

## Clinical and Metabolic Effects of Ramadan Fasting among A Sample of Diabetic Patients Attending Qualubeya Governorate Hospitals

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### Abstract

**Background:** During Ramadan month Muslims neither eat or drink from dawn to sunset. Islam exempts some Muslims from fasting including diabetic patients. However, many diabetic patients insist on fasting without proper medical advice. **Objectives:** To determine the clinical effects of Ramadan fasting on diabetic patients, to identify the underlying factors of these effects and to outline recommendations for safe fasting. **Method:** This follow up study recruited 284 Muslim diabetic patients from two hospitals in Qualubeya Governorate, of these; only 200 patients completed the study. The patients were assessed by a structured questionnaire sheet, diabetes symptom checklist, anthropometric measurement and blood samples were collected to measure fasting blood glucose, cholesterol, triglyceride, High Density Lipoprotein, Low Density Lipoprotein and glycated hemoglobin (HbA1C). **Results:** There was a statistically significant increase in five DM symptom domain scores at the end of Ramadan than before; neuropathic pain, psychological fatigue, cardiovascular, psychological cognitive function and hyperglycemia ( $P < 0.05$  for all). Anthropometric measurements (weight, BMI, waist-hip ratio), lipid profile and HbA1C were significantly ( $P < 0.05$ ) decreased at the end of Ramadan. Complicated DM during Ramadan fasting was related to physical inactivity, previous DM complications during Ramadan fasting, decreased food intake, increased fluid and sugar intake. **Conclusion:** Ramadan fasting is associated with DM complications in diabetic patients. So, management plans are recommended to minimize these complications.

**Key words:** Diabetes Mellitus; DM; Ramadan fasting; Complications; Risk factors

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### Introduction

Diabetes Mellitus (DM) is a metabolic disorder of multiple etiologies characterized by development of disabling and life-threatening health complications.<sup>1</sup> DM is one of the major causes of morbidity and mortality in most developed and developing countries.<sup>2,3</sup> In 2015, about 9.1% of adults aged 20-79, are living with DM in the Middle East and North Africa Region. In Egypt, the prevalence of DM was 14.5% in 2017. The

International Diabetes Federation (IDF) listed Egypt among the world top 10 countries regarding the number of diabetic patients.<sup>1,3,4</sup>

Fasting during the month of Ramadan is one of the five fundamental rituals of Islam. Muslims neither eat nor drink anything from dawn until sunset. This change of meal schedule is accompanied with changes in lifestyle and the drug schedule during the day time because of

fasting, which may have an effect on DM patients.<sup>5,6</sup> Moreover, the time of fasting differs each year because it is a lunar calendar and the fasting period varies with the geographical site and the season.<sup>7</sup>

The risks of fasting in diabetic patients include hypoglycemia, hyperglycemia, dehydration and thrombosis.<sup>8</sup> Islam exempts some Muslims from fasting including individuals who are sick mainly those with chronic illnesses such as DM in whom fasting may be detrimental to health. People with diabetes are categorized by the American Diabetes Association into four risk groups as follows: *very high risk, high risk, moderate risk and low risk*.<sup>8</sup> Patients who are in the two highest categories risk should not fast. Moreover, many of those who are at moderate and low risk need to be aware of the risks associated with fasting and of methods to decrease these risks. Patients should be provided with an individualized management plan and be advised on the measures they can take to have safe fasting.<sup>9</sup>

It was assessed that the quantity of Muslims ran between 1.1– 1.5 billion around the world, containing 18– 25% of the total populace in 2014. Notwithstanding, there is absence of information on the best of fasting in Ramadan with DM. This examination researched the impact of Ramadan fasting on DM patients and its association with way of life changes in Ramadan.

The specific objectives of the current study were to determine the clinical effects due to Ramadan fasting on diabetic patients, to identify the underlying factors of these effects and to outline recommendations for the lifestyle changes, diet modifications and treatment modifications for diabetic patients during Ramadan.

