

Khat Chewing and Type 2 Diabetes Mellitus

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Objective: Knowledge about the effects of khat chewing on type 2 diabetes mellitus (T2DM) development and glycemic control is very sparse. Emerging data suggest that khat chewing may increase the risk of T2DM occurrence. Therefore, this study aimed to measure the prevalence of khat chewing in Saudi people with T2DM in Jazan, Saudi Arabia and to determine the association of khat chewing with T2DM development and glycemic control in T2DM.

Methods: This is an analytical, cross-sectional study that included 472 Saudi participants selected randomly from primary healthcare centers in Jazan, Saudi Arabia. A chi-square test and logistic regression were performed in the statistical analysis.

Results: The prevalence of khat chewing in Saudi patients with T2DM in Jazan was 29.3%. After adjusting for covariates, khat chewing was significantly associated with T2DM (odds ratio 3.5), indicating that khat chewers had a more than three times higher risk of developing T2DM than those who do not chew khat. However, there was no association between khat chewing and glycemic control in T2DM.

Conclusion: Khat chewing was highly prevalent in Saudi people with T2DM in Jazan, Saudi Arabia. There was an association between khat chewing and the development of T2DM. Establishing the causal association of khat chewing with T2DM development and glycemic control and clarifying the biological role of khat in T2DM are important aims for future studies.

Keywords: type 2 diabetes mellitus, catha edulis, khat chewing

Introduction

Diabetes mellitus is a metabolic disorder characterized by chronically high levels of glucose in the blood (known as hyperglycemia) due to insulin deficiency, resistance or both.¹ Diabetes mellitus may lead to serious complications that increase morbidity and mortality.² In Saudi Arabia, the prevalence of type 2 diabetes mellitus (T2DM) was 18.3% and becomes a major health concern.³

Khat (also known as catha edulis) is an amphetamine-like stimulant in the form of plant leaves that are chewed for euphoric effects.⁴ Khat contains psychoactive substances, cathinone and cathine, which have a stimulating effect on the sympathetic nervous system and give the chewer a temporary sensation of activeness and happiness,⁵ mood disturbance and anxiety.⁶ Khat is commonly abused by Ethiopian and Somali people in East Africa and Yemeni people in the southern Arabian Peninsula.⁷ With the recent globalization, African and Arabian immigrants have spread khat chewing to Europe,^{8,9} Australia^{10,11} and the United States.¹² The World Health Organization (WHO) categorized khat as an illegal drug and indicated that its abuse may cause a range of health problems.¹³ In Jazan, Saudi Arabia, about 33.2% of people chew khat as a habit because the Jazan region borders Yemen to the south, which is considered the main producer of khat to Jazan.¹⁴

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There is growing evidence of the effect of khat chewing on T2DM and glycemic control.^{15–19} However, the role of khat chewing in T2DM is not fully understood. Up to our knowledge, very few published papers have tried to draw a conclusion about khat chewing and its effect on T2DM and glycemic control. Thus, the aim of this study was to measure the prevalence of khat chewing in Saudi patients with T2DM in Jazan and to investigate the association of khat chewing with the risk of T2DM occurrence and glycemic control.

Methodology

Study Design and Sample Size

Jazan is located in the southwest corner of Saudi Arabia with a predominantly homogenous population that shares similar ethnic and socioeconomic characteristics. In this study, we applied an analytical, cross-sectional design on Saudi participants recruited randomly from primary healthcare (PHC) centers in Jazan (Figure 1).

The sample size was calculated using the Epi Info software program²⁰ with the following parameters: confidence interval, 95%; alpha, 0.5. The expected frequency of khat chewing was obtained from a previous study conducted in Jazan, Saudi Arabia.¹⁴ The computed sample size was 383, but 50% (191 subjects) were added to the total calculated sample size for non-respondents. The current study successfully recruited 472 out of the 574 selected participants. About 68 subjects (11.8%) did not meet the inclusion criteria, 22 (3.8%) did not respond and 12 (2.1%) refused to participate in the current study (Figure 1).

