	Don't know	15(83.3%)	1(5.6%)	2(11.1%)	18(13.7%)	
Have you received root canal treatment?	Yes	41(61.2%)	25(37.3%)	1(1.5%)	67(51.1%)	0.031
	No	46(90.2%)	5(9.8%)	0	51(38.9%)	
	Don't know	11(84.6%)	0	2(15.4%)	13(9.9%)	
Did you have an abscessed tooth?	Yes	14(37.8%)	22(59.5%)	1(2.7%)	37(28.7%)	0.0001
	No	72(92.3%)	6(7.7%)	0	78(60.5%)	
	Don't know	12(85.7%)	0	2(14.3%)	14(10.9%)	
Did you have gum problems ?	Yes	34(57.6%)	24(40.7%)	1(1.7%)	59(45.4%)	0.005
	No	46(90.2%)	5(9.8%)	0	51(39.2%)	
	Don't know	18(90%)	0	2(10%)	20(15.4%)	
Did you have a root damage during orthodontic treatment?	Yes	7(23.3%)	22(73.3%)	1(3.3%)	30(23.3%)	0.0001
	No	72(92.3%)	6(7.7%)	0	78(60.5%)	
	Don't know	19(90.5%)	0	2(9.5%)	21(16.3%)	
Did you suffer from dental caries?	Yes	44(62.9%)	25(35.7%)	1(1.4%)	70(53.8%)	0.032
	No	40(90.9%)	4(9.1%)	0	44(33.8%)	
	Don't know	14(87.5%)	0	2(12.5%)	16(12.3%)	

The fundamental requirement of quality healthcare services is the adoption of a system that is ‘patient orientated’. In any health care set up, patient satisfaction with regards to quality of services and treatment provided is a very important indicator and a sensitive issue. It is a determining factor since patients choose the healthcare providers who can respond to their needs and meet their expectations (Khan et al. 2014). Patient level of satisfaction has been shown to correlate positively with the success of treatment provided. There is variation in patients' expectations of orthodontic treatment and these differences arise commonly from factors such as age, gender, satisfaction with facial appearance, as well as influence from peers, parents, and others. Understanding the patients' expectations and attitude is a prerequisite for appropriate behavioral and clinical management. Increasingly, patient-centered measures aim to improve health services and are used to assess these subjective attributes in assessing orthodontic need and in determining the outcomes of orthodontic care. Assessment of patients' expectations is central to understanding the oral health needs, patient satisfaction with the treatment, and ultimately the perceived overall quality of health systems (Farishta 2015; Afrashtehfar et al. 2020).

The results revealed that the level of satisfaction was lower among type II than type I diabetic patients. This could be explained by the fact that type II diabetic patients' satisfaction levels with the care they received is affected by many factors such as age, gender, and education levels (Othman et al. 2015; Jalil et al. 2017). In addition, adults with type II DM, especially those in middle age, do care more about treatment cost, convenience, duration, and results. Hence, they develop more practical expectations, and do approach to an Orthodontist for consultation more than patients with type I DM. Several studies reported that the key to any orthodontic treatment for a patient with diabetes is good medical control. OT should not be performed in a patient with uncontrolled diabetes (Chauhan et al. 2018). Similar result was reported in the current study, where the main reason for orthodontists' refusal of providing treatment for diabetic patients was due to uncontrolled blood sugar. Previous studies reported that it is essential to pay attention to maintaining good oral hygiene, especially when fixed appliances were used. Diabetes related microangiopathy can affect the peripheral vascular supply, resulting in unexplained toothache, tenderness to percussion and even loss of vitality. Furthermore, applying

light forces during OT is recommended, where uncontrolled or poorly controlled diabetic patients have an increased

tendency for periodontal breakdown (Rizvi et al. 2014; Muhamad et al. 2015).

