

Scientific Research Report

Awareness About the Oral and Systemic Complications of Diabetes Among a Cohort of Diabetic Patients of the Republic of Mauritius



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ABSTRACT

Background: Persistent hyperglycaemia in patients with uncontrolled or poorly controlled diabetes may cause serious oral and systemic complications. Persons with diabetes are mostly unaware of their increased risk of oral complications.

Objective: This study investigated awareness about the association of diabetes with other diseases and knowledge about the systemic and oral complications of diabetes among patients with diabetes in the Republic of Mauritius.

Methods: Data were collected from 720 patients with diabetes using an anonymous closed-end questionnaire. Descriptive statistics and multivariate logistic regression analyses were used to report the results and to identify factors associated with awareness about the link between diabetes and other diseases and knowledge about oral and systemic complications.

Results: The majority of the study participants were aware of the association between diabetes and other diseases. However, knowledge about oral complications of diabetes was limited (caries [29%], periodontal disease [37%], and xerostomia [52%]). Education and the number of years since diagnosis of diabetes were the most significant predictors of awareness about complications. The experience of xerostomia and periodontal disease were associated with knowledge about their respective increased risk. Receiving advice from diabetes care providers increased awareness about caries and periodontal disease. Age and type of diabetes were associated with knowledge about systemic complications.

Conclusion: Awareness about the oral complications of diabetes was limited and was mainly linked with the experience of disease. This indicates a need for increased health promotion with customised educational programs to inform patients with diabetes of their increased risk of developing complications.

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Introduction

Diabetes mellitus is one of the most prevalent chronic diseases worldwide. It was recently estimated that 463 million adults were living with diabetes mellitus, and it is expected that this number will increase to 700 million people by 2045.¹

Diabetes is a metabolic disorder characterised by an increase in blood sugar level (hyperglycaemia) as a result of a

defect in insulin secretion, insulin action, or both. Depending on the pathogenesis of the disease, diabetes is classified into 4 main groups: type 1 diabetes (T1DM), type 2 diabetes (T2DM), gestational diabetes (GDM), and specific types of diabetes because of other causes.² Persistent hyperglycaemia in T1DM and T2DM is significantly associated with the development of micro- and macrovascular complications such as retinopathy with potential loss of vision, nephropathy leading to renal failure, peripheral neuropathy, coronary heart disease, cerebrovascular disease, and peripheral artery disease with an increased risk of diabetic foot and amputation.^{3,4} GDM has been found to be associated with an increased risk of adverse pregnancy outcomes,⁵ including the high likelihood of later developing T2DM.⁶ Although there are

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no specific oral lesions associated with diabetes, prolonged hyperglycaemia can cause oral manifestation such as burning sensation of the oral mucosa, xerostomia, caries, and periodontal disease (gingivitis and periodontitis), leading to premature tooth loss.^{7,8} Although the evidence for links between diabetes and caries remains inconclusive,⁹ there is an increasing body of evidence showing a bidirectional relationship between diabetes and periodontal disease. Diabetes increases the risk for periodontitis,⁹ and periodontal inflammation negatively affects glycaemic control.¹⁰ In addition, the presence of severe periodontitis in patients with uncontrolled or poorly controlled diabetes may lead to severe complications with increased morbidity and mortality.^{10,11} Nonetheless, people with diabetes are mostly unaware of the association between diabetes and oral health and of their increased risk of various oral health complications.¹²

The Republic of Mauritius has one of the highest prevalence of diabetes in the world. It is predicted that the percentage of the population diagnosed with diabetes will rise from 22% in 2019 to 25.3% in 2045, making it the country with the highest prevalence in Africa and second-highest in the world.¹ Furthermore, about one-third of the known diabetes cases have poor glycaemic control,¹³ thus increasing the risk for adverse disease outcomes. The Global Burden of Disease (GBD) study 2017¹⁴ listed diabetes as the leading cause of disability-adjusted life years (DALYs; a measure that represents the sum of potential life lost because of premature mortality and years of productive life loss because of disability) in the country. Moreover, the DALYs as a result of periodontal disease increased by 2.8% during the last decade. Nonetheless, little is known about the oral health of Mauritians suffering from diabetes and about their awareness of the increased risk for people with diabetes to develop oral and systemic complications.

This study was designed to analyse a group of Mauritian participants with diabetes and their:

1. Awareness about the association between diabetes and other diseases.
2. Knowledge of the possible oral and systemic complications of diabetes.

Methods

Ethics

The study protocol was reviewed and approved by the University of Western Australia Human Research Ethics Committee (RA/4/1/8609) and the National Ethics Committee, Ministry of Health and Quality of Life of Mauritius (MHC/CT/NETH/PAON).

Study sample and inclusion criteria

During the period between 2016 and 2018, patients attending 13 selected diabetic clinics were invited to participate in the present study. Seventeen patients declined to fill in the questionnaire because of lack of time. A total of 720 patients with diabetes (98% response rate) completed a closed-end questionnaire.

The clinics were selected because they provide access to large numbers of patients with diabetes, and their geographical distribution ensured the inclusion of participants from both urban and rural areas of the country. Different types of clinics were also included to ascertain that both public and private patients participated in the study. Participation was voluntary. All patients were provided with oral and written information about the research, which included assurance of anonymity and data protection. All participants provided their signed informed consent before inclusion in this survey.