## Method

*Study design and participants:* This was a follow up clinical cohort study that was conducted upon Muslim diabetic patients attending Qualubeya Governorate hospitals, above 18 years old, diagnosed and under DM treatment and reported to fast Ramadan 2017. Multi-stage sampling technique was used to choose the participants where the districts were listed. Of these, two districts were selected by simple random sample (Banha and Shibin Al-Qanater). From each district one hospital was selected, Banha university hospitals and Shibin Al-Qanater central hospital, by simple random sample.

The minimum sample size (n=191) was calculated according to the equation:

$$\text{Sample size} = \frac{Z_{1-\alpha/2}^2 P(1-P)}{d^2}$$

Where:  $Z_{1-\alpha/2}$  is the standard normal variate at 5% type 1 error ( $P < 0.05$ ); it is 1.96.  $P$  = the expected proportion based on previous studies (14.5%) (4).  $d$  = the absolute error (0.05)

Diabetic patients who do not fast Ramadan, at very high and high risks and pregnant diabetics were excluded.

The subjects of the study were identified 4 months before Ramadan by meeting them in outpatient clinics of the chosen hospitals where the items of the study were explained to them. Data were collected from patients who accepted to participate within two weeks before and during the last week of Ramadan. The study participants comprised 284 DM patients, of them, 200 (70.4%) patients attended the follow up visit.

*Data collection tools:* (1) A structured questionnaire-based on face-to-face interview was used to collect information about: personal data (age, sex, residence and marital status), socio-economic level (modified after Fahmy and El Sherbinin, 1983)<sup>10,11</sup>, smoking habit and physical activity.<sup>2</sup> Diabetes history: type, duration,

**Table (1):** Frequency distribution of the studied group according to their socio –demographic, clinical characteristics and lifestyles changes during Ramadan fasting

Variables	No	%		
Gender	Male	32	16.0	
	Female	168	84.0	
Age (years)	Mean ±SD (Range)	56.5±9.5(35-75)		
Residence	Rural	100	50.0	
	Urban	100	50.0	
Marital status	Married	148	74.0	
	Widow	52	26.0	
Socioeconomic state*	Low	50	25.0	
	Middle	58	29.0	
	High	92	46.0	
Smoking†	Current smokers	14	7.0	
	Former smoker	15	7.5	
	Never smokers	171	85.5	
Being passive smoker	Yes	76/186	40.9	
	No	110/186	59.1	
Daily physical activity ††	Active	70	35.0	
	Inactive	130	65.0	
Type of DM	Type 1	18	9.0	
	Type 2	182	91.0	
Duration of DM (ys)	Median (Range)	9	1-32	
Drug used for DM	Insulin	23	11.5	
	Oral hypoglycemic drug	119	59.5	
	Both types	58	29.0	
Compliance to treatment	Always	170	85.0	
	Sometimes	30	15.0	
Source of DM information	Physicians only	188	94.0	
	Friends only	3	1.5	
	Physicians and Family	5	2.5	
	Physicians and friends	2	1.0	
	Physicians and social media	2	1.0	
Self monitoring of blood glucose	Yes	68	34.0	
	No	132	66.0	
Frequency of monitoring blood glucose (n=68)	Daily	6	8.8	
	Week	22	32.4	
	Month	10	14.7	
	On demand	30	44.1	
Ramadan fasting advice given to patients	Yes	38	19.0	
	No	162	81.0	
Form of advice (n=38)	Treatment changes	4	10.5	
	Diet changes	22	57.9	
	Treatment and Diet changes <sup>4</sup>	12	31.6	
Advice compliance(n38)	Yes	36	94.7	
	No	2	5.3	
during	Physical activity	Increased	1	0.5
		Decreased	72	36.0
		No change	127	63.5
changes	Food intake	Increased	12	6.0
		Decreased	90	45.0
		No change	98	49.0
Ramadan fasting	Fluid intake	Increased	126	63.0
		Decreased	14	7.0
		No change	60	30.0
Lifestyle	Sugar intake	Increased	44	22.0
		Decreased	34	17.0
		No change	122	61.0

\* (Low < 15, Middle ; 15-18 and high ≥19). † Former smoker (quit smoking at least 6 months), never smoker (never smoked a cigarette or who smoked fewer than 100 cigarettes in their entire lifetime) †† Active : walking or cycling for more than 30 min/day (*Bener and Yousafzai, 2014*)

