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HIGHLIGHTED OF RAMADAN FASTING ON DIABETES-STUDY OF COMPLICATIONS, BIOCHEMICAL ASPECTS AND ANTHROPOMETRY

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Abstract

Background and aims*: The diabetic exempted from fasting by religion, wishing or not to observe the fast, is exposed like any other during Ramadan to a change in lifestyle. The objective of this study was to highlight the effects of Ramadan fasting on diabetes.* ***Material and methods****: Multicentre study on 899 diabetics was carried to collect data on the behaviour of diabetics with regard to the fast of Ramadan, biochemicals and anthropometry parameters.* ***Results****. The sample consists of 541 diabetic fasters (DTMF) and 358 no fasters. The causes of interruption of fasting were: hypoglycemia (82.4%), dehydration (44.5%), hyperglycemia (12.6%), high blood pressure (13.7%), loss of consciousness (8.3%). The risk factors related to fasting for DTMF were the type of diabetes and gender. Discussion and modifications about dietary, blood glucose monitoring and nutritional education sessions showed a protective effect against the occurrence of hypo and hyperglycemia and loss of consciousness. Decreasing differences were noted for Hb1Ac, LDL and Total-Cholesterol between before and after Ramadan. The weight of DTMF decreased in post-Ramadan (p=0.0000).* ***Conclusion****. There is a need to consider regular preventive measures based on public information on the effects of diabetes related complications and the benefits of a balanced diet combined with regular physical activity in nutrition education sessions.*

key words: *Diabetes, Ramadan, complications, biochemical parameters, anthropometry*

Background and aims

The holy month of the Ramadan is the ninth of the lunar calendar of the Hegira (Muslim calendar); it usually lasts from 29 to 30 days, depending on the lunar crescent. Fasting during this month is an obligation for all healthy Muslim adults. They must abstain from eating, drinking, taking oral medications and smoking from dawn to sunset. Despite the religious exemption, many diabetics fast despite the risks of complications and decompensation [1]. In the Muslim community, there is an intense desire to participate in fasting, even among those who

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qualify for the exemption [2]. For several years various organizations have devoted expert recommendations for a fast with least complications: The Foundation Hassan II [3], the American Diabetes Association [4,5] and the International Diabetes Federation in collaboration with the Diabetes and Ramadan-International Alliance [2]. In these recommendations, it was noted that clear and thorough counselling should be provided to all patients with diabetes in order to limit the risks associated with fasting. The objective of this study is to highlight the effects of Ramadan fasting by comparing a population of diabetic fasters (DTMF) with no fasters (DTMNF) by assessing fasting-related complications, biochemical and anthropometric parameters.

Material and method

Framework of the study and selection of subjects

An epidemiological and multicentre study was carried out on a sample of 899 diabetics from three Algerian cities (El Taref, Laghouat, Djelfa). After having obtained the favourable notice of the heads of the health establishments (Public Health Institutions, hospitals), the selection of diabetic patients could be realized. They were recruited during consultations at these establishments during the investigation period.

Concerning the part reserved for anthropometric measurements and to compare our results, a healthy control population was selected (905 controls) representing a sample of residents from the three cities surveyed.

Inclusion criteria for the study

Regarding the recruitment of diabetics, the inclusion criteria taken into account were: all diabetic, adult, of both genders, present during the period of our investigation, with an T1DM or T2DM old of one year and more and whether or not they intend to fast the month of Ramadan.

Exclusion criteria included diabetics with other forms of diabetes (other than T1DM and T2DM) and not having the mental and/or physical abilities to answer the questions asked.

The criteria for inclusion in the control population were any adult, free from any pathology (noncommunicable diseases, physical disability, motor or mental) that may interfere with Ramadan fasting, in good health and expressing the wish to fast the month of Ramadan.

Conduct of the investigation

The survey was carried out between 8 April and 12 July 2018 in three Algerian cities. The study concerned the period before Ramadan (T0), during Ramadan (T1) and after Ramadan (T2) of the year 1439 Hegira.