Questionnaire

The anonymous closed-end questionnaire was developed following a comprehensive review of the existing literature. Its feasibility was confirmed in a previous pilot study among patients with diabetes in Mauritius. The questionnaire included 15 questions grouped under 5 categories: (i) demography (age, gender, education, rural/urban place of residence, type of diabetes clinics); (ii) medical status (type of diabetes, number of years since diagnosed with diabetes); (iii) health behaviours (annual visit to diabetes care providers, frequency of visits to dental care providers); (iv) knowledge about the association between diabetes and other diseases (receiving advice from diabetes and dental care providers, knowledge about specific oral and systemic complications of diabetes); and (v) present and past experience of oral complications of diabetes (xerostomia and periodontal disease).

For unaccompanied patients with no reading and writing skills, the researcher asked the questions verbally in Creole (local spoken dialect) and filled in the form in their presence.

Measures

The main outcome variables for this study were (i) knowledge about the association between diabetes and systemic and oral diseases; (ii) awareness about specific systemic complications of diabetes (ocular, renal and cardiac); and (iii) awareness about specific oral complications of diabetes (caries, periodontal disease and xerostomia). Demographic characteristics (age, gender, rural or urban residence, education, type of diabetes clinics), health status (number of years since diagnosis, self-reported type of diabetes), general and oral health practices (annual visits to diabetes care provider, frequency of dental visits), receiving advice from diabetes or dental care provider, and type of diabetes clinic were considered as potential covariates.

For the purpose of statistical analyses, answers to the questions about the association between diabetes and other diseases and awareness about specific systemic and oral complications were dichotomised as "Yes" or "No."

Statistical analysis

The data were analysed by applying descriptive and inferential statistical analysis, using SPSS version 25 (SPSS Inc.). Univariate statistical analysis of differences between subgroups was performed using the χ^2 test. All tests were 2-sided with $P < .05$ set as the significance level. Further analyses using multiple logistic regressions were performed to identify the

variables most strongly associated with the following objectives of the research: investigate awareness of the association between diabetes and other diseases and knowledge of oral and systemic complications of diabetes.

Results

The study population included men and women from urban and rural areas of the island and was equally distributed between the age groups: younger than 60 (50.4%) and 60 and older (49.6%) (Table 1).

More than half of the study population (59.5%, data not available for 2 participants) had an education level that was lower than secondary level. While the majority of participants visited their treating doctor at least once a year, only 10.7% had dental visits either annually or every 6 months, and 23.2% could identify the type of diabetes they suffered from (Table 1). The majority of participants did not receive advice from diabetes care providers about the importance of good oral health or from the dental care providers about the importance of glycaemic control (Table 2).

A high percentage of the participants were aware of the association between diabetes and other diseases and knew about the following systemic complications of diabetes:

ocular (78.2%), renal disease (73.6%), and heart disease (66.5%) (Table 2). Knowledge about oral complications of diabetes was less prevalent, with caries being the less cited complication (Figure 1). About half of the cohort were suffering from or had experienced periodontal disease or xerostomia. Data about the experience of caries and systemic complications was not collected.

Awareness of the association of diabetes with oral and systemic diseases

Logistic regression analysis shows that after adjusting for confounders, the following factors were significant predictors ($P < .05$) of awareness about the association between diabetes and other diseases: education, the number of years since diagnosis of diabetes, self-reported type of diabetes, and the experience of xerostomia (Table 3).

Awareness increased with education and was highest among participants with tertiary education (Table 4). The likelihood of knowing about the association was highest among respondents with T1DM, among those diagnosed with diabetes for more than 5 years, and having experienced xerostomia. All the participants with T2DM reported being aware of the association (Table 4).

Table 1 – Distribution according to demography, medical status, and health behaviours.

Variables	Age (years)				Total
	<20	20-39	40-59	≥60	
Gender					
Male	20(55.6%)	18(26.9%)	101(38.8%)	154(43.1%)	293(40.7%)
Female	16(44.4%)	49(73.1%)	159(61.2%)	203(56.9%)	427(59.3%)
Education					
None	0(0.0%)	0(0.0%)	20(7.7%)	76(21.3%)	96(13.4%)
Primary	16(44.4%)	12(17.9%)	122(47.1%)	181(50.8%)	331(46.1%)
Secondary	19(52.8%)	39(58.2%)	108(41.7%)	91(25.6%)	257(35.8%)
Tertiary	1(2.8%)	16(23.9%)	9(3.5%)	8(2.2%)	34(4.7%)
Address					
Rural	26(72.2%)	33(49.3%)	159(61.2%)	177(49.6%)	395(54.9%)
Urban	10(27.8%)	34(50.7%)	101(38.8%)	180(50.4%)	325(45.1%)
Years with diabetes					
<5years	17(47.2%)	44(65.7%)	112(43.2%)	81(23.1%)	254(35.6%)
5-9 years	16(44.4%)	7(10.4%)	61(23.6%)	69(19.7%)	153(21.5%)
10+ years	3(8.4%)	16(23.9%)	86(33.2%)	201(57.2%)	306(42.9%)
Self- reported DM type					
Type 1	34(94.4%)	18(26.9%)	15(5.8%)	8(2.2%)	75(10.4%)
Type 2	0(0.0%)	10(14.9%)	31(11.9%)	36(10.1%)	77(10.7%)
Do not know	2(5.6%)	24(35.8%)	214(82.3%)	313(87.7%)	553(76.8%)
Gestational	0(0.0%)	15(22.4%)	0(0.0%)	0(0.0%)	15(2.1%)
Annual medical follow-up					
Yes	34(94.4%)	57(85.1%)	242(93.1%)	348(97.5%)	681(94.6%)
No	2(5.6%)	9(13.4%)	15(5.8%)	7(2.0%)	33(4.6%)
No recent diagnosis of DM	0(0.0%)	1(1.5%)	3(1.2%)	2(0.6%)	6(0.8%)
Dental visit					
Every 6 months	7(19.4%)	7(10.4%)	9(3.5%)	9(2.5%)	32((4.4%)
Annually	7(19.4%)	9(13.4%)	18(6.9%)	11(3.1%)	45(6.3%)
On need	20(55.6%)	50(74.6%)	230(88.5%)	331(92.7%)	631(87.6%)
Never	2(5.6%)	1(1.5%)	3(1.2%)	6(1.7%)	12(1.7%)
Type of diabetes clinic					
Public	17(47.2%)	53(79.1%)	234(90.0%)	340(95.2%)	644(89.4%)
Private	19(52.8%)	14(20.9%)	26(10.0%)	17(4.8%)	76(10.6%)

