ORIGINAL ARTICLE

Impact of Fasting during Ramadan on Daily Habits, Diet and Body Weight of individuals with diabetes: A sample of Saudi Arabia

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ABSTRACT

Introduction: Many changes occur in Muslims' lives during Ramadan that affect body weight, diet and calorie intake. This study investigated the impacts of fasting during Ramadan on the daily habits, diet, and weight of people with diabetes in Saudi Arabia. **Methods:** A cohort study analyzed 104 Saudi individuals with diabetes (42 and 62 patients with type I and type II diabetes, respectively) aged ≥ 20 years who fasted a minimum of 15 days during Ramadan. The patients were seen twice per study period (before and during Ramadan). The patients' demographic data was obtained, their average daily food intake was assessed, and anthropometric parameters were measured. **Results:** During Ramadan, 52% of patients with type I DM and 66% of patients with type II DM did not perform any physical activity compared to 37% and 42%, respectively, pre-Ramadan. A high percentage of patients slept during the daytime. A paired-sample T test analysis showed that during Ramadan, the calorie intake and carbohydrate intake increased significantly in patients with type II diabetes ($p = 0.03$). Protein intake remained unchanged, whereas fat consumption increased in patients with both types of diabetes ($p = 0.03$ and 0.04, respectively). In addition, there was a decrease in anthropometric parameters (statistically significant in patients with type II diabetes, $p < 0.05$). **Conclusion:** Ramadan fasting changed the dietary and daily habits of patients with diabetes in Saudi Arabia and had beneficial effects on weight, mainly in patients with type II DM.
Malaysian Journal of Medicine and Health Sciences (2022) 18(4):141-149. doi:10.47836/mjmhs18.4.20

Keywords: Diabetes, Ramadan, Sleeping pattern, Exercise, Diet

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INTRODUCTION

Ramadan is a very religious month for Muslims and is the ninth month of the lunar Islamic (Hijri) calendar. During this month, Muslims (except those who are sick or traveling) fast from sunrise to sunset by abstaining from eating, drinking, smoking, and conjugal relations (Holy Qur'an, Al-Bakarah, verses 183–187). Being the fourth pillar of Islam, which is the religion practiced in Saudi Arabia (SA), fasting is sacred to Muslims. Fasting hours vary by season and geographical location and can last for 18 hours daily (1). The Ramadan fast lasts for one month a year and involves making specific changes in daily practices. The nutritional habits and lifestyles of Muslims usually change during this period. For instance, they eat only two main meals: sahur before dawn and iftar at sunset (2). Their sleeping patterns and time spent on daily activities also change during this fasting period. Results from previous studies have shown that people tend to have a short duration of sleep during the night and increased sedentary time during Ramadan (3–5). Modification of food habits during fasting affects the type and amount of food consumed. Dishes high in sugar, starch, protein, and fat are consumed during Ramadan (2). In addition, a reduction in vegetable and fruit intake has been observed (6). The total daily intakes of calories and nutrients during Ramadan are different from those consumed in other months (2). Several factors, including social, cultural, and personal, could affect total energy intake during Ramadan, and their impact can result in increased or decreased body weight (7–9).

Over the last decade, the prevalence of diabetes mellitus (DM) has significantly increased worldwide. According to the International Diabetes Federation, the number of individuals living with diabetes was estimated to be 463 million in 2019, and it is predicted to increase to 700 million by 2045 (10). This rapid increase will be highest in the Middle East and North Africa regions (10),