Patients and healthy controls were initially interviewed between April 8 and April 26, 2018 (T0). Then they were recalled between May 20 and June 12, 2018 (T1) and a third and last pass (T2) between June 28 and July 12, 2018.

The interview was conducted in a semi-directive manner. The time spent on each patient was, on average, 20 minutes. Qualified investigators were trained to conduct interviews and anthropometric measurements.

Data questionnaire

The survey questionnaire included the following topics:

- General characteristics of subjects: Gender, age, type of diabetes, duration of diabetes, family history of diabetes, complications associated with diabetes;
- Behaviour and knowledge of diabetics with regard to the fast of the month of Ramadan: factors of interruption of fasting, observance of fasting Ramadan and fasting outside Ramadan, consultation and discussion with physician, food habits, Blood glucose

monitoring and follow-up of nutritional education sessions;

- Biochemical parameters: fasting glucose, glycated hemoglobin (HbA1c), total cholesterol, high density lipoprotein-Cholesterol (HDL-Cholesterol), Low density lipoprotein-cholesterol (LDL-Cholesterol) and triglycerides (TG). These parameters were used to determine the health status of diabetics. They were taken from patient records.
- Anthropometry: The measures concerned the diabetics and the healthy control population. Measurements of weight (kg) and height (cm) were carried out by taking care of the instructions of the Word Health Organization [6]. The weight and height measured allowed BMI to be calculated to characterize the nutritional status of subjects according to their stoutness [7]. The equipment used for these anthropometric measurements was that available at the offices of the physicians of the health establishments of the three cities surveyed. Measurements were repeated during the three periods.

Statistical analysis

It was realized with the software Epi-Info 3.5.3. [8]. We calculated the number and percentage (qualitative variables) and the mean and standard deviation (quantitative variables). To highlight the factors that can contribute to the onset of disease, we calculated the Odds Ratio (OR), with a 95% confidence interval. The t-Student was used to compare between two means and the analysis of variance to compare between several means. The significance threshold considered was 0.05.

Results

General characteristics of patients

In Table 1 are presented the general characteristics of the DTMF, DTMNF subjects and the healthy control population.

Table 1. Characteristics of the subjects surveyed.

Variables	DTMF (N=541)	DTMNF (N=358)	Healthy control population (N=905)
Gender			
Féminin	265 (49.0%)	167 (46.6%)	454 (50.2%)
Masculin	276 (51.0%)	191 (53.4%)	451 (49.8%)
Age (years)	52.6± 6.8	50.4 ± 8.2	52.7 ± 4.5
Type of diabetes			/
T1DM	35 (6.5%)	91 (25.4%)	
T2DM	506 (93.5%)	267 (74.6%)	
Duration of diabetes (years)	10.4 ± 7.6	14.3 ± 8.2	/
Family history of diabetes	364 (67.3%)	255 (71.2%)	/
Complications associated with diabetes			/
Retinopathy	130 (24.0%)	64 (17.9%)	
Nephropathy	72 (13.3%)	45 (12.6%)	
Neuropathy	143 (26.4%)	85 (23.7%)	
Arteriopathy	77 (14.2%)	56 (15.6%	
Coronary artery disease	57 (10.5%)	34 (9.5%)	
OALE	4 (0.7%)	12 (3.3%)	
CVDs	6 (1.1%)	10 (2.8%)	
High blood pressure Dyslipidemia	291 (53.8%)	201 (56.1%)	
	256 (47.3%)	131 (36.6%)	

DTMF: Diabetic fasters; DTMNF: diabetics not fasting; T1DM: type 1 diabetes mellitus; T2DM: type 2 diabetes mellitus; OALE: Obliterative arteriopathy of the lower extremities; CVDs: Cardiovascular diseases

Behaviour and knowledge of diabetics with regard to the fast of the month of Ramadan

Factors of interruption of fasting

According to DTMF reports, the causes of interruption of fasting during the survey were: hypoglycemia (82.4%), hyperglycemia (12.6%), dehydration (44.5%), high blood pressure (13.7%) and loss of consciousness (8.3%).