DM = diabetes mellitus.

Table 2 – Distribution according to advice received, knowledge about complications, and experience of oral complications.

Variables	Responses		
	Yes	No	Do not Know
Received advice from diabetes care provider	114(15.8%)	606(84.2%)	—
Received advice from dental care provider	171(23.8%)	549(76.2%)	—
Awareness about association with other diseases	609(84.6%)	17(2.4%)	94(13.0%)
Knowledge of complications of diabetes			
Ocular problems	563(78.2%)	21(2.9%)	136(18.9%)
Renal disease	530(73.6%)	54(7.5%)	136(18.9%)
Heart disease	479(66.5%)	105(14.6%)	136(18.9%)
Caries	208(28.9%)	373(51.8%)	139(19.3%)
Periodontal disease	267(37.1%)	315(43.8%)	138(19.2%)
Xerostomia	372(51.7%)	211(29.3%)	137(19.0%)
Experience of periodontal disease	367(51.0%)	353(49.0%)	0(0.0%)
Experience of xerostomia	361(50.1%)	352(48.9%)	5(0.7%)

Awareness about oral complications of diabetes

Multivariate logistic regression analyses show that gender, education, the number of years since diagnosis of diabetes, frequency of dental visits, receiving advice from diabetes and dental care providers, and the experience of periodontal disease and xerostomia significantly predicted ($P < .05$) knowledge about at least 1 of the oral complications of diabetes (Table 5).

Women and participants with regular dental visits were more likely to be aware of their increased risk of having caries (Table 6). Primary level of education, being diagnosed with diabetes for more than 5 years prior to this study, having received advice from diabetes care providers, and having experienced periodontal disease were all strong predictors of knowledge about both caries and periodontal disease as possible complications of diabetes. The likelihood of being aware of the increased risk of xerostomia increased with increasing levels of education. The experience of xerostomia and receiving advice from dental care providers were the other factors that

were significantly associated with knowledge about xerostomia as a possible complication of diabetes (Table 6).

Awareness about systemic complications of diabetes

Multivariate logistic regression analyses highlight the following factors as significant predictors ($P < .05$) of the cohort's awareness about at least 1 systemic complication of diabetes: age, education, the number of years since diagnosis of diabetes, self-reported type of diabetes, receiving advice from dental care providers, and experience of xerostomia (Table 7).

Of these, education, number of years since diagnosis of diabetes, and the experience of xerostomia were significantly associated with knowledge about all 3 systemic complications analysed. Knowledge increased with increasing level of education and with the experience of xerostomia (Table 8). It was higher among participants diagnosed with diabetes for more than 5 years prior to the study. Self-reported type of diabetes was found to be significantly associated with

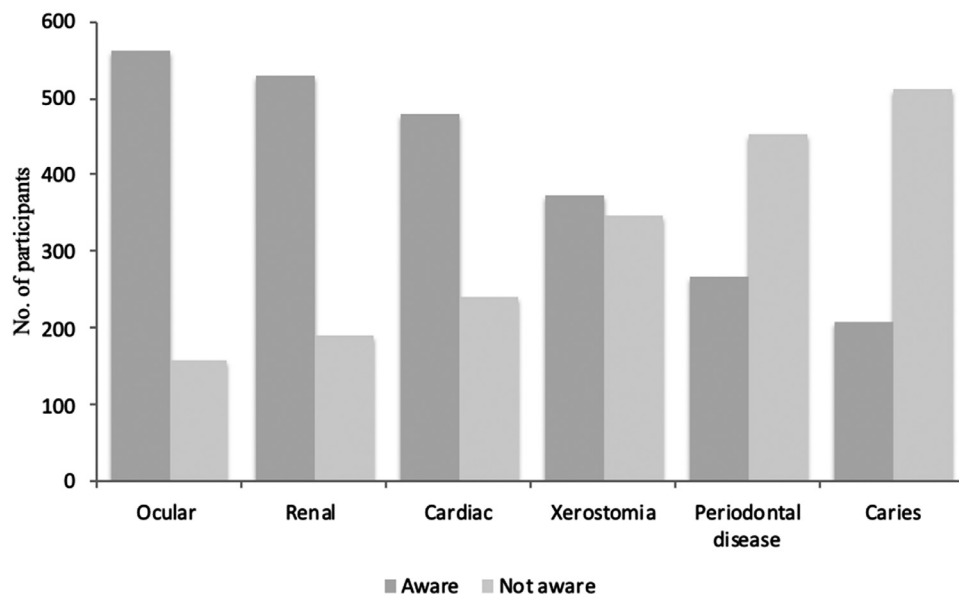


Figure 1 – Comparison between awareness about systemic and oral complications of diabetes.