wherein the number of Muslims are high (approximately 93%) in these regions (11). In the Middle East, SA has rated the second while in the world the seventh for prevalence of diabetes, with an estimated seven million individuals with diabetes (12). Although Islam allows an individual not to observe the Ramadan fast in certain cases, many diabetes patients insist on fasting. It has been reported that approximately 79% of Muslims with diabetes fast for a minimum of 15 days during Ramadan, 42.8% of patients with type I diabetes and 78.7% of those with type II diabetes (13). The 2010 Multi-Country Retrospective Observational Study of the Management and Outcomes of Patients with Diabetes during Ramadan found that 94.2% of patients with type II DM fasted for a minimum of 15 days, of which 63.6% fasted the whole month (14). Although previous results have revealed that fasting Ramadan does not have any clinically negative impact on individuals with or without diabetes, managing diabetes during Ramadan is a big challenge for health care professionals (15). Several factors may affect glycaemic control in people with diabetes during Ramadan because of the sudden changes in both dietary practices and daily patterns, and these may require sudden changes in treatment regimens (15). Therefore, appropriate instructions concerning dietary management and medical therapy during Ramadan are required. Understanding the daily pattern and dietary habits of individuals with diabetes is crucial to help patients to manage their glycemia during Ramadan. Few studies have assessed the impact of fasting during Ramadan on the daily habits, energy, and diet of patients with diabetes, and these studies have yielded mixed results (5,16–18). For instance, Vasan et al. reported increased consumption of calories and macronutrients during Ramadan in type II DM (16). On the other hand, a study of 276 obese women with type II DM reported a decrease in total calorie intake, and thus in body weight, associated with a decrease in the number of meals eaten during Ramadan (17). Moreover, higher consumption of fat and dietary cholesterol was observed, which could have an adverse effect on diabetes control (17). Therefore, the current study aimed to investigate the impact of fasting during Ramadan on the daily habits, diet, and body weight of individuals with diabetes in SA.

MATERIALS AND METHODS

Study design and participants

A cohort study that was carried out on patients with diabetes at the diabetes center at King Saud University in Riyadh city, SA between May 2014 and July 2014. A convenience sampling method was used. Eligible patients were recruited during their routine visits 2-3 months prior to Ramadan. Patients less than 20 years of age, pregnant women, those fasting for fewer than 15 days, and those with significant health problems that may affect their total dietary intake such as renal, liver, or thyroid diseases were excluded from this study. The patients were assessed initially during the 6 weeks preceding Ramadan, which was considered a baseline evaluation of all the participants. Follow-up assessments were performed during Ramadan, and this was done after at least 15 days of fasting. The patients were instructed to follow the advice of their physicians and diabetes educators regarding their medication and diet regimen. All patients were reminded to return for their follow-up assessment.

Study Tools

The participants were interviewed individually using a predesigned questionnaire with close-ended questions; the questionnaire was developed on the basis of the knowledge available in the literature. It included data on sociodemographic information (such as sex, age, marital status, level of education, and family monthly income) and medical history (type of diabetes, onset of diabetes, and type of treatment), which were assessed during the initial visit. In addition, daily habits—including exercise patterns (frequency and duration), sleeping patterns (hours and time), and meal patterns (number of main meals and snacks)—were assessed at the initial and follow-up visits. Questions about the first food eaten to break the fast and sahur, which is the last meal eaten before resuming fasting the next day, were asked during the follow-up visit during Ramadan.

Dietary intake

A trained dietician obtained information on dietary intake at both initial and follow-up visits to assess participants' calorie and nutrients intake pre- and during Ramadan. Two nutrition assessment methods were used: Food Frequency Questionnaire (FFQ) and one day Food Recall (24-hrFR) to increase the accuracy of usual dietary intakes estimate of an individual as previously reported (19). For all participants, the two assessment methods were always performed in the same order.

Food Frequency Questionnaire (FFQ)

A validated FFQ was used in the study with some adaptations to suit the Saudi culture (20). It consisted of 156 food items and contained approximately every food item that is usually consumed by the Saudi population during and/or after Ramadan. The participants were asked to recall an average of how often and how much they consumed each food item with four possible responses: per day, per week, per month, or never. Food models and household measurements (e.g., samples of cups, dishes, and spoons of various sizes) were used to estimate the quantity or portion size of different food items for each participant.

Food Recall (24-hrFR)

On the day of the interview, the participants were asked to recall what they had eaten (all food and beverages consumed) in the previous 24 hours. The 24-hrFR questionnaire included the type and amount of each food consumed on that day and at what time the meal

was consumed. To estimate the portion size consumed for every food item, food models and household utensils were also used.

Dietary Analysis

Food items derived from the FFQ and 24-hrFR questionnaires were then analysed using the National Nutrient Database for Standard Reference (release 21, 2010; US Department of Agriculture) to obtain the daily calorie and macro- and micro- nutrients intake. For the local food items, the Arabic Program for Food Analysis (1st version, 2007; Saudi Arabia) was used. Averages of the daily intake were calculated from both FFQ and 24-hrFR questionnaires to give better estimation of true intakes (19) and then were used in the data analysis.

