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ORIGINAL ARTICLE

Dietary pattern of patients with type 2 diabetes mellitus including date consumption

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Abstract

Aim Assess the relationship between date palm fruit consumption and diabetic control among Saudi patients with type 2 diabetes mellitus.

Subjects and methods Saudi patients with type 2 diabetes ($n = 404$, aged 55.3 ± 9.7 years) were included in this study. Height, weight and blood pressure were initially measured. Blood glucose levels (fasting and random), glycated hemoglobin HbA_{1c}, total cholesterol, high-density lipoprotein, low-density lipoprotein and triglycerides were retrieved from the patient's medical records. The amount and frequency of habitual consumption of date fruits were obtained from patients using a validated dietary questionnaire.

Results The results revealed that high consumption of date fruits was statistically significantly correlated with lower HbA_{1c} and fasting blood glucose ($p < 0.01$).

Conclusion This cross-sectional study found an association between high date fruit consumption by patients with type 2 diabetes mellitus and lower HbA_{1c} and fasting blood glucose levels. Further studies are required to verify this interesting finding

Keywords Blood glucose · Blood lipids · Dates · HbA_{1c}

Introduction

Diabetes mellitus (DM) is a life-long health condition and is considered an epidemic disease that is a major cause of morbidity and mortality worldwide (Jaacks et al. 2016). It is estimated that the increase in the prevalence of DM between 2017 and 2045 will be 48% (IDF 2017). In fact, DM is the greatest challenge to the healthcare system worldwide, and the major objective of the clinical management of diabetes is to prevent long-term complications (IDF 2017). The majority of diabetic cases fall into the type 2 DM category (T2DM), which accounts for 90–95% of all patients with diabetes (ADA 2019).

In Saudi Arabia, the prevalence of diabetes is ranked seventh in the world and second in the Middle East (Al Dawish et al. 2016). Most Saudi people habitually enjoy consuming dates and are considered to have the highest consumption in the world (Aleid et al. 2015). It is well known that the predominant constituent of dates is carbohydrates in the form of glucose, fructose and non-starch polysaccharides (NSPs) (Al-Farsi et al. 2007; Zhang et al. 2015). In addition, dates contain a considerable amount of some minerals, such as potassium, sodium, calcium, magnesium and phosphorus (AlJuhaimi et al. 2014; Hossain 2015). Moreover, dates are a good source of phenolic contents, such as phenolic acids, carotenoids, flavonoids, polyphenols and phytosterols (Al-Farsi et al. 2005; Bouhlali et al. 2017; Septembre-Malaterre et al. 2018; Vayalil 2014). It is commonly believed among the public and health care providers that patients with diabetes should limit or even avoid consumption of date fruits. This belief is not based on scientific evidence; however, it is probably based on

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extrapolation from the chemical composition since dates mainly consist of simple sugar (Ahmed and Ahmed 1995; Ali et al. 2009; Khan et al. 2008). Most date varieties have a low glycemic index (GI) value, and their reported postprandial effect on blood glucose levels in both healthy participants and those with diabetes vary from low to moderate (AlGeffari et al. 2016; Ali et al. 2009; Alkaabi et al. 2011; Al-Mssallem and Brown 2013; Gourchala et al. 2016; Miller et al. 2003). Moreover, the consumption of date fruits has not been shown to have deleterious effects on serum glucose levels (Rock et al. 2009). The aim of this observational study was to assess the relationship between habitual date consumption and diabetes control in patients with T2DM.

Patients and methods

Patients

A cross-sectional observational study was carried out in the primary health care center, National Guard Health Affairs, Eastern Province, Al-Ahsa, Saudi Arabia. Patients with T2DM were included with exclusion criteria of pregnancy, chronic kidney and liver diseases, and medications that affect diabetic control, e.g., glucocorticoids. One proportion equation was used for sample size calculation assuming that the proportion of date fruit consumption among patients with diabetes is 50% with a 95% confidence interval and a 5% margin of error. The minimum required number is 385 patients with diabetes. Convenience sampling was used in which all Saudi patients with T2DM who attended the diabetic clinic from November 2018 to March 2019 were included. The study was approved by the Institutional Research Board (IRB), Ministry of National Guard Health Affairs. All patients gave informed written consent. Blood pressure, height and weight, body mass index (BMI), fasting blood glucose (FBG), random blood glucose (RBG), glycated hemoglobin (HbA_{1c}), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglyceride (TG) values were retrieved from patient electronic medical records, which were available at the time of the interview.