**Table (2): Frequency distribution of the studied group according to past and current history of DM complications during Ramadan fasting.**

Variables		Total no= 200		
		No	%	
Past history of DM complications	Previous DM complications	Yes	130	65.0
		No	70	35.0
	Types of DM complications * (n=130)	Diabetic coma	8	6.1
		Neuropathy	119	91.5
		Dizziness	17	13.1
		Foot complications	11	8.5
		Retinopathy	37	28.4
	Types of foot complications (n=11)	Foot abscess	2	18.2
		Fungal infection	7	63.6
		Gangrene and amputation	2	18.2
	Breaking fast due to complications	Yes	33	25.4
		No	97	74.6
	Hospital admission due to DM complications	Yes	10	7.7
		No	120	92.3
Cause of admission	Diabetic coma	8	80.0	
	Gangrene and amputation	2	20.0	
DM complications during the current study	Incidence of DM complications	Yes	73	36.5
		No	127	63.5
	Form of symptoms of complications* (n=73)	Dizziness	54	74.0
		Syncope	8	11.0
		Thirst	15	20.5
		Fatigue	18	24.7
		Palpitation	2	2.7
		Headache	6	8.2
		Blurred vision	2	2.7
	Foot complications	1	1.3	
Breaking fast due to complications	Yes	26	35.6	
	No	47	64.4	
Hospital admission due to complications	Yes	0	0.0	
	No	73	100.0	

\*More than one answer was allowed

treatment, compliance to treatment, source of health information about diabetes, self-monitoring of blood glucose level, advice from the healthcare providers concerning best practice during Ramadan fasting.<sup>2,12,13,14</sup> Past and current history of DM complications and lifestyle changes during Ramadan fasting.<sup>2,12,15</sup> Diabetes Symptom Checklist-Revised (DSC-R): this

comprised 34 items, which are grouped into eight symptom domains; each measures a different aspect of diabetes symptomatology: psychological-fatigue, psychological-cognitive, neurological-pain, neurological-sensory, cardiovascular, ophthalmologic, hypoglycemic and hyperglycemic. For each item, participants

**Table (3): Comparison between DM symptom domains among the studied group**

DM symptom domains (no=200)	Before Ramadan	At the end of Ramadan	Wilcoxon Signed rank test	P value
	Median (IQR),* (Range)	Median (IQR),* (Range)		
Neuropathic pain	7 (5-9), (4-16)	8 (6-9), (4-16)	3.899	<0.001
Psychological fatigue	7 (5-8), (4-15)	7 (6-8), (4-15)	6.224	<0.001
Cardiovascular	5 (5-7), (4-14)	6 (5-7), (4-14)	3.377	0.001
Ophthalmologic	7 (5-8), (5-20)	7 (6-9), (5-19)	1.711	0.087
Psychological cognitive	6 (5-7), (4-15)	7 (6-8), (4-12)	5.182	<0.001
Hyperglycemic	11 (8-12), (4-20)	11 (9-13), (4-18)	3.458	0.001
Neuropathic sensoric	11 (8-14), (6-19)	10 (7-13), (6-18)	1.894	0.058
Hypoglycemic	5.5 (4-6), (3-12)	6 (4-6), (3-12)	0.56	0.575
Total	59 (50-65), (36-110)	62 (54-66), (37-110)	5.933	<0.001

\* Interquartile Range

**Table (4): Comparison of anthropometric, blood pressure measurement and laboratory investigations among the studied group**