Table 3 – Factors predicting awareness about association of diabetes with other diseases.

Variables	Association with other diseases		P value	
	Yes	No		
Age (years)	<20	35(97.2%)	1(2.8%)	.667
	20-39	60(89.6%)	7(10.4%)	
	40-59	227(87.3%)	33(12.7%)	
	60+	287(80.4%)	70(19.6%)	
Gender	Male	255(87.0%)	38(13.0%)	.987
	Female	354(82.9%)	73(17.1%)	
Education	None	65(67.7%)	31(32.3%)	.000*
	Primary	274(82.8%)	57(17.2%)	
	Secondary	236(91.8%)	21(8.2%)	
	Tertiary	33(97.1%)	1(2.9%)	
Address	Rural	329(83.3%)	66(16.7%)	1.000
	Urban	280(86.2%)	45(13.8%)	
Years with diabetes	<5	203(79.9%)	51(20.1%)	.042*
	5-9	136(88.9%)	17(11.1%)	
	10+	264(86.3%)	42(13.7%)	
Self-reported type of diabetes	T1DM	73(97.3%)	2(2.7%)	.000*
	T2DM	77(100.0%)	0(0.0%)	
	GDM	11(73.3%)	4(26.7%)	
	Do not know	448(81.0%)	105(19.0%)	
Annual visit to diabetes care provider	Yes	576(84.6%)	105 (15.4%)	.901
	No	28(84.8%)	5(15.2%)	
Frequency of dental visits	every 6 months	30(93.8%)	2(6.3%)	.184
	Yearly	44(97.8%)	1(2.2%)	
	On need	524(83.0%)	107(17.0%)	
	Never	11(91.7%)	1(8.3%)	
Advice from diabetes care provider	Received	103(90.4%)	11(9.6%)	.794
	Did not receive	506(83.5%)	100(16.5%)	
Advice from dental care provider	Received	155(90.6%)	16(9.4%)	.343
	Did not receive	454(82.7%)	95(17.3%)	
Type of diabetes clinic	Public	536(83.2%)	108(16.8%)	.696
	Private	73(96.1%)	3(3.9%)	
Experience of xerostomia	Yes	318(88.1%)	43(11.9%)	.017*
	No	288(81.8%)	64(18.2%)	
Experience of periodontal disease	Yes	312(85.0%)	55(15.0%)	.946
	No	297(84.1%)	56(15.9%)	

GDM = gestational diabetes mellitus; T1DM = type 1 diabetes mellitus; T2DM = type 2 diabetes mellitus.

* P < .05.

Table 4 – Stepwise logistic regression analysis with awareness about association with other diseases as dependent variable.

Dependent variable	Factors in final model		Adjusted OR	95% CI	P value	
Are aware about the association with other diseases	Education	None	1.0(reference)			
		Primary	2.5	1.44-4.30	0.001*	
		Secondary	4.3	2.24-8.36	0.000*	
		Tertiary	7.6	0.90-63.67	0.063	
	Years with diabetes	<5	1.0(reference)			
		5-9	2.0	1.05-3.79	0.034*	
		10+	1.7	1.03-2.79	0.038*	
	Self-reported type of diabetes	Do not know	1.0(reference)			
		Type 1	6.9	1.62-29.2	0.009*	
		Type 2	—	— [†]	—	
		GDM	0.7	1.10-2.71	0.591	
	Experience of xerostomia	No	1.0(reference)			
		Yes	1.7	1.10-2.72	0.018*	
No						

CI = confidence interval; GDM = gestational diabetes mellitus; OR = odds ratio; T2DM = type 2 diabetes mellitus.

* P < .05.

[†] 95% CI for T2DM cannot be calculated.

Table 5 – Factors associated with knowledge about oral complications of diabetes.