Risks related to fasting Ramadan

According to Table 2, fasting in a diabetic increased the risk of different complications with varying risks and a significant difference.

Non-modifiable risk factors

The non-modifiable risk factors for DTMF were the type of diabetes and gender. Patients with T1DM had a higher risk of having at least one complication than those with T2DM. Regarding gender, the risk was the same with a significant difference (Table 2).

Modifiable risk factors

Fasting outside Ramadan had a protective effect on the occurrence of hypo and hyperglycemia. A similar observation was noted for the pre-Ramadan consultation (Table 2).

Discussion about food, modifications dietary habits, blood glucose monitoring and nutritional education sessions had shown a protective effect against the occurrence of hypo and hyperglycemia and loss of consciousness.

Only changes in dietary habits during Ramadan and nutritional education sessions showed a protective effect against dehydration and the development of high blood pressure.

Table 2. Effect of fasting Ramadan on the occurrence of complications in diabetics

	Hypoglycemia	Hyperglycemia	Dehydration	High blood pressure	Loss of consciousness
	OR [95% CI]				
Observance of fasting Ramadan	3.6 [1.8 - 2.7]	1.5 [1.1 - 1.9]	2.5 [1.7 - 3.3]	1.8 [1.4 - 2.2]	2.3 [1.5 - 2.9]
Type of diabetes	4.9 [1.9 - 9.6]	2.5 [1.4 - 4.8]	4.4 [3.1 - 8.7]	2.1 [1.0 - 3.6]	5.2 [4.6 - 11.2]
Gender	1.1 [0.8 - 1.4]	1.0 [0.8 - 1.4]	1.0 [0.7 - 1.3]	0.9 [0.5 - 1.9]	1.0 [0.8 - 1.2]
Fasting outside Ramadan	0.0 [0.0 - 0.3]	0.6 [0.2 - 0.9]	1.1 [0.7 - 1.3]	0.7 [0.3 - 0.8]	0.8 [0.7 - 1.3]
Consultation before the month of Ramadan	0.3 [0.1 - 0.7]	0.5 [0.4 - 0.9]	1.0 [0.6 - 1.5]	0.8 [0.3 - 1.4]	0.8 [0.4 - 1.9]
Consultation during the month of Ramadan	1.0 [0.9 - 1.4]	1.0 [0.3 - 1.6]	1.0 [0.7 - 1.6]	1.0 [0.6 - 1.2]	1.0 [0.7 - 1.3]
Discussion about food	0.4 [0.2 - 0.4]	0.5 [0.5 - 0.8]	1.0 [0.6 - 1.3]	0.9 [0.6 - 1.4]	0.3 [0.2 - 0.7]
Modification of the food habits	0.0 [0.1 - 0.4]	0.3 [0.2 - 0.8]	0.5 [0.1 - 0.9]	0.4 [0.4 - 0.8]	0.6 [0.5 - 0.9]
Blood glucose monitoring	0.5 [0.4 - 0.8]	0.7 [0.3 - 0.9]	1.1 [0.7 - 1.5]	1.0 [0.7 - 1.6]	0.3 [0.2 - 0.8]
Follow-up of nutritional education sessions	0.0 [0.2 - 0.7]	0.4 [0.1 - 0.8]	0.3 [0.4 - 0.9]	0.5 [0.3 - 0.6]	0.4 [0.1 - 0.5]

OR: Odds Ratio; CI: Confidence interval

Biochemical parameters

The biochemical parameters of DTMF and DTMNF are presented in Table 3.

Comparing between the two periods, we found differences for fasting glucose for both groups of diabetics and Hb1Ac and LDL-Cholesterol for only the DTMF. For the

DTMNF, a decrease was observed for Total-Cholesterol (p