Anthropometric measurement and Laboratory investigations (no=200)	Before Ramadan	At the end of Ramadan	Wilcoxon Signed rank test	P value
	Median (IQR),* (Range)	Median (IQR),* (Range)		
Weight (Kg)	90 (80-100), (54-130)	89.5 (78-100), (55-129)	5.369	<0.001
Body mass index (kg/m <sup>2</sup> )	34.1 (30.1-39.1), (22.48-53.33)	33.82 (29.7-39.3), (21.8-53.78)	5.250	<0.001
Waist circumference (CM)	99 (93-106), (79-130)	99 (92-105), (79-130)	5.37	<0.001
Hip circumference (CM)	117 (108-123), (90-140)	117 (107-123), (90-140)	4.516	<0.001
Waist-hip ratio	0.858 (0.831-0.898), (0.77-1.11)	0.857 (0.829-0.897), (0.76-1.11)	4.4	<0.001
Blood pressure (mmHg)				
Systolic	121 (115-137), (92-165)	119 (113-129), (96-145)	3.996	<0.001
Diastolic	77 (71-83), (62-102)	76 (70-83), (60-102)	0.979	0.328
Fasting blood glucose (mg/dl)	152.5 (103-205), (70-402)	152.5 (103-200), (68-412)	1.337	0.181
Blood cholesterol (mg/dl)	216.3±45.5†	202.8±40.4†	9.365††	<0.001
Triglycerides (mg/dl)	121.5 (94-170), (53-276)	109 (95-148), (55-299)	6.213	<0.001
High density lipoproteins(mg/dl)	55 (49-61), (37-80)	54 (49-60), (36-81)	0.952	0.341
Low density lipoproteins(mg/dl)	134.5±42†	124±36.2†	7.09 ††	<0.001
Hb A1C (%)	7.4 (6.8-8.5), (5.72-10.4)	7 (6.2-7.8), (5.1-12)	8.139	<0.001

\* Interquartile Range † Mean± standard deviation for normally distributed data †† Paired t test

were asked if they had experienced the symptom during the preceding days of Fasting, and if yes, how troublesome that particular symptom was for them. The patients' responses were coded as 1, 2, 3, 4 and 5 corresponding to *not at all, little, moderately, very and extremely* respectively. Items were summed to form domain scores. Higher scores indicate greater symptom burden.<sup>16</sup>

Blood pressure measurements were taken using a standard zero mercury sphygmomanometer.<sup>2</sup>

Anthropometric measurements: height, weight, BMI, waist circumference, hip circumference and waist-hip ratio were taken according to standards.<sup>14,17</sup>

Laboratory investigations: A blood sample of 5ml was collected by qualified nurses, after fasting for 10 hours, through venipuncture from each participant into

**Table (5): Stepwise logistic regression for the predictors of complications of Ramadan fasting this year**

Variables	OR	95% CI	P value
<b>Past history of DM complications during Ramadan fasting</b> Yes vs. no	2.57	1.20 to 5.54	0.016 (S)
<b>Daily physical activity</b> Inactive vs. active	2.77	1.20 to 6.25	0.016 (S)
<b>Food intake</b>			
No change	1		
Decreased	2.72	1.28 to 5.81	0.01(S)
Increased	1.14	0.22 to 6.0	0.87
<b>Fluid intake</b>			
No change	1		
Decreased	1.55	0.31 to 7.70	0.59
Increased	4.02	1.61 to 10.06	0.003(S)
<b>Sugar intake</b>			
No change	1		
Decreased	1.2	0.79 to 5.05	0.14
Increased	7.31	2.97 to 17.97	<0.001(S)

tubes containing EDTA under complete aseptic precautions. The samples were collected within 2 weeks before Ramadan to know their baseline condition and in the last week of Ramadan to assess changes in plasma glucose, total cholesterol, triglyceride, High Density Lipoproteins (HDL), Low Density Lipoproteins (LDL) and glycated Hemoglobin (HbA1c) (2,18). Laboratory investigations were done in the Department of clinical pathology at Benha University Hospitals

#### Statistical analysis:

The collected data were tabulated and analyzed using the Statistical Package for Social Science, version 16.0 for windows, (SPSS Inc, Chicago,IL). Quantitative data were expressed as mean  $\pm$ Standard deviation (SD) or median and range for parametric and nonparametric data respectively as proved by Kolmogorov Smirnov test, assuming normality at  $P>0.05$ . Categorical data were summarized as frequency and proportion. Statistical comparisons between the different study groups were carried out using the Mann-

Whitney U-test, the Student t-test, the paired t-test, the Wilcoxon signed rank test, Chi-square test, the Fishers exact test and the Mc Nemar-Bowker as appropriate. Multiple logistic regression analysis was carried out to identify significant predictors for complications of Ramadan fasting using the stepwise method. A P-value  $\leq 0.05$  was considered statistically significant.