Dietary assessment

The frequency and amount of date fruit consumption of both *Rutab* (partially ripened stage) and *Tamer* (fully ripened stage) were collected from patients by face-to-face interview with a dietitian using a validated questionnaire. This has been modified from previous studies (Al-Mssallem 2018; Al-Mssallem et al. 2019), which were reviewed by three experts: an academic nutritionist, an endocrinology consultant and an epidemiologist. In addition, a pilot study was conducted on 20 patients with diabetes, and the questionnaire was modified accordingly.

Table 1 General characteristics of diabetic patients ($n = 404$)

Item	Categories	Number	Percentage
Gender	Male	207	51.2%
	Female	197	48.8%
SBP (mmHg)	≤ 140 mmHg	230	56.9%
	> 140 mmHg	170	43.1%
DBP (mmHg)	< 90 mmHg	377	93.3
	> 90 mmHg	27	6.7
BMI (kg/m^2)	Underweight (BMI < 18.5)	1	0.2%
	Normal (18.5 ≤ BMI < 25)	20	5%
	Overweight (25 ≤ BMI < 30)	92	22.8%
	Obese (30 ≤ BMI < 35)	226	55.9%
	Severely obese (BMI ≥ 35)	65	16.1%
DM treatment	Diet alone	3	0.7%
	Oral agents	196	48.5%
	Insulin + oral agents	205	50.7%

SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; DM, diabetes mellitus

The serving size of consumed date fruits has been identified as three pieces (27 g) (Al-Mssallem 2018; Al-Mssallem et al. 2019; Ismail et al. 2006; Qazaq and Al Adeeb 2010). Therefore, in this study, the number of date fruits consumed was classified into three categories: < 1 date serving size (0–26 g), 1–3 date serving size (27–81 g) and > 3 date serving size (> 81 g).

Statistical analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS software, version 21.0). The proportion, mean and standard deviation of laboratory test results and food items were addressed as descriptive statistics. Bivariate analysis was carried out using a one-way ANOVA test based on date consumption and a Pearson correlation between date consumption and HbA_{1c} with a two-tailed significance level of 5% ($p < 0.05$).

Table 2. Descriptive statistics (mean ± SD) of laboratory test results for type 2 diabetic patients ($n = 404$)

Variables	Mean ± SD
Glycated hemoglobin (HbA_{1c}, %)	8.2 ± 1.5
Fasting blood glucose (FBG, mmol/l)	9.7 ± 3.7
Random blood glucose (RBG, mmol/l)	11.2 ± 4.3
Total cholesterol (TC, mmol/l)	4.4 ± 0.9
High-density lipoprotein (HDL, mmol/l)	1.0 ± 0.6
Low-density lipoprotein (LDL, mmol/l)	2.7 ± 0.8
Triglycerides (TG, mmol/l)	1.7 ± 0.9

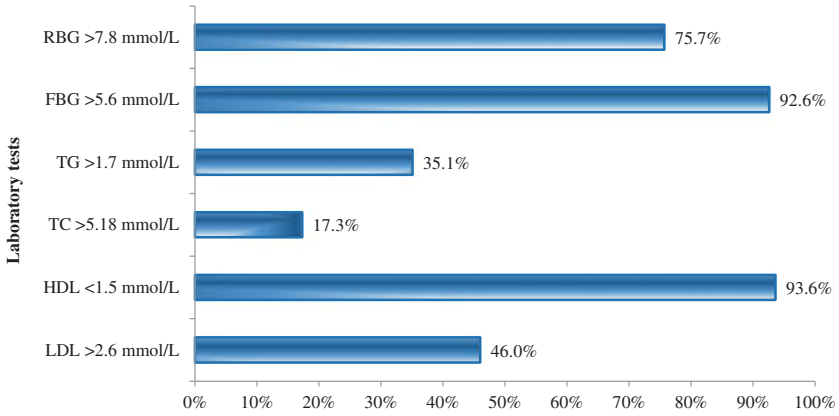

Fig. 1. Prevalence of laboratory tests (abnormal results) for patients with type 2 diabetes (n = 404). RBG, random blood glucose; FBG, fasting blood glucose; TG, total glycerides; TC, total cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure

A multiple regression test was used based on the HbA_{1c} level to adjust the results of dietary habits for patients with diabetes.