**Table 5. The relation between DM type and participants' satisfaction level (After completion of OT).**

Variable		Diabetes Mellitus				P value
		Type I	Type II	GDM	Total	
Q1- Have you had a bone resorption?	Yes	10(83.3%)	2(16.7%)	0	12(11.9%)	0.298
	No	58(96.7%)	2(3.3%)	0	60(59.4%)	
	Don't know	25(86.2%)	2(6.9%)	2(6.9%)	29(28.7%)	
Q2- Have you had TMJ pain and clicking?	Yes	20(83.3%)	3(12.5%)	1(4.2%)	24(24%)	0.812
	No	54(94.7%)	3(5.3%)	0	57(57%)	
	Don't know	16(84.2%)	1(5.3%)	2(10.5%)	19(19%)	
Q3- Did you feel mobility in your teeth?	Yes	32(97%)	1(3%)	0	33(34%)	0.067
	No	38(90.5%)	4(9.5%)	0	42(43.3%)	
	Don't know	19(86.4%)	1(4.5%)	2(9.1%)	22(22.7%)	
Q4- Have you had root resorption ?	Yes	11(84.6%)	2(15.4%)	0	13(13%)	0.506
	No	56(94.9%)	3(5.1%)	0	59(59%)	
	Don't know	25(89.3%)	1(3.6%)	2(7.1%)	28(28%)	
Q5- Has your speech improved after treatment?	Yes	36(94.7%)	2(5.3%)	0	38(38.4%)	0.288
	No	23(88.5%)	3(11.5%)	0	26(26.3%)	
	Don't know	32(91.4%)	1(2.9%)	2(5.7%)	35(35.4%)	
Q6- Did you remove or lose any of your teeth?	Yes	46(93.9%)	2(4.1%)	1(2%)	49(46.7%)	0.151
	No	32(88.9%)	4(11.1%)	0	36(34.3%)	
	Don't know	17(85%)	1(5%)	2(10%)	20(19%)	
Q7- Has your chewing ability improved after treatment?	Yes	42(97.7%)	1(2.3%)	0	43(43.9%)	0.103
	No	19(82.6%)	4(17.4%)	0	23(23.5%)	
	Don't know	29(90.6%)	1(3.1%)	2(6.3%)	32(32.7%)	
Q8- Are you satisfied about your appearance?	Yes	47(88.7%)	5(9.4%)	1(1.9%)	53(53.5%)	0.481
	No	25(96.2%)	1(3.8%)	0	26(26.3%)	
	Don't know	17(85%)	1(5%)	2(10%)	20(20.2%)	
Q9- In general are you convinced with your treatment results?	Yes	53(89.8%)	5(8.5%)	1(1.7%)	59(57.8%)	0.398
	No	21(95.5%)	1(4.5%)	0	22(21.6%)	
	Don't know	18(85.7%)	1(4.8%)	2(9.5%)	21(20.6%)	
Q10- Is your appearance improved significantly?	Yes	54(91.5%)	4(6.8%)	1(1.7%)	59(57.8%)	0.190
	No	23(92%)	2(8.0%)	0	25(24.5%)	
	Don't know	15(83.3%)	1(5.6%)	2(11.1%)	18(17.6%)	
Q11- Have you noticed improvement on your self-confidence?	Yes	55(91.7%)	4(6.7%)	1(1.7%)	60(58.3%)	0.356
	No	15(88.2%)	2(11.8%)	0	17(16.5%)	
	Don't know	23(88.5%)	1(3.8%)	2(7.7%)	26(25.2%)	
Q12- Do you noticed better social acceptance after treatment?	Yes	49(94.2%)	3(5.8%)	0	52(51.5%)	0.217
	No	15(88.2%)	2(11.8%)	0	17(16.8%)	
	Don't know	29(90.6%)	1(3.1%)	2(6.3%)	32(31.7%)	
Q13- Are you satisfied about your smile?	Yes	56(90.3%)	5(8.1%)	1(1.6%)	62(60.8%)	0.289
	No	20(95.2%)	1(4.8%)	0	21(20.6%)	
	Don't know	16(84.2%)	1(5.3%)	2(10.5%)	19(18.6%)	
Q14- Is your doctor has given you the dates for future follow-up?	Yes	40(90.9%)	4(9.1%)	0	44(43.6%)	0.220
	No	36(97.3%)	1(2.7%)	0	37(36.6%)	
	Don't know	17(85%)	1(5%)	2(10%)	20(19.8%)	
Q15- Can you repeat the experience to undergo orthodontic treatment again?	Yes	48(96%)	2(4%)	0	50(49.5%)	0.093
	No	20(87.0%)	3(13%)	0	23(22.8%)	
	Don't know	25(89.3%)	1(3.6%)	2(7.1%)	28(27.7%)	
Q16- Would you recommend diabetic patients to undergo orthodontic treatment?	Yes	60(92.3%)	4(6.2%)	1(1.5%)	65(62.5%)	0.208
	No	10(90.9%)	1(9.1%)	0	11(10.6%)	
	Don't know	24(85.7%)	2(7.1%)	2(7.1%)	28(26.9%)	