Variables	Caries		P value	Periodontal disease		P value	Xerostomia		P value
	Yes	No		Yes	No		Yes	No	
Age (years)			.405			.502			.894
<20	17(47.2%)	19(52.8%)		14(38.9%)	22(61.1%)		19(52.8%)	17(47.2%)	
20-39	25(37.3%)	42(62.7%)		25(37.3%)	42(62.7%)		38(56.7%)	29(43.3%)	
40-59	68(26.2%)	192(73.8%)		104(40.0%)	156(60.0%)		137(52.7%)	123(47.3%)	
60+	98(27.5%)	259(72.5%)		124(34.7%)	233(65.3%)		178(49.9%)	179(50.1%)	
Gender			.011*			.149			.905
Male	76(25.9%)	217(74.1%)		106(36.2%)	187(63.8%)		154(52.6%)	139(47.4%)	
Female	132(30.9%)	295(69.1%)		161(37.7%)	266(62.3%)		218(51.1%)	209(48.9%)	
Education			.016*			.004*			.000*
None	17(17.7%)	79(82.3%)		20(20.8%)	76(79.2%)		33(34.4%)	63(65.6%)	
Primary	101(30.5%)	230(69.5%)		134(40.5%)	197(59.5%)		176(53.2%)	155(46.8%)	
Secondary	79(30.7%)	178(69.3%)		98(38.1%)	159(61.9%)		139(54.1%)	118(45.9%)	
Tertiary	11(32.4%)	23(67.6%)		15(44.1%)	19(55.9%)		24(70.6%)	10(29.4%)	
Address			.810			.311			.335
Rural	108(27.3%)	287(72.7%)		142(35.9%)	253(64.1%)		190(48.1%)	205(51.9%)	
Urban	100(30.8%)	225(69.2%)		125(38.5%)	200(61.5%)		182(56.0%)	143(44.0%)	
Years with diabetes			.013*			.000*			.514
<5 years	60(23.6%)	194(76.4%)		70(27.6%)	184(72.4%)		112(44.1%)	142(55.9%)	
5-9 years	45(29.4%)	108(70.6%)		60(39.2%)	93(60.8%)		83(54.2%)	70(45.8%)	
10+ years	100(32.7%)	206(67.3%)		134(43.8%)	172(56.2%)		174(56.9%)	132(43.1%)	
Self-reported DM type			.150			.604			.164
T1DM	32(42.7%)	43(57.3%)		28(37.3%)	47(62.7%)		40(53.3%)	35(46.7%)	
T2DM	28(36.4%)	49(63.6%)		37(48.1%)	40(51.9%)		53(68.8%)	24(31.2%)	
Do not know	145(26.2%)	408(73.8%)		198(35.8%)	355(64.2%)		274(49.5%)	279(50.5%)	
GDM	3(20.0%)	12(80.0%)		4(26.7%)	11(73.3%)		5(33.3%)	10(66.7%)	
Annual medical follow-up			.332			.136			.666
Yes	196(28.8%)	485(71.2%)		251(36.9%)	430(63.1%)		357(52.4%)	324(47.6%)	
No	11(33.3%)	22(66.7%)		15(45.5%)	18(54.5%)		14(42.4%)	19(57.6%)	
Dental visit			.006*			.303			.433
Every 6 months	17(53.1%)	15(46.9%)		17(53.1%)	15(46.9%)		17(53.1%)	15(46.9%)	
Annually	21(46.7%)	24(53.3%)		18(40.0%)	27(60.0%)		22(48.9%)	23(51.1%)	
On need	168(26.6%)	463(73.4%)		227(36.0%)	404(64.0%)		328(52.0%)	303(48.0%)	
Never	2(16.7%)	10(83.3%)		5(41.7%)	7(58.3%)		5(41.7%)	7(58.3%)	
Received advice from diabetes care provider			.000*			.001*			.855
Yes	55(48.2%)	59(51.8%)		59(51.8%)	55(48.2%)		67(58.8%)	47(41.2%)	
No	153(25.2%)	453(74.8%)		208(34.3%)	398(65.7%)		305(50.3%)	301(49.7%)	
Total	208(28.9%)	512(71.1%)		267(37.1%)	453(62.9%)		372(51.7%)	348(48.3%)	
Received advice from dental care provider			.295			.416			.017*
Yes	67(39.2%)	104(60.8%)		79(46.2%)	92(53.8%)		106(62.0%)	65(38.0%)	
No	141(25.7%)	408(74.3%)		188(34.2%)	361(65.8%)		266(48.5%)	283(51.5%)	
Type of diabetes clinic			.605			.093			0.999
Public	182(28.3%)	462(71.7%)		243(37.7%)	401(62.3%)		332(51.6%)	312(48.4%)	
Private	26(34.2%)	50(65.8%)		24(31.6%)	52(68.4%)		40(52.6%)	36(47.4%)	
Experience of xerostomia			.281			.142			0.000*
Yes	104(28.8%)	257(71.2%)		151(41.8%)	210(58.2%)		260(72.0%)	101(28.0%)	
No	103(29.3%)	249(70.7%)		114(32.4%)	238(67.6%)		111(31.5%)	241(68.5%)	
Experience of periodontal disease			.029*			.033*			.778
Yes	124(33.8%)	243(66.2%)		155(42.2%)	212(57.8%)		205(55.9%)	162(44.1%)	
No	84(23.8%)	269(76.2%)		112(31.7%)	241(68.3%)		167(47.3%)	186(52.7%)	

DM = diabetes mellitus; GDM = gestational diabetes mellitus; T1DM = type 1 diabetes mellitus; T2DM = type 2 diabetes mellitus.

* P < .05.

knowledge about the increased risk of ocular and renal complications. (Table 8). It was highest among participants with T2DM for ocular complications and among participants with T1DM for renal complications.

Although age was not found to be associated with knowledge about ocular complications, participants aged between 40 to 59 years had the highest likelihood of being aware of their increased risk of renal and cardiac complications. Similarly, while receiving advice from dental care providers was

not found to be associated with knowledge about ocular and renal complications, participants receiving advice were 50% more likely to know about cardiac complications.

Discussion

The present study showed that the majority of the participants were aware of the association between diabetes and

Table 6 – Stepwise logistic regression analysis with knowing about oral complications as dependent variables.