Results

General characteristics

The study included 404 patients with T2DM, 49% on oral antidiabetic medications and 51% on insulin. The characteristics of the patients with diabetes are presented in Table 1. Forty-three percent of the patients had high blood pressure based on their systolic blood pressure. Obese and severely obese constituted 72% of the patients with diabetes.

Blood glucose and lipid levels

The means of FBG, RBG, HbA_{1c}, TC, HDL, LDL and TG are displayed in Table 2. The means of HbA_{1c}, FBG and RBG exceeded the normal range. The prevalence of blood glucose and lipid profiles is presented in Fig. 1. Approximately 93% of participants had low HDL levels, 92.6% had high RBG levels and 75.7% had high FBG levels.

The association between date consumption and clinical and laboratory tests for patients with diabetes was assessed using a one-way ANOVA (Table 3). The mean HbA_{1c} of patients with diabetes with low date consumption was 8.65 ± 1.66 compared with 8.25 ± 1.46 and 8.06 ± 1.50 for patients with diabetes with moderate and high date consumption, respectively, with a p value of 0.045. Likewise, the mean FBG was 11.58 ± 4.81 in patients with diabetes with low date consumption, which was higher than that of patients with diabetes with moderate (9.48 ± 3.32) and high date consumption (9.33 ± 3.32, p = 0.000). In terms of blood lipids, the differences in the HDL, LDL, TC, and TG levels were not statistically significant (p > 0.05). Furthermore, there was a reduction in the BMI by a value of 1.3 (kg/m^2) in patients who had consumed many dates compared with patients who had consumed few, but this reduction was not statistically significant (p = 0.35).

Moreover, multivariable analysis was carried out by a multiple regression statistical test based on HbA_{1c}. Low date consumption was significantly associated with a high HbA_{1c} level for patients with diabetes (B = − 0.135–; p = 0.001, 95% CI =

Table 3 Distribution of date fruit intake by clinical and laboratory tests among diabetic patients (bivariate analysis, ANOVA) (n = 404, mean ± SD)

Variables	< 1 date serving size (0–26 g)	1–3 date serving size (27–81 g)	> 3 date serving size (> 81 g)	P value
HbA_{1c} (mmol/l)	8.65 ± 1.66	8.25 ± 1.46	8.06 ± 1.50	0.045
FBG (mmol/l)	11.58 ± 4.81	9.48 ± 3.32	9.33 ± 3.32	0.000
RBG (mmol/l)	13.07 ± 5.08	10.72 ± 3.90	11.14 ± 4.31	0.001
LDL (mmol/l)	2.78 ± 0.83	2.72 ± 0.84	2.65 ± 0.74	0.521
HDL (mmol/l)	1.07 ± 0.29	1.05 ± 0.24	1.01 ± 0.22	0.184
TC (mmol/l)	4.49 ± 0.92	4.42 ± 0.94	4.35 ± 0.90	0.615
TG (mmol/l)	1.63 ± 0.87	1.58 ± 0.79	1.79 ± 1.11	0.114
SBP (mmHg)	140.72 ± 20.17	138.47 ± 17.79	138.11 ± 18.12	0.635
BMI (kg/m^2)	34.59 ± 6.66	33.93 ± 6.19	33.29 ± 5.73	0.351

HbA_{1c}, glycated hemoglobin A_{1c}; RBG, random blood glucose; FBG, fasting blood glucose; LDL, low-density lipoprotein; HDL, high-density lipoprotein; TC, total cholesterol; TG, total glycerides; SBP, systolic blood pressure; BMI, body mass index

Table 4 Multivariable analysis through multiple regression based on HbA_{1c} level. Statistics (mean ± SD) of laboratory test results for type 2 diabetic patients ($p = 404$)