Table 6. The relation between DM type and orthodontic discontinuation.

Variable	Diabetes Mellitus				P value
	Type I	Type II	GDM	Total	
If your orthodontic treatment had to be discontinued this was:					
Your decision	43(95.6%)	0	2(4.4%)	45(54.9%)	0.898
Parents decision	10(90.9%)	1(9.1%)	0	11(13.4%)	
Orthodontist decision	14(93.3%)	1(6.7%)	0	15(18.3%)	
Physician decision	8(88.9%)	1(11.1%)	0	9(11%)	
Others	2(100%)	0	0	2(2.4%)	
If you answered the previous question, the cause of discontinuing treatment was due to:					
Bad oral hygiene	19(100%)	0	0	19(23.2%)	0.0001
Mobility of teeth	12(92.3%)	1(7.7%)	0	13(15.9%)	0.006
Recurrent fainting on dental chair	1(100%)	0	0	1(1.2%)	0.392
Teeth invitality	3(100%)	0	0	3(3.7%)	0.136
Severe inflammation of the gums	3(75%)	1(25%)	0	4(4.9%)	0.334
Transition to another place	8(100%)	0	0	8(9.8%)	0.014
Lacking cooperation and attention from me	2(100%)	0	0	2(2.4%)	0.225
Transportation	13(100%)	0	0	13(15.9%)	0.001
Treatment expenses	18(94.7%)	0	1(5.3%)	19(23.2%)	0.001
Caries	4(80%)	1(20%)	0	5(6.1%)	0.210
Physician recommendation	1(50%)	1(50%)	0	2(2.4%)	0.884
Recurrent mouth ulcers	0	0	0	0	
Uncontrolled sugar level	6(85.7%)	1(14.3%)	0	7(8.5%)	0.085
eRoot resorption	2(100%)	0	0	2(2.4%)	0.225
I cannot tolerate the pain	7(100%)	0	0	7(8.5%)	0.021
There are no progress in the treatment	0	0	0	0	
Orthodontist transferred	4(80%)	1(20%)	0	5(6.1%)	0.396
Others	4(100%)	0	0	4(4.9%)	0.084
Other health problems adversely affect the treatment	4(100.0%)	0	0	4(4.9%)	0.084
If you advice others not to undergo orthodontic treatment this is because:					
You are not satisfied about treatment results	19(100%)	0	0	19(9.2%)	0.0001
Risks of the results is more than the benefits	9(100%)	0	0	9(4.4%)	0.009
It was difficult to maintain good oral hygiene with orthodontic appliances	17(94.4%)	1(5.6%)	0	18(8.7%)	0.001
Changing in the dietary habits	8(100.0%)	0	0	8(3.9%)	0.014
Recurrent mouth ulcers and fungus	1(100.0%)	0	0	1(0.5%)	0.392
Bad mouth breath after treatment	6(100.0%)	0	0	6(2.9%)	0.034
Teeth mobility and bone resorption	8(88.9%)	1(11.1%)	0	9(4.4%)	0.035
Treatment was stressful	8(80.0%)	2(20.0%)	0	10(4.9%)	0.073
Several carious lesions	5(83.3%)	1(16.7%)	0	6(2.9%)	0.133
Root resorption	2(100%)	0	0	2(1%)	0.225
Painful Treatment	23(100%)	0	0	23(11.2%)	0.0001
gingival recession	0	0	1(100%)	1(0.5%)	0.031
TMJ problems	4(100%)	0	0	4(2%)	0.084
Other	2(100%)	0	0	2(1%)	0.225