Inclusion and Exclusion Criteria

Saudi patients with T2DM who were older than 18 years of age were included. Patients with type 1 diabetes mellitus and gestational diabetes were excluded.

Covariates and Data Collection

The risk factors (covariates) that were shown in the literature to be associated with T2DM development were accounted in this study. Sociodemographic data, anthropometrics and laboratory measurements were gathered from the participants' medical records at the diagnosis date of T2DM, including age, sex, body mass index (BMI), waist circumference and glycated hemoglobin (A1C). Additionally, face-to-face interviews with the participants were held and they were asked about history of diabetes in the family, khat chewing, past history of gestational diabetes and physical activity before the diagnosis date of T2DM.

Following the WHO's guidelines,²¹ BMI was calculated as weight in kilograms divided by the square of the person's height in meters. BMI was categorized as not obese if the score was <30 and obese if ≥ 30 . T2DM was diagnosed following the American Diabetes Association's guidelines.²² A1C $\geq 7\%$ was categorized as poor glycemic control, while A1C $< 7\%$ was good glycemic control.²³ Waist circumference was measured and classified as obese if ≥ 94 cm for males and ≥ 80 cm for females, following the Arabian-specific waist circumference.²⁴ Physical activity of less than 150 mins per week was categorized as physically inactive, following the American Diabetes Association's guidelines.²⁵

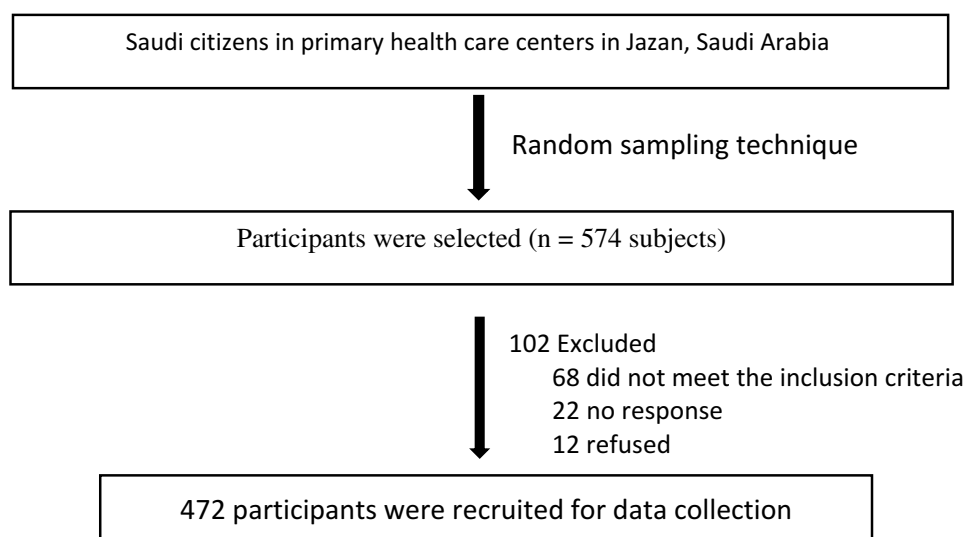


Figure 1 Participant enrolment in the current study.

Ethical Consideration

The Jazan Hospital Institutional Review Board (reference number: H-10-Z-068)²⁶ granted ethical approval (No. 1851) for the study, which also complied with the Helsinki Declaration. Written informed consent was obtained from all the participants before enrolment.

Statistical Analysis

Data entry and analysis were performed using Statistical Package for the Social Sciences software version 24.²⁷ The data were coded with anonymous identification numbers in order to guarantee the privacy of the participants. The continuous variables were described by means and standard deviation (SD) and the categorical variables by percentages and frequencies. A chi-square test for independence was used to assess the associations among the categorical variables. Binary logistic regression was used to explore the predictors of T2DM including the significant variables in univariate regression. The assumptions of the binary logistic regression were checked for the presence of outliers and multicollinearity (high inter-correlations among independent variables). In other way in the analysis, an independent *t*-test was also performed to test for any mean differences between the studied groups. P values <0.05 were considered to be statistically significant.