Variables	*B*	*t*	*P value*	CI	
				Lower bound	Upper bound
BMI (kg/m^2)	−0.015–	−1.275–	0.203	−0.038–	0.008
Oral medication	1.071	7.584	0.000	0.793	1.348
Date fruits (serving size)	−0.135–	−3.494–	0.001	−0.211–	−0.059–
Fruits and vegetables (serving size)	−0.071–	−0.985–	0.325	−0.211–	0.070
Juices and sweetened beverages (serving size)	0.068	0.918	0.359	−0.077–	0.213
Bread and grains (serving size)	0.061	3.509	0.001	0.027	0.096
Confectionery (serving size)	0.170	1.903	0.058	−0.006–	0.345

−0.211– to −0.059–). Additionally, there was a significant positive association between HbA_{1c} level and consumption of bread and grains ($B = 0.061$; $p = 0.001$, 95% CI = 0.027 to 0.096). These results were adjusted for BMI, treatment type and consumption of fruits, vegetables, breads, grains, confectionery and date fruits (Table 4).

The relationship between the consumption of dates and the HbA_{1c} level is demonstrated in Fig. 2. It is obvious that high consumption of date fruits resulted in a lower level of HbA_{1c} ($r = -0.167$, $p = 0.001$). This negative association was also observed between the consumption of date fruits and FBG ($r = -0.150$, $p = 0.002$).

Discussion

Date palm fruits are commonly consumed at the *Rutab* (partially ripened) and *Tamer* (fully ripened) stages at breakfast time or as a snack. In this study, we found that the average date consumption by patients with diabetes reached 152 g per day. This consumption of dates is approximately 34% higher than that previously reported among Saudi patients with diabetes (Al-Mssallem 2018). This difference could be explained by the effect of the sample size. Worldwide, the consumption of dates is the highest among the Arab Gulf population, where it varies from 68 g to 164 g per day (Aleid et al. 2015; Ali et al. 2012; Al-Mssallem 2018; Al-Mssallem et al. 2019; Ismail et al. 2006; Qazaq and Al Adeeb 2010). In Oman, the daily consumption of dates per capita was estimated to be 55–164 g (Al-Farsi et al. 2005). Among the UAE citizens, the consumption of dates was 72 g per day (Qazaq and Al Adeeb 2010). Ismail et al. (2006) found that the daily date consumption by UAE citizens reached 114 g; this estimation included six date food groups. However, our study estimated only the consumption of dates at the *Rutab* and *Tamer* stages.

Patients with diabetes are usually advised to restrict their consumption of date fruits. This advice is based on the chemical constituents of date fruits because their main ones are glucose and fructose (Al-Farsi et al. 2007; Ismail et al. 2006; Zhang et al. 2015). However, this study found that regular consumption of dates did not have deleterious effects on diabetes control, where patients with T2DM who consumed many dates had significantly lower HbA_{1c} than those who consumed few dates ($p < 0.05$). The association between HbA_{1c} level and date fruit consumption remained statistically significant after adjusting for BMI, treatment type and consumption of fruits, vegetables, breads, grains and confectionery.

This favorable effect of consumed date fruits on HbA_{1c} can be explained by the fact that they have a low postprandial effect, which has been measured by the GI. Indeed, most date fruit varieties have low GI values (AlGeffari et al. 2016; Ali et al.

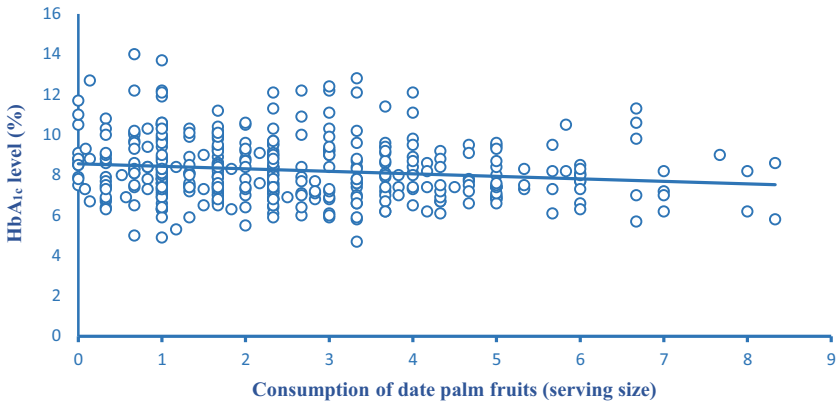

Fig. 2. Negative correlation between date consumption and HbA_{1c} level among patients with type 2 diabetes ($r = -0.151$, $p = 0.002$)