The results in the present study showed that even though the orthodontists dealt with of these issues, patients reported medium level of satisfaction during treatment and after treatment. Most of the responses showed that there was no root damage, no endodontic treatment, and no abscessed teeth during OT. On the other hand, they reported having toothache, suffering from dental caries, and having gum problems during OT. Various previous studies have established that patients and dentists' interaction is the most important factor that can influence satisfaction levels among dental patients. Patients judge dentist skills and the quality of care they receive on the basis of their personal interaction with dentist. Behavior of the dentist towards the patient, which must include showing empathy to patients needs and reassuring them regarding their expectations and demands, needs to be given top priority by all dental professionals (Khan et al. 2014; Luo et al. 2018).

In the present study, the findings revealed low levels of satisfaction with adult patients over young patients regarding access to services provided to them. Financial cost is a key factor from patients' perspective. High dental treatment costs are one of the important factors that can hinder patients' visits to dental clinics and their decision to seek dental treatment. Many previous studies have reported that patients prefer to visit teaching dental hospitals due

to a good source of quality, reduced-cost dental treatment as most of these teaching facilities have clinics that allow dental students to gain experience treating patients while providing care at a reduced cost (Khan et al. 2014; Khan et al. 2017). In this study, only 25.7% of patients visiting Orthodontic department found that the cost of OT to be reasonable. Similar result was reported in previous studies (Al-Hussyeen 2010). In the present study, most of the responses showed that the appointment time was not convenient, and they didn't receive their treatment on time. This finding is consistent with the conclusion drawn by other researchers who found that long waiting times in dental clinics and lack of proper waiting areas are the main reasons of disappointment and dissatisfaction among dental patients (Al-Hussyeen 2010; Khan et al. 2014; Yong et al. 2021).

The satisfaction level in the present study was higher among type I DM patients in all variables than type II DM patients. This finding could be attributed to the fact that responsibilities and life stress among younger individuals are less than those among adults. In addition, their increased exposure to dental care facilities and their modest expectations and demands are more likely to be attained. Finally, it is necessary to mention that the present study has some limitations. Most importantly is the small sample



size and the subjective nature that is difficult to quantify. In addition, the long-term nature of OT, and the results that involve both functional and aesthetic components limit the generalization of the results to all Saudi community. Therefore, further studies are required to increase the sample size and to evaluate the level of satisfaction among Orthodontic diabetic patients to improve the quality of provided services.

## CONCLUSION

The findings of the present study has shown that the level of satisfaction among orthodontic diabetic patients with access to services provided to them, patient satisfaction during and after completion of OT and causes of treatment discontinuation was medium in the present study. Regular feedback and evaluation of patient satisfaction level is essential in order to further improve quality of services. Orthodontist should be conscious about the importance of diabetes in relation to the patients' susceptibility to periodontitis, especially if uncontrolled. Periodontal health and proper oral hygiene should be strictly observed during treatment.

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**Ethical Statement:** I am pleased to inform you that your above-mentioned research project was reviewed by the institutional Review Board on 19 October 2015 (06 Muharram 1437). The Project was **approved**. Work on this project may begin. Research Project No **E-15-1657**.

**Data Availability Statement:** The database generated and /or analysed during the current study are not publicly available due to privacy, but are available from the corresponding author on reasonable request.

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