Dependent variables	Factors in final model		Adjusted OR	95% CI	P value	
Caries	Gender	Male	1.0			
		Female	1.6	1.11-2.30	0.012*	
	Education	None	1.0			
		Primary	2.5	1.36-4.75	0.003*	
		Secondary	2.3	1.20-4.40	0.012*	
		Tertiary	1.5	0.56-4.25	0.396	
	Years since diagnosis	<5	1.0			
		5-9	1.3	0.81-2.13	0.263	
		10+	1.8	1.21-2.72	0.004*	
	Dental visits	Never	1.0			
		Every 6 months	5.6	1.01-31.41	0.049*	
		Annually	4.1	0.78-21.91	0.094	
	Received advice from diabetes care provider	On need	1.8	0.39-8.63	0.439	
		No	1.0			
Experience of periodontal disease	Yes	2.5	1.57-3.86	0.000*		
	No	1.0				
Periodontal disease	Education	Yes	1.5	1.04-2.10	0.030*	
		None	1.0			
		Primary	2.7	1.53-4.71	0.001*	
		Secondary	2.4	1.32-4.22	0.004*	
	Years since diagnosis	Tertiary	2.7	1.11-6.34	0.029*	
		<5	1.0			
		5-9	1.6	1.06-2.54	0.028*	
	Received advice from diabetes care provider	10+	2.1	1.46-3.06	0.000*	
		No	1.0			
	Experience of periodontal disease	Yes	2.0	1.32-3.13	0.001*	
		No	1.0			
	Xerostomia	Education	Yes	1.4	1.03-1.96	0.033*
			None	1.0		
			Primary	2.6	1.55-4.49	0.000*
Received advice from dental care provider		Secondary	3.1	1.76-5.31	0.000*	
		Tertiary	6.2	2.43-15.74	0.000*	
Experience of xerostomia		No	1.0			
	Yes	1.6	1.09-2.40	0.017*		
		Yes	6.2	4.44-8.78	0.000*	

CI = confidence interval; OR = odds ratio;

* $P < .05$.

systemic complications. However, knowledge about the oral complications of diabetes was limited.

The finding that patients with diabetes appear to lack important knowledge about their increased risk of various oral health complications and are more aware of systemic than oral complications of diabetes are in accordance with the conclusions of previous studies.^{12,15} The prevalence of awareness about the increased risk of caries (29%), periodontal disease (37%), and xerostomia (52%) are comparable to the findings of Boyer et al.¹⁶ The percentage of participants listing periodontitis as a possible complication of diabetes is within the range of 23%-48% found in most of the studies included in the systematic review by Poudel et al.¹² However, it is much lower than the minimum of 60% found in other studies.¹⁷⁻¹⁹ The difference in awareness about oral and systemic complications may be linked to the high mortality and morbidity associated with systemic complications of diabetes. In Mauritius, diabetes was found to be associated with a 67% increased odds of disability, 40% of which was linked with diabetes-related risk factors and concomitant diseases.²⁰ It was also estimated that during the last decade the age-standardised DALYs rate (per 100,000 population) because of

diabetes and chronic kidney disease as a complication of T2DM increased by 2.5% and 2.8% respectively.¹⁴ Moreover, Mauritius has the highest age standardised death rate resulting from diabetes in Africa and second-highest in the world.²¹ The country's last statistics report²² listed the disease as the principal underlying cause of mortality, representing 20.6% of all deaths. Of all persons whose cause of death were assigned to diabetes, 70% ultimately died with complications of diabetes, namely 40% with heart disease and 30% with cerebrovascular disease. The difference in awareness between oral and systemic complications may also be explained by the fact that in Mauritius patients with diabetes are screened for podiatric, retinal, and renal complications.²³ In contrast, oral screening is neither performed by diabetes care providers nor are patients with diabetes referred to dental care providers for examination and follow-up.

The factors found to significantly predict awareness about the association of diabetes with other diseases and knowledge about both oral and systemic complications of diabetes were education and the number of years since diagnosis of diabetes. Awareness increases with increasing level of education (except for caries and periodontal disease) and with

Table 7 – Factors associated with knowledge about systemic complications of diabetes.