#### Ethical consideration:

An informed written consent was obtained from the participants, it included data about objectives, methods, benefits, expected harms and confidentiality of data. Also, approvals from the Research Ethics Committee in Benha Faculty of Medicine and Benha Health Directorate were obtained.

#### Results:

The mean age of the studied sample was  $56.5 \pm 9.5$  years and ranged between 35 and 75 years. The females constituted 84.0% of the studied sample. 74% were married, 50% were from rural areas, 46% belonged

to high socioeconomic state while 54% were from low and middle social classes. Seven percent were current smoker, 7.5% were former smokers and 85% were never smokers, from which 40.9% were passive smokers. Only 35.0% were physically active. Regarding type of DM, 91.0% of the studied sample were of type 2 DM, 59.5% were on oral hypoglycemic alone, 85.0% were always compliant to treatment and 34.0% self-monitor their blood glucose level. During the Ramadan fasting, 19% of the studied patients were given advice regarding Ramadan fasting, 57.9 % of this advice was in the form of diet changes. Thirty six percent of the studied group decreased their daily physical activity, 45% decreased their food intake, 63% increased their fluid intake and 22% increased their sugar intake (Table1).

Sixty five percent of the studied sample had past history of DM complications during fasting, 91.5% of these complications were neuropathy, 25.4% broke their fast due to the complications, and 7.7% of complicated patients were admitted to the hospital. During fasting Ramadan of the current study, 36.5% of the studied group had complication, Dizziness was the most frequent symptom and 35.6% of them broke their fasting due to the complications (Table 2).

There was a statistically significant increase in median and/or IQR of five DM symptom domains at the end of Ramadan fasting than before; neuropathic pain [8 (6-9) and 7 (5-9) respectively,  $P<0.001$ ], psychological fatigue [7 (6-8) and 7 (5-8) respectively  $P<0.001$ ], cardiovascular [ (6 (5-7) and 5 (5-7) respectively,  $P=0.001$ ], psychological cognitive [ 7 (6-8) and 6 (5-7) respectively,  $P<0.001$ ] and hyperglycemia [ 11 (9-13) and 11 (8-12) respectively,  $P=0.001$ ]. but there were no statistically significant difference regarding ophthalmologic, neuropathic

sensoric or hypoglycemia domains ( $P>0.05$  for them) (Table 3).

Also, there was a statistically significant decrease in median and IQR of BMI ( $P<0.001$ ), waist-hip ratio ( $P<0.001$ ), systolic blood pressure ( $P<0.001$ ), blood cholesterol ( $P<0.001$ ), triglycerides ( $P<0.001$ ), LDL ( $P<0.001$ ) and Hb A1C ( $P<0.001$ ) at the end of Ramadan compared to before among the studied group (Tables 4).

Logistic regression analysis (Table 5) revealed that DM complications during Ramadan fasting were more likely in patients who had past history of DM complications during Ramadan (OR= 2.57, 95% CI= 1.20 to 5.54) , inactive daily physical activity (OR=2.77, 95% CI=1.20 to 6.25), decreased food intake (OR=2.72 , 95% CI=1.28 to 5.81), increased fluid intake (OR=4.02, 95% CI=1.61 to 10.06) and sugar intake (OR=7.31, 95% CI=2.97 to 17.97).

## Discussion

The mean age of the examinee was  $56.5\pm 9.5$  years which is like examination led in Oman in which the mean age was  $54.3 \pm 11.7$ .<sup>14</sup> In the current study 66% of the study sample of patients did not screen their blood glucose, which is a lot higher than detailed in Singapore where 37.3% of patients announced that they didn't screen their blood glucose<sup>19</sup>, observing blood glucose enables the patients to successfully self-oversee themselves, recognize and avoid scenes of hypoglycemia and hyperglycemia. In this study the level of patients who counseled a doctor previously to Ramadan fasting was 19.0 which is less than made reference to in Pakistan as 33.3% of patients counseled doctors pre Ramadan fasting.<sup>20</sup> Consultation with doctors pre Ramadan is imperative to give diabetic patients their administration plan incorporating adjustments in eating

regimen, meds and ways of life to maintain a strategic distance from confusions in Ramadan fasting.