Anthropometric Assessment

Anthropometric parameters were measured at initial and follow-up visits, including height (cm), weight (kg), and body mass index (BMI, kg/m^2) was computed. The height and weight were measured using an appropriate international standard scale (Digital Person Scale; ADAM Equipment Inc., USA). In addition to measuring the waist (WC, cm) and hip (HC, cm) circumferences twice using a non-stretching tape and an average of each measurement was taken. The waist-to-hip ratio (WHR) was then computed. A professional trained nurse took all the measurements in accordance with the standard procedure identified by the World Health Organization (21).

Statistical Analysis

Frequency (percenters) and mean ± (standard deviation) were presented for categorical and continuous variables respectively. To compare between the two-time assessments (pre- and during Ramadan), a paired-sample t-test analysis was used. In addition, Pearson's correlation coefficients were used to investigate the strength of correlations between dietary intakes and those anthropometric parameters under study. A significant level was considered as p¬-value of ≤ 0.05. The Statistical Package for Social Sciences version 16.0 software (SPSS Inc., Chicago, IL, USA) was used for all data analysis.

Ethical Approval

The study proposal was approved by the College of Medicine Institutional Review Board at King Saud University - (IRB approval number 13/3930, dated December 04, 2013). Prior to the inclusion, informed consent was taken from the participants and the study protocol was explained to them. Participants had the chance to withdraw anytime from the study with no obligations.

RESULTS

Sociodemographic and clinical Characteristics

A total of 104 Saudi individuals with DM participated in the study; 42 (40.4%) of these patients had type I DM and 62 (59.6%) had type II DM were recruited during the initial assessment. However, a total of 68 (~65.4%) patients returned for their follow-up assessment: 27 (39.7%) patients with type I and 41 (60.3%) patients with type II DM. Compared to patients with type II DM, those with type I DM were younger (mean age of 30.73 ± 12.77 years), 52.4% were male, 54.8% were single, 52.4% had completed high school education, and 40.5% had a family monthly income of more than 15,000 Saudi riyals. About 40% of patients in both groups had been diabetic for longer than 15 years. Almost half (48.4%) of the patients with type II DM used oral antidiabetic drugs (OAD), 45.2% used OAD + insulin, and only 6.5% used diet alone as a type of treatment. The demographics and clinical information of the study subjects are shown in Table I.

Table I: The Sociodemographic and Clinical Characteristics of the Study Subjects (n=104)

Characteristics	Type I DM n (%)	Type II DM n (%)
Sociodemographic Characteristics		
Sex		
Male	22 (52.4)	48 (77.4)
Female	20 (47.6)	14 (22.6)
Social Status		
Single	23 (54.8)	0 (0)
Married	17 (40.4)	60 (96.8)
Divorced/ Widowed	2 (4.8)	2 (3.2)
Educational Level		
Illiterate	3 (7.1)	1 (1.6)
Primary School	2 (4.8)	5 (8.1)
Secondary	22 (52.4)	25 (40.3)
University or above	15 (35.3)	31 (50.0)
Occupation		
Student	15 (35.7)	0 (0)
Working	17 (40.5)	39 (62.9)
Retired/not working	10 (23.8)	23 (37.1)
Family Monthly Income (SR)		
<3000	4 (9.5)	1 (1.6)
3000-<6000	5 (11.9)	7 (11.3)
6000-<10000	10 (23.8)	8 (12.9)
10000-15000	6 (14.3)	13 (21)
>15000	17 (40.5)	33 (53.2)
Clinical Characteristics		
Type of Diabetes	42 (40.4)	62 (59.6)
Duration of DM in years	0 (0)	2 (3.2)
<1	9 (21.4)	8 (12.9)
1-5	9 (21.4)	14 (22.6)
6-10	7 (16.7)	13 (21)
11-15	17 (40.5)	25 (40.3)
>15		
Type of treatments	0 (0)	30 (48.4)
OAD	42 (100)	0 (0)
Insulin	0 (0)	28 (45.2)
OAD + Insulin	0 (0)	4 (6.5)
Diet only		

SR = Saudi Riyals. OAD = Oral Antidiabetic Drug

Daily Habit Characteristics

The daily habits of the patients during the first visit preceding Ramadan differed from those habits during Ramadan, as shown in Table II. The physical activity