Variables	Ocular problems		P value	Renal disease		P value	Heart disease		P value
	Yes	No		Yes	No		Yes	No	
Age (years)			.194			.000*			.000*
<20	29(80.6%)	7(19.4%)		23(63.9%)	13(36.1%)		15(41.7%)	21(58.3%)	
20-39	57(85.1%)	10(19.4%)		55(82.1%)	12(17.9%)		39(58.2%)	28(41.8%)	
40-59	217(83.5%)	43(16.5%)		213(81.9%)	47(18.1%)		192(73.8%)	68(26.2%)	
60+	260(72.8%)	97(27.2%)		239(66.9%)	118(33.1%)		233(65.3%)	124(34.7%)	
Gender			.716			.319			.189
Male	237(80.9%)	56(19.1%)		219(74.7%)	74(25.3%)		196(66.9%)	97(33.1%)	
Female	326(76.3%)	101(23.7%)		311(72.8%)	116(27.2%)		283(66.3%)	144(33.7%)	
Education			.000*			.000*			.000*
None	51(53.1%)	45(46.9%)		49(51.0%)	47(49.0%)		46(47.9%)	50(52.1%)	
Primary	254(76.7%)	77(23.3%)		236(71.3%)	95(28.7%)		222(67.1%)	109(32.9%)	
Secondary	225(87.5%)	32(12.5%)		213(82.9%)	44(17.1%)		183(71.2%)	74(28.8%)	
Tertiary	32(94.1%)	2(5.9%)		31(91.2%)	3(8.8%)		27(79.4%)	7(20.6%)	
Address			.762			.790			.802
Rural	301(76.2%)	94(23.8%)		285(72.2%)	110(27.8%)		258(65.3%)	137(34.7%)	
Urban	262(80.6%)	63(19.4%)		245(75.4%)	80(24.6%)		221(68.0%)	104(32.0%)	
Years with diabetes			.029*			.002*			.003*
<5 years	184(72.4%)	70(27.6%)		169(66.5%)	85(33.5%)		143(56.3%)	111(43.7%)	
5-9 years	126(82.4%)	27(17.6%)		121(79.1%)	32(20.9%)		107(69.9%)	46(30.1%)	
10+ years	248(81.0%)	58(19.0%)		235(76.8%)	71(23.2%)		224(73.2%)	82(26.8%)	
Self-reported DM type			.001*			.004*			.099
T1DM	65(86.7%)	10(13.3%)		61(81.3%)	14(18.7%)		44(58.7%)	31(41.3%)	
T2DM	76(98.7%)	1(1.3%)		71(92.2%)	6(7.8%)		66(85.7%)	11(14.3%)	
Do not know	412(74.5%)	141(25.5%)		389(70.3%)	164(29.7%)		364(65.8%)	189(34.2%)	
GDM	10(66.7%)	5(33.3%)		9(60.0%)	6(40.0%)		5(33.3%)	10(66.7%)	
Annual medical follow-up			.380			.296			.658
Yes	535(78.6%)	146(21.4%)		504(74.0%)	177(26.0%)		459(67.4%)	222(32.6%)	
No	24(72.7%)	9(27.3%)		22(66.7%)	11(33.3%)		18(54.5%)	15(45.5%)	
Dental visit			.247			.266			.643
Every 6 months	27(84.4%)	5(15.6%)		26(81.3%)	6(18.8%)		23(71.9%)	9(28.1%)	
Annually	42(93.3%)	3(6.7%)		40(88.9%)	5(11.1%)		30(66.7%)	15(33.3%)	
On need	486(77.0%)	145(23.0%)		455(72.1%)	176(27.9%)		417(66.1%)	214(33.9%)	
Never	8(66.7%)	4(33.3%)		9(75.0%)	3(25.0%)		9(75.0%)	3(25.0%)	
Received advice from diabetes care provider			.419			.841			.846
Yes	94(82.5%)	20(17.5%)		91(79.8%)	23(20.2%)		78(68.4%)	36(31.6%)	
No	469(77.4%)	137(22.6%)		439(72.4%)	167(27.6%)		401(66.2%)	205(33.8%)	
Received advice from dental care provider			.066			.437			.047*
Yes	150(87.7%)	21(12.3%)		138(80.7%)	33(19.3%)		130(76.0%)	41(24.0%)	
No	413(75.2%)	136(24.8%)		392(71.4%)	157(28.6%)		349(63.6%)	200(36.4%)	
Type of diabetes clinic			.614			.940			.194
Public	497(77.2%)	147(22.8%)		466(72.4%)	178(27.6%)		432(67.1%)	212(32.9%)	
Private	66(86.8%)	10(13.2%)		64(84.2%)	12(15.8%)		47(61.8%)	29(38.2%)	
Experience of xerostomia			.027*			.020*			.036*
Yes	296(82.0%)	65(18.0%)		282(78.1%)	79(21.9%)		257(71.2%)	104(28.8%)	
No	264(75.0%)	88(25.0%)		246(69.9%)	106(30.1%)		219(62.2%)	133(37.8%)	
Experience of periodontal disease			.757			.496			.176
Yes	290(79.0%)	77(21.0%)		279(76.0%)	88(24.0%)		245(66.8%)	122(33.2%)	
No	273(77.3%)	80(22.7%)		251(71.1%)	102(28.9%)		234(66.3%)	119(33.7%)	

DM = diabetes mellitus; GDM = gestational diabetes mellitus; T1DM = type 1 diabetes mellitus; T2DM = type 2 diabetes mellitus.

* $P < .05$.

being diagnosed with diabetes for more than 5 years. The increase in awareness with increasing level of education confirms previous findings.²⁴ One possible explanation is that patients with diabetes are not informed about their increased risk of complications at the onset of disease. Those with low level of education lack the necessary level of literacy to self-educate about the association of diabetes with other diseases and are, hence, unaware of the link. However, given that the Mauritius Institute of Health trained about 60 specialised

diabetes nurses in 2012-2014 and that an oral health module was included in their training, further study about the course content, its delivery, and whether diabetes care personal completing the course have the confidence and time to provide health education to patients with diabetes is required. The association between the number of years since diagnosis of diabetes and awareness about the link with other diseases as well as with knowledge about complications may indicate that patients with diabetes learn

Table 8 – Stepwise logistic regression analysis with knowing about systemic complications as dependent variables.