The results demonstrated that 36.5% of the examinee had DM complications in Ramadan fasting, this figure is like that uncovered in Libya, where 30% of the patients had complexities in Ramadan fasting.<sup>21</sup> In this investigation, 87% of the considered patients finished 30 days of Ramadan fasting like examination directed in Oman, 93.1% of type 2 DM patients finished 30 days fasting.<sup>14</sup>

In this work, there was a statistically significant increase in neuropathic pain, psychological fatigue, cardiovascular, psychological cognitive and hyperglycemic symptoms domains at the end of Ramadan as compared to before Ramadan. These findings are in accordance with the Epidemiology of Diabetes and Ramadan (EPIDIAR) study that was carried out in 13 countries including Egypt, the study revealed that the incidence of severe hyperglycemia was found to be increased during Ramadan 3-fold and 5-fold in patients with type 1 DM and type 2 DM, respectively.<sup>22</sup> Along with this, a study of 493 DM patients in Benghazi, Libya, revealed that 11.2% of the diabetic patients who fast during Ramadan had severe hyperglycemia.<sup>21</sup>

Essentially, a study in Istanbul, discovered that 5.7 % of the patients revealed at least one extreme hyperglycemia pre Ramadan compared to 11.4 % in Ramadan, anyway these differences were not significant.<sup>23</sup> In Pakistan, 16.3% of patients had hyperglycemic manifestations in Ramadan.<sup>24</sup>

In any case, the consequences of this investigation can't help contradicting a subsequent report in Dhahira region, Oman that detailed the mean number of hyperglycemic episodes decreased

significantly after Ramadan compared to pre Ramadan ( $P < 0.05$ ).<sup>14</sup>

Hyperglycemia can occur due to the excessive decrease in hypoglycemic meds in fasting, expanded nourishment or potentially sugar consumption at Iftar (breakfast) time causing quick increase in blood glucose prompting postprandial hyperglycemia and diminished physical activity in Ramadan.<sup>8,25,26</sup>

In the current study, Ramadan fasting significantly correlated with the reduction in BMI and waist-hip ratio proportion toward the end of Ramadan when compared to pre Ramadan among diabetic patients. Fasting in Ramadan affected the circadian rhythm. This circadian rhythm in breakfast state, increases anabolic processes while in fasting state, increases anabolic processes. During Fasting, the body can consume fat, which can't be accessible in breakfast. This is the motivation behind why numerous individuals who start fasting will lose fat and weight.<sup>27,28,29,30</sup>

These results are consistent with previous investigations in Pakistan<sup>31</sup>, Iran<sup>32</sup>) and Singapore.<sup>33</sup>

While in Algeria, type 2 DM patients had no statistically significant changes in BMI.<sup>34</sup> Correspondingly, in Turkey, there were no statistically significant differences in body weight and BMI among fasting and non-fasting diabetic patients.<sup>35</sup>

Increase or decrease of weight in Ramadan may be due to that there is no limitation on amount or type of food consumed around night. Likewise, diabetic patients may reduce their daily physical activities in Ramadan inspired for fear of hypoglycemia.<sup>37,38</sup>

In the current study, Ramadan fasting was significantly correlated with decreasing blood cholesterol, triglycerides, LDL and HbA1c, while no significantly changes in fasting blood glucose and HDL toward the



end of Ramadan when compared to pre Ramadan in diabetic patients. Changes in glucose level and lipid profile among various investigations may be because of variety in amount and type of food consumed in Ramadan, physical action, or medical prescriptions.<sup>18,38</sup>

The current study results are in agreement with the investigation conducted in Algeria and revealed that there was a significant statistically decrease in all cholesterol, triglycerides, LDL and HbA1c.<sup>34</sup> Similarly, in Tunis, there was a significant decrease in fasting blood glucose, cholesterol, LDL and HDL while there was no significant difference in triglyceride.<sup>36</sup>