Table II: The daily habits Pre- and During Ramadan of patients with diabetes

	Type I DM n (%) 27 (*42*) [§]		Type II DM n (%) 41 (*62*) [§]	
	Pre-Ramadan	During Ramadan	Pre-Ramadan	During Ramadan
No. of exercise per week				
Never	10 (37)	14 (5*2*)	17 (4*2*)	27 (6*6*)
1-2 time	4 (1*5*)	4 (1*5*)	8 (*19*)	2 (*5*)
3-4 time	7 (2*6*)	2 (7)	6 (1*5*)	2 (*5*)
>4 time	6 (22)	7 (2*6*)	10 (24)	10 (24)
Duration of exercise (minutes)				
<10	1 (*4*)	1 (*3.7*)	0 (0)	0 (0)
10-20	4 (1*5*)	1 (*3.7*)	4 (*10*)	5 (12)
20-30	3 (11)	3 (11)	7 (17)	4 (*10*)
>30	9 (33)	8 (*29.6*)	13 (31)	5 (12)
Sleeping time				
Night	17 (63)	2 (7)	34 (8*3*)	7 (17)
Day	10 (37)	25 (9*3*)	7 (17)	34 (8*3*)
Sleeping hours				
<5	2 (7)	4 (1*5*)	3 (7)	6 (14)
5-6	10 (37)	6 (22)	17 (4*2*)	15 (3*7*)
7-8	7 (2*6*)	9 (33)	18 (44)	18 (44)
>8	8 (*30*)	8 (*30*)	3 (7)	2 (*5*)
Eating habits				
No. of Meals/day	2.29	2.07	2.46	1.8* [Δ]
No. of Snacks/day	2.18	1.25*	1.8	1.07* [Δ]

[§] The total number of the subject that completed the study from total participants; * Significant level P =0.000; using Paired-Samples T Test to compare the results of pre- and during Ramadan; Δ Significant level P ≤0.001; using Independent-Samples T Test to compare the results of Type I with Type II DM patients

pattern and duration decreased during Ramadan in both groups of diabetes. During Ramadan, 52% of participants with type I DM and 66% of those with type II DM were not performing any physical activity compared to pre-Ramadan periods (37% vs. 42% respectively). Regarding sleeping time, 93% of patients with type I DM and 83% of those with type II DM patients slept during the daytime in Ramadan compared to during the pre-Ramadan period (37% vs. 17%). Sleeping hours were almost unchanged; however, the duration of sleep was longer (>8 hours) in participants with type I compared to that of those with type II DM both pre- and during Ramadan.

Most patients (89% of type I DM and 98% of type II DM) broke their fast with dates, and most participants ate their sahur meal with higher proportion in patients with type I DM (93% of type I DM and 63% of type II DM patients; data are not shown). The mean number of daily meals and snacks decreased during Ramadan, as presented in Table II. The number of main meals significantly changed among patients with type II DM (2.46 vs. 1.8 pre- and during Ramadan; P < 0.001), while it remains unchanged among patients with type I DM (2.29 vs. 2.07 pre- and during Ramadan; P = 0.14).

Dietary consumption analysis

The total nutrient intake varied between pre- and during Ramadan, as given in Tables III-V. Participants with type II DM had a significant increase in their total calorie (1595±272 vs. 1652±219 kcal) and carbohydrate (139±41 vs. 145±35 g) consumption pre- and during Ramadan, respectively. Furthermore, the total fat consumption increased during Ramadan; the increment was significant in patients with either of the two types of DM (Type I DM 72±19 vs. 77±23 g) and (Type II DM 78±19 vs. 81±19 g) pre- and during Ramadan respectively. The amount of proteins consumed did not significantly change. Generally, patients with type I DM consumed more calories and carbohydrates, whereas patients with type II DM consumed more protein and fat (Table III).

Table III: Differences of Calories and Macronutrient Intake Pre- and During Ramadan

	Pre-Ramadan Mean ± SD	During Ramadan Mean ± SD	P value
Energy (Kcal)			
Type I DM	1694 ± 421	1687 ± 313	0.83
Type II DM	1595 ± 272	1652 ± 219	0.03*
P value	0.008 Δ	0.040 Δ	
Carbohydrate (gm)			
Type I DM	206 ± 85	186 ± 46	0.05
Type II DM	139 ± 41	145 ± 35	0.03*
P value	0.001 Δ	0.292	
Protein (gm)			
Type I DM	55 ± 14	61 ± 16	0.07
Type II DM	85 ± 28	85 ± 26	0.95
P value	0.030 Δ	0.004 Δ	
Fat (gm)			
Type I DM	72 ± 19	77 ± 23	0.03*
Type II DM	78 ± 19	81 ± 19	0.04*
P value	0.416	0.472	