Results

The current study recruited 472 participants who were categorized into two groups: participants with T2DM and participants without T2DM (Table 1). The participants' sociodemographic characteristics and their associations are presented in Table 1 using a chi-square test for independence.

The Prevalence of Type 2 Diabetes Mellitus and Associated Factors

The prevalence of T2DM in the studied population was 17.6%. The mean age of non-diabetic participants was 32.1 years \pm 12.9 (range 11–89 years), and the mean age of participants with T2DM was 49.7 years \pm 11.5, ranging from 31 to 80 years. Age \geq 34 years, family history of diabetes, khat chewing, obesity and central obesity are significantly associated with T2DM (Table 1).

Type 2 Diabetes Mellitus and Khat Chewing

The prevalence of khat chewing was 29.3% in patients with T2DM in the studied population. Most of the khat chewers

had approximately similar dose and duration of khat chewing. There was a significant association between khat chewing and T2DM (Table 1). After adjusting for covariates (Table 2), khat chewer participants were more likely to have T2DM (odds ratio (OR) = 3.5), which indicated that participants with T2DM who chewed khat had approximately a more than three times greater risk than non-diabetic participants for T2DM development.

Khat Chewing and Glycemic Control

The prevalence of poor glycemic control was 71% in participants with T2DM in the studied population. Medication adherence was accounted, and the majority of participants were adherent to medication regimen (98.3%). About 83% of khat chewers reported that they take sugary drinks during khat chewing. There was no statistically significant association between khat chewing and glycemic control in the result of the chi-square test. For another analysis, an independent *t*-test was also performed to compare the A1C mean difference between participants with T2DM who were khat chewers and

Table 1 Sociodemographic Characteristics and Chi-Square Test for Independence Assessed the Association Among Categorical Variables

Variable		Without T2DM = 380		T2DM = 92		P-value
		n (%)	n (%)	n (%)	n (%)	
Sex	Male	218	57.40%	57	62%	0.26
	Female	162	42.60%	35	38%	
Age ^a	<34 years	223	58.70%	8	8.70%	0.0001*
	\geq 34 years	157	41.30%	84	91.30%	
Family history of diabetes	No	173	45.50%	21	22.80%	<0.0001*
	Yes	207	54.50%	71	77.20%	
Women with past history of GDM	No	142	87.70%	32	91.40%	0.53
	Yes	20	12.30%	3	8.60%	
Physically active	No	250	65.80%	58	63%	0.48
	Yes	130	34.20%	34	37%	
Khat chewing	No	340	89.50%	65	70.70%	<0.0001*
	Yes	40	10.50%	27	29.30%	
Obesity	No	281	73.90%	48	52.20%	<0.0001*
	Yes	99	26.10%	44	47.80%	
Waist circumference male (central obesity)	No	108	49.50%	6	10.50%	<0.0001*
	Yes	110	50.50%	51	89.50%	
Waist circumference female (central obesity)	No	116	71.60%	16	45.70%	<0.0001*
	Yes	46	28.40%	19	54.30%	

Notes: *Significant results (P value <0.05); ^aAge was categorized based on median.

those who were non-khat chewers. The results also revealed that there was no significant difference in mean A1C for khat chewers (8.8 ± 2.3) and non-khat chewers (8.6 ± 1.9) $P = 0.68$.