In Iranian studies there was significant increase in fasting blood glucose, HbA1c and HDL, while there was a significant decrease in LDL and there were no significant differences in cholesterol and triglycerides (32). In Turkey, there were no significant differences in fasting blood glucose and HbA1c in fasting and non-fasting groups.<sup>35</sup>

In this current study there was a statistically significant relation between DM complications in Ramadan and daily physical activities. It discovered that physical inertia was related to the risk of complications. This finding is consistent with the study conducted in London, the patients were divided into group A (57 patients) who got an educational program including physical activities and group B (54 patients) who did not get the educational program. The study showed that there was significant statistically decrease in weight and hypoglycemic episodes in group A and significant statistically increase in weight and hypoglycemic episodes in group B.<sup>39</sup> Similarly, in a study conducted on a sample of 774 diabetic patients recruited in Egyptian, Iranian, Jordanian and Saudi Arabian facilities, patients divided into two

groups; intervention group (515 patients) who got an individualized educational program and control group (259 patients) who received traditional care. The study showed that there was a significant decrease in weight, BMI, HbA1c and severe hypoglycemic episodes in the intervention group compared to the control one.<sup>40</sup>

Regular exercises promote insulin sensitivity; enhance HbA1c so enhance blood glucose control. Additionally, this exercise add to weight decrease and enhance welfare and well-being. Thorough exercise before sunset is avoided because it expands the risk of hypoglycemia.<sup>40,41</sup>

In the current study there was a statistically association between DM complications in Ramadan and positive past history of DM complications with Ramadan. This outcome agrees with a multi nation retrospective observational study conducted in 4 areas (Asia, Europe, North Africa and Middle East), showed that hypoglycemic episodes pre Ramadan expanded the risk of hypoglycemia in Ramadan.<sup>42</sup> Also, this work showed that decrease in food intake, increase in fluid intake and increase sugar intake in Ramadan are significant predictors of complicated DM during Ramadan fasting. Diet is fundamental in diabetic patients to enhance stability of glycaemia and to reduce the risk of complications. So, diet during Ramadan should not differ from healthy and balanced diet for diabetic patients. Many health problems emerge from inappropriate diet regimen. Increased intake of sweet, sugary fluid and fried food during non-fasting hours leading to increase the risk of hyperglycemia and increase weight. Also, the decrease in food intake is a risk factor for developing hypoglycemia.<sup>8,43</sup>

The main strength of the current study is the follow-up of patients, which allowed

detecting incident complications, changes in physical examinations and laboratory results due to Ramadan fasting. Furthermore, the investigation of a wide range of risk factors that might be correlated to DM complications in Ramadan. Also, it was the first study investigated DM complications due to Ramadan fasting in Qualubeya governorate.

The study main limitations were the dropout of 26.6% of patients who did not participate in the follow-up session at the end of Ramadan. This the situation with previous studies such as in Oman, where only 334 (73.7%) patients completed the follow-up period (14), in Singapore only 23 (79.3%) patients completed follow-up (33), and in Pakistan only 150 (77.3%) patients completed the study.<sup>20</sup> However, the number of the recruited subjects in this study exceeded the calculated minimal sample size.

### Conclusion:

It can be concluded that diabetic patients who fast Ramadan have some metabolic changes as respects lipid profile and glycosemia and are at risk of DM complications. These complications are related to various modifiable risk factors including wrong dietary habits and physical inertia in Ramadan. These call for plans to manage these risk factors, controls complications and enable diabetic patients to have a safe fast during Ramadan.

### Recommendations:

A comprehensive program to limit the complications in Ramadan is indicated. This program should incorporates the following: I) pre Ramadan medical and therapeutic check; one - two months before Ramadan to identify the risky patients, ii) pre-Ramadan patients' education about DM complications in Ramadan and their

risk factors, iii) modify the wrong lifestyle such as physical inertia and wrong dietary habits and iv) train and motivate patients to regularly check their blood glucose level.

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