2009; Alkaabi et al. 2011; Al-Mssallem and Brown 2013; Miller et al. 2003). The low glycamic response to date fruits is not only found in healthy individuals, but is rather low when measured in patients with T2DM (Alkaabi et al. 2011). The low GI value of date fruits could be due to the high content of fructose and NSPs (Al-Farsi et al. 2007; Zhang et al. 2015). Fructose is a monosaccharide present naturally in date fruit at approximately 28% (Al-Farsi and Lee 2008). It has been found that fructose is less diabetogenic than glucose (Ali et al. 2018). Fructose also plays a role in lowering the plasma glucose response by inhibiting gluconeogenesis (Evans et al. 2017; Heacock et al. 2002; Louie et al. 2008). Additionally, fructose can lower circulating insulin as fructose is not an insulin secretagogue (Havel et al. 2004). However, the presence of soluble and insoluble NSPs in date fruits works as a barrier, delaying gastric emptying and lowering the digestion and absorption of carbohydrates (Anderson et al. 2009). Additionally, high NSP foods have a favorable effect on insulin sensitivity (Liese et al. 2005). Epidemiological studies have shown that there is a significant association between high intakes of NSPs and decreased risk of developing T2DM (Meyer et al. 2000; Salmeron et al. 1997; Schulze et al. 2004; Sluijs et al. 2010; Stevens et al. 2002).

Paients with diabetes who consumed low amounts of dates had significantly higher FBG than those who ate high quantities ($p < 0.01$). This profitable effect of dates on FBG can also be justified by the quality of the carbohydrate content in date fruits. As mentioned earlier, date carbohydrates consist of glucose, fructose and NSPs (Al-Farsi et al. 2007; Zhang et al. 2015). After consuming date fruits, only one-third of its nutrient content (glucose) can cause a direct rise in blood glucose. The presence of NSPs helps lower the absorption process of glucose in the human small intestine (Anderson et al. 2009). Additionally, the fructose in date fruits is delivered to the liver where it is metabolized for energy (Havel et al. 2004).

It is well known that T2DM is strongly associated with an inactive lifestyle and obesity (Al-Quwaidhi et al. 2013; Meisinger et al. 2006; Reis et al. 2013). Our findings have shown that approximately two-thirds of participants were obese or severely obese. Moreover, the consumption of dates was higher in patients who had a low mean BMI than in those with a high mean BMI, but this difference was not statistically significant ($p = 0.3$).

Interestingly, this finding contradicts the common belief that date intake increases blood glucose levels and causes worse diabetic control. A possible explanation is that patients with uncontrolled diabetes avoid date intake; however, a lack of date effects or even beneficial effects cannot be excluded by this study. This study has the natural limitation of being cross-sectional so can only demonstrate an association.

In conclusion, this study showed a weak negative association between date intake and HbA_{1c} in patients with T2DM. This must be interpreted carefully because of the limited nature of the study as cross-sectional. Further study with a better design is needed.

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Authorship contribution statement All authors contributed to the study conception and design. Study conduct and data collection were performed by Muneera Q Al-Mssallem. Data analysis was done by Mohammed A Al-Jamaan. The study was supervised by Ali A Al-Qarni. All authors contributed to the results interpretation. The first draft of the manuscript was written by Muneera Q Al-Mssallem and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Disclosure Statement No competing financial interests exist.

Conflict of interest The authors declare no conflict of interest.

Ethical approval The study was approved by the Institutional Research Board (IRB), Ministry of National Guard Health Affairs, and its memo reference no. is HAS–18–437,780–177,552. All patients gave informed written consent.

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