Discussion

Type 2 Diabetes Mellitus and Its Associated Factors

T2DM is prevalent in Jazan, Saudi Arabia. In 2015, Bani²⁸ reported that the prevalence of T2DM was 12.3% in Jazan. However, the current study estimated the prevalence of T2DM in Jazan to be 17.6%, which indicates that the prevalence of T2DM has increased dramatically in Jazan. We focused on T2DM in this study, as it is the most common type of diabetes mellitus in Jazan²⁸ and is associated with preventable risk factors. The study revealed that there are several potential factors associated with T2DM development. Subjects with T2DM in this study were older than 34 years, which reflects that this could be due to insulin sensitivity decreasing with age.²⁹ Family history of diabetes, central obesity and obesity were also significant predictors of T2DM, as is well established in previous studies.^{30–32}

Type 2 Diabetes Mellitus and Khat Chewing

To our knowledge, this study is the first study in Saudi Arabia that assessed the prevalence of khat chewing in patients with T2DM and its association with T2DM. Thus, the current study focused on khat chewing as an interesting outcome. Our study findings revealed that khat chewing was prevalent (29.3%) and significantly associated with T2DM of Saudi participants. Khat chewers had more risk of developing T2DM than those who do not chew khat. These findings are consistent with that reported by other studies.^{16,33} A systemic review and meta-analysis study included 25 studies from 1976 to 2016, its results suggested that khat is predisposing factor contributing to

the development of T2DM.³³ Moreover, an experimental study in Malaysia suggested that the cytotoxic effect of khat induced diabetes mellitus through the destruction of pancreatic β -cells and changing the structures of the islets of Langerhans.¹⁶ However, the effect of khat chewing on the risk of T2DM development has not yet been elucidated. Further studies are needed to clarify the effect of khat and its chemical substances on pancreatic cells.

Khat and Glycemic Control

In the present study, the prevalence of poor glycemic control in patients with T2DM was 71%. This percentage is not far from what was found in a previous study about the poor glycemic control in T2DM that was conducted in Jazan.^{34,35} The current study finding also revealed that there was no significant association between khat chewing and glycemic control. This result was supported by other studies that reported similar findings.^{16,19,35} A systemic review and meta-analysis study included 25 studies, its results also show that khat had no effect in reducing blood glucose levels.³⁵ Another experimental study in Malaysia also showed no association between khat chewing and glycemic control.¹⁶ Similarly, a study was conducted in Somalia reported that khat had no influence on blood glucose levels.¹⁹ However, two studies carried out in Yemen found that khat chewing increased the blood glucose levels in patients with T2DM.^{15,18}

Study Limitation

The current study was an analytical, cross-sectional study. Establishing the causal association of khat chewing with T2DM development and glycemic control and clarifying the biological role of khat in T2DM are important aims for future studies. Furthermore, the dose and duration of khat chewing were difficult to be accounted precisely, however, most of the khat chewers had approximately similar dose and duration of khat chewing.

Table 2 Predictors of Diabetic Mellitus Development in Multivariate Binary Logistic Regression

Variables	Univariate Analysis			Multivariate Analysis		
	OR	(CI 95%)	P-value	OR	(CI 95%)	P-value
Age ≥ 34 years	14.9	(6.7–19.2)	<0.0001*	9.6	(6.1–11.2)	<0.0001*
Central obesity	4.6	(1.7–7.7)	<0.0001*	4.2	(2.3–8.7)	<0.0001*
Khat chewing	3.6	(1.3–6.5)	<0.0001*	3.5	(1.1–5.8)	<0.0001*
Family history of diabetes	2.8	(1.2–4.1)	<0.0001*	2.2	(0.8–3.7)	0.0001*
Obesity	2.6	(1.3–3.9)	<0.0001*	1.8	(0.4–2.8)	0.001*

Notes: *Significant results (P value <0.05); Central obesity was entered as one variable for both sex (present or absent).

Conclusion

Khat chewing is highly prevalent in Saudi people with T2DM in Jazan, Saudi Arabia. There is an association between khat chewing and the development of T2DM. Khat chewers have a more than three times higher risk of developing T2DM than those who do not chew khat. Furthermore, khat chewing is not associated with glycemic control.

Data Sharing Statement

The data that support the findings of this study are available on request from the corresponding author, [Mohammed Badedi].

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Disclosure

The authors report no conflict of interests in this work.

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