Dependent variables	Factors in final model		Adjusted OR	95% CI	P value	
Ocular complications	Education	None	1.0			
		Primary	3.2	1.96-5.30	.000*	
		Secondary	5.9	3.27-10.64	.000*	
		Tertiary	9.5	2.00-44.84	.005*	
	Years since diagnosis	<5 years	1.0			
		5-9 years	1.8	1.03-3.05	.040*	
		10 years & above	1.7	1.10-2.69	.017*	
	Self-reported type of diabetes	Do not know	1.0			
		T1DM	1.6	0.78-3.43	.192	
		T2DM	13.2	1.78-97.63	.012*	
		GDM	0.67	0.21-2.16	.507	
	Experience of xerostomia	No	1.0			
		Yes	1.6	1.05-2.33	.028*	
Renal complications	Age (years)	<20	1.0			
		20-39	9.3	1.93-44.90	.005*	
		40-59	9.8	2.41-40.07	.001*	
		60 & above	4.9	1.17-20.53	.029*	
	Education	None	1.0			
		Primary	2.6	1.55-4.24	.000*	
		Secondary	4.1	2.29-7.43	.000*	
		Tertiary	5.2	1.33-20.48	.018*	
	Years since diagnosis	<5 years	1.0			
		5-9 years	2.2	1.28-3.64	.004*	
		10 years & above	2.0	1.28-3.10	.002*	
	Self-reported type of diabetes	Do not know	1.0			
		T1DM	4.1	1.17-14.39	.028*	
		T2DM	2.7	1.11-6.64	.029*	
		GDM	0.5	0.13-2.18	.388	
	Experience of xerostomia	No	1.0			
		Yes	1.6	1.07-2.26	.020*	
Cardiac complications	Age (years)	<20	1.0			
		20-39	2.3	0.91-5.67	.078	
		40-59	5.1	2.35-11.28	.000*	
		60+	3.7	1.68-8.17	.001*	
	Education	None	1.0			
		Primary	2.5	1.56-4.15	.000*	
		Secondary	3.6	2.09-6.13	.000*	
		Tertiary	5.7	2.04-16.11	.001*	
	Years since diagnosis	<5 years	1.0			
		5-9 years	1.8	1.11-2.81	.017*	
		10+ years	1.9	1.29-2.90	.001*	
	Received advice from dental care provider	No	1.0			
		Yes	1.5	1.00-2.35	.050	
Experience of xerostomia	No	1.0				
	Yes	1.4	1.02-2.01	.037*		

CI = confidence interval; OR = odds ratio.

* $P < .05$.

about the association with time after developing complications.²⁵ This is corroborated by our study results showing that the experience of xerostomia and periodontal disease significantly predict awareness about the increased risk of developing these respective oral disorders. The same analysis was not performed for caries and systemic complications because unavailability of data.

This study also highlights that the experience of xerostomia and age are significant predictors of knowledge about systemic complications of diabetes. The link between experience of xerostomia and knowledge may be explained by the use of certain medications in the treatment of systemic complications of diabetes. Research shows that polypharmacy increases the risk of developing xerostomia.²⁶ Similarly,

knowledge increases with age and is highest among participants aged 40-59 years. Hence participants' knowledge of their increased risk of systemic complications of diabetes is linked to their experience of disease following treatment for diabetes comorbidities and complications or ageing. Evidence suggests that the severity of periodontitis correlates significantly with the development and outcomes of cardiorenal and retinal complications of diabetes.²⁷ Contrary to expectation, experience of periodontal disease was not a strong predictor of knowledge about systemic complications of diabetes. This is an indication that in Mauritius, patients with periodontitis and diabetes are not being provided with relevant information about their increased risk of developing serious complications.

During pregnancy the body undergoes important physiological changes that affect the oral cavity. There is a decrease in salivary pH that may lead to an increased incidence of dental caries.²⁸ Endocrine and immune changes increase the susceptibility of women to infections, including gingivitis and periodontitis. Moreover, there is growing evidence supporting an association between periodontitis and the risk of various adverse pregnancy outcomes.²⁹ Similarly, there is strong evidence about the bidirectional association of T2DM with diabetes. Nonetheless, despite their increased risk of developing periodontal diseases participants with GDM and T2DM had limited awareness about oral complications.

The findings of the present study may indicate that the health system in Mauritius is not geared towards prevention. Oral health is currently either not covered or inadequately covered in diabetes education programs or as part of self-management education provided to people with diabetes. The high morbidity and mortality associated with diabetes complications in the country calls for enhanced health promotion and disease prevention. This may be achieved through a closer collaboration between medical and dental teams in the joint management of patients with diabetes. Diabetes care providers should be trained and empowered in providing adequate oral health education to their patients and in referring them for dental treatment and follow-up. Similarly, dentists should be alert for both general and oral signs and symptoms suggestive of uncontrolled or poorly controlled diabetes. Patients with suggestive symptoms or with abnormal blood glucose levels identified by screening tests should be referred to a physician for diagnosis and any treatment necessary. Dental care providers should counsel patients with diabetes about the importance of good oral health in the management of diabetes. Additional research is needed to investigate whether people with diabetes are being adequately advised by health care providers.

Limitations in the method used

The sample in this study was not a random sample and may not represent the diabetes population of the island. Although the use of questionnaires proved to be cost-effective and practical because a large amount of information was collected from a large number of people in a short period of time, it is impossible to know how truthful and how much thought participants put in answering the questions. There was no validation of the medical or dental self-reported data provided by study participants to the survey against their medical or dental records. More than half of the study cohort had either no formal education or only primary education. However, questions were formulated to be easy and direct. In addition, the researcher used a questionnaire translated into their mother tongue (Creole) to ask the questions verbally and filled in the form in their presence.

Conclusion

In Mauritius, people with diabetes are mostly unaware of their increased risk of oral complications. Moreover,

awareness of both oral and systemic complications appears to be mainly associated with level of education, duration of diabetes, and the experience of adverse outcomes. This may indicate that people with diabetes are not being informed of their increased risk of complications at the beginning of treatment and that health promotion and disease prevention is not prevalent. Therefore, customised educational programs to inform people with diabetes of their increased risk of developing complications should be developed and implemented. A closer collaboration between oral and medical care providers should be encouraged.

Conflict of interest

None disclosed.

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