* Significant level *P* value < 0.05; using Paired-Samples T Test to compare the results of pre- and during Ramadan; Δ Significant level *P* value < 0.05; using Independent-Samples T Test to compare the results of Type I with Type II DM patients

In terms of different fatty acid consumption, the mean omega-3 fatty acid and saturated fat intakes were significantly higher in both types of diabetes during Ramadan (Table IV). In addition, the mean daily dietary fibre consumption during Ramadan increased in patients with type I DM and decreased in patients with type II DM; however, the change was not statistically significant (Table IV). In addition, patient with type II DM consumed more omega-6 both pre- and during Ramadan (P = 0.01; Table IV).

In terms of micronutrient intake, patients with type I DM had a significantly higher mean daily consumption of calcium and lower mean daily consumption of vitamin D during Ramadan (P = 0.01 and 0.004, respectively). On the contrary, calcium and vitamin D intake decreased in patients with type II DM, but it was insignificant (Table V). Moreover, the mean daily manganese and vitamin K consumptions were higher in those with type II DM (Table V).

Table IV: Differences of Fatty Acids, Cholesterol, and Fiber Intake, and Kcal from Fat Pre- and During Ramadan

	Pre-Ramadan Mean ± SD	During Ramadan Mean ± SD	P value
Omega 3 FA (gm)			
Type I DM	0.34 ± 0.1	0.40 ± 0.2	0.02*
Type II DM	0.42 ± 0.3	0.48 ± 0.2	0.03*
P value	0.09	0.15	
Omega 6 FA (gm)			
Type I DM	6.6 ± 2.3	6.7 ± 2.3	0.64
Type II DM	8.2 ± 3.5	8.2 ± 3.9	0.77
P value	0.01Δ	0.01Δ	
Saturated FA (gm)			
Type I DM	26 ± 3.2	33 ± 7.9	0.000*
Type II DM	30 ± 9.4	34 ± 10.1	0.001*
P value	0.06	0.19	
Unsaturated FA (gm)			
Type I DM	47.2 ± 19.0	46.1 ± 20.2	0.51
Type II DM	47.6 ± 21.2	46.9 ± 22.2	0.58
P value	0.52		
Cholesterol (mg)			
Type I DM	409 ± 97.5	434 ± 140.6	0.48
Type II DM	388 ± 91.5	384 ± 96.9	0.84
P value	0.62	0.13	
Fiber(gm)			
Type I DM	14 ± 6.2	18 ± 8.2	0.08
Type II DM	16 ± 6.3	16 ± 6.9	0.79
P value	0.83	0.26	
Kcal from Fat			
Type I DM	651 ± 169	695 ± 208	0.04*
Type II DM	700 ± 173	728 ± 172	0.046*
P value	0.49	0.48	

FA= fatty acid; * Significant level P value < 0.05; using Paired-Samples T Test to compare the results of pre- and during Ramadan; Δ Significant level P value < 0.05; using Independent-Samples T Test to compare the results of Type I with Type II DM patients.

Table V: Differences of Micronutrient Intake Pre- and During Ramadan

	Pre-Ramadan Mean ± SD	During Ramadan Mean ± SD	P value
Calcium (mg)			
Type I DM	523 ± 209	571 ± 198	0.01*
Type II DM	602 ± 174	599 ± 169	0.50
P value	0.23	0.41	
Manganese (mg)			
Type I DM	0.53 ± 0.5	0.52 ± 0.3	0.91
Type II DM	0.87 ± 0.7	0.76 ± 0.5	0.16
P value	0.000Δ	0.003Δ	
Vitamin D (g)			
Type I DM	8.0 ± 4.1	7.4 ± 4.0	0.004*
Type II DM	6.9 ± 2.1	6.7 ± 2.1	0.42
P value	0.01Δ	0.008Δ	
Vitamin K (g)			
Type I DM	70.4 ± 36.5	71.1 ± 34.2	0.71
Type II DM	72.3 ± 23.3	72.8 ± 20.1	0.62
P value	0.02Δ	0.002Δ	

* Significant level *P* value < 0.05; using Paired-Samples T Test to compare the results of pre- and during Ramadan; Δ Significant level *P* value < 0.05; using Independent-Samples T Test to compare the results of Type I with Type II DM patients

Anthropometrics Analysis

Compared to the measurements taken pre-Ramadan, all anthropometric measurements (weight, BMI, WC, HC, and WHR) decreased during Ramadan in patients with both types of diabetes. This decrease was statistically significant in type II DM patients, with P < 0.001 for weight, BMI and WC, 0.01 for HC and 0.02 for WHR (Table VI).

Table VI: Anthropometric Measurements Pre- and During Ramadan

	Pre-Ramadan Mean ± SD	During Ramadan Mean ± SD	P value
Weight (kg)			
Type I DM	72.2 ± 19.3	71.4 ± 18.8	0.10
Type II DM	83.7 ± 13.8	82.7 ± 13.5	0.000*
P value	0.32	0.09	
BMI (kg/m²)			
Type I DM	26.7 ± 5.6	26.4 ± 5.6	0.12
Type II DM	30.0 ± 5.1	29.6 ± 4.9	0.000*
P value	0.79	0.40	
WC (cm)			
Type I DM	91.0 ± 15.4	90.1 ± 14.9	0.17
Type II DM	105.2 ± 9.5	102.3 ± 8.9	0.000*
P value	0.06	0.05	
HC (cm)			
Type I DM	103.0 ± 11.7	101.4 ± 11.1	0.06
Type II DM	107.6 ± 9.7	106.3 ± 9.6	0.01*
P value	0.77	0.41	
WHR			
Type I DM	0.88 ± 0.08	0.88 ± 0.07	0.66
Type II DM	0.98 ± 0.06	0.96 ± 0.06	0.02*
P value	0.17	0.93	

BMI=body mass index; WC=waist circumferences; HC=hip circumferences; WHR= waist to hip ratio; * Significant level *P* value < 0.05; using Paired-Samples T Test to compare the results of pre- and during Ramadan; Δ Significant level *P* value < 0.05; using Independent-Samples T Test to compare the results of Type I with Type II DM patients

DISCUSSION

This study aimed to investigate the impact of fasting during Ramadan on the daily habits, diet, and body weight of patients with diabetes in Saudi Arabia. The main findings indicate that daily habits including sleeping pattern and physical activity changed during Ramadan compared to pre-Ramadan. Furthermore, dietary habits changed, and the frequency of meals decreased during Ramadan. This is expected because fasting is restricting Muslims from eating between sunrise (Fajer) and sunset (Maghrib). Even with the decrement in the number of meals and snacks, the study results revealed that the eating pattern of participants with diabetes seem to be rich in energy-dense food. This could reflect the type and variety of food items eaten, such as fried food (sambosa) and Arabic sweets (luqmat al qadi), especially at iftar to compensate for lower frequency of meals during Ramadan (9,15). Nutrient intake was different in both patients with type I and type II diabetes. Type I DM patients consumed more calories and vitamin D, whereas those with type II DM consumed more protein, omega-6, vitamin K, and

manganese. This could be due to variations in the age between both groups, patients with type II DM were older, and with age patients become more motivated to follow more balanced diet (22).

During Ramadan fasting, the daily habits of participants changed and the levels of physical activity decreased in most cases. This result is consistent with those of a previous study on the Malaysian population showing that physical activity levels were higher pre-Ramadan (23). Another study demonstrated that sedentary habits, such as lying down, sitting, and watching television were longer during Ramadan than during other months (24). In addition, sleeping patterns changed during Ramadan, with most participants starting to sleep during the day. Previous studies reported that sleeping hours during the day were significantly longer during Ramadan than in other months (25-27). However, the total sleep duration in the current study was not found to be affected during Ramadan, this is in line with the results from a previous study on healthy Muslims (3).

Comparing the dietary habits of patients with the two types of diabetes during Ramadan fasting, significant changes were found in terms of the number of meals and snacks and the sahur meal eaten by patients with type I DM. This could be attributed to the treatment regimen adopted (insulin therapy) for patients with type I DM and the nutritional counselling they might have received pre-Ramadan compared to those of patients with type II DM.

During Ramadan fasting, the total calories consumed by patients with type I DM were not differ compared to pre-Ramadan, whereas they were significantly increased among patients with type II DM. This could be due to the significant increase in the total fat and carbohydrate consumption in participants with type II DM. These results are in line with those of an Indian study on patients with type II DM, wherein a considerable increase in calorie, carbohydrate and fat consumption was found during Ramadan fasting (16). Furthermore, the current study showed that intake of protein was not different during Ramadan compared to pre-Ramadan in participants with either type of diabetes. This is similar to a study in healthy participants, wherein protein intake remained unchanged (2). Another study conducted in the Emirate of Ajman found that the total calorie intake during Ramadan was unchanged, with an increased fat consumption and decreased protein and carbohydrate consumption (25). A study from Iran showed a reduction in the total calorie and other macronutrient intake during Ramadan (28). The population-based survey in 13 countries, The Epidemiology of Diabetes and Ramadan 2001 study, on diabetes patients revealed that the percentage of the study population that did not change or decrease their total food intake was higher than that of those participants who showed an increase in food intake during Ramadan (13). These varying results could be explained by the differences in the cultures studied population.

Mixed results were found in terms of saturated fatty acid and cholesterol consumption in previous studies. Their intake was either increased (17, 2), unchanged (29), or decreased (28,30) during Ramadan. The amount of fibre consumed during Ramadan in the current study increased among participants with type I DM, whereas it decreased among those with type II DM however, this was not statistically significant. Mixed results were also seen in dietary fibre consumption during Ramadan (2, 17, 28, 30-31).

In terms of micronutrient intake, the only significant differences were seen among type I DM patients in their calcium and vitamin D intake during Ramadan. No significant changes in micronutrient intake were noted among participants with type II DM during Ramadan. However, manganese intake was significantly high in type II DM patients compared to those with type I DM; this could be because type II DM cases consumed more dates, which provide 7% of the daily recommended manganese intake per 100 grams (32).

Despite the changes in daily habits and dietary consumption during Ramadan, all anthropometric parameters decreased, particularly in type II DM patients. This raises the question of how the Ramadan fast may induce weight loss despite no change or even an increase in dietary intake. A systematic review and meta-analysis investigating the effect of the Ramadan fast on the weight and body composition of 2947 individuals found that the pre-Ramadan BMI positively correlated with weight loss during Ramadan in overweight/obese people but not in people with normal weight. Moreover, people with overweight/obesity had a significantly lower fat mass than people with normal weight (33). A small pilot study also reported that the Ramadan fast had beneficial effects on the body composition of participants with type II DM, particularly in terms of total fat mass, compared to healthy controls (34). One possible explanation for these effects is an increase in energy expenditure that could protect against diet-induced obesity during time-restricted feeding (35). This is also supported by a study on patients with metabolic syndrome that attributed changes in body weight to efficient utilization of body fat, especially abdominal fat (25). Moreover, a study conducted in Shiraz, Iran, showed a significant reduction in weight and BMI among overweight males. This was explained by the possible effect of drinking large quantities of fluids, which may have suppressed appetite and restricted food consumption (36). In another study, drinking excessive amounts of water induced an increase in thermogenesis through an increase in sympathetic nervous system activity and energy expenditure and was thus considered a possible reason for weight loss (37). Conversely, a study conducted in Tunisia found an increase in BMI

among healthy participants at the end of the Ramadan fast (30). Changes in biological and anthropometric parameters during Ramadan could be of major clinical significance, particularly in terms of atherosclerosis risk, if individuals' BMI continues to increase over Ramadan each year (30).

To our knowledge, the current investigation is one of the few studies to assess the consumption of calories and nutrients consumption among individuals with diabetes in SA during Ramadan. However, this study is limited to the sampling method, which was a convenience sampling method, thus the results may not be generalized to the Saudi population with diabetes. Furthermore, the response rate of the participants during Ramadan was lower than expected therefore, we could not evaluate the results based on other differences such as age and gender.

CONCLUSION

In conclusion, the current study showed changes in dietary and other daily habits during Ramadan among individuals with diabetes in SA, wherein the patients were found to have decreased physical activity levels, changed sleeping pattern and total daily calorie and nutrients intake. However, Ramadan fasting was found to have beneficial effects on weight, mainly in those with type II DM. Hence, further longitudinal studies are crucial to study the effect of the month of Ramadan before, during, after fasting, on dietary intakes, anthropometric parameters, and different biomarkers in a larger population with diabetes in SA taking into consideration all aspects including age and gender.

ACKNOWLEDGEMENTS

The authors would like to thank the King Abdulaziz City for Science and Technology for funding this study (grant number a-t-34-0165). In addition, we would like to thank the Deanship of Scientific Research, Princess Nourah bint Abdulrahman University for supporting the study through the Fast-track Research Funding Program. Extended thanks were also given to all volunteers for their participating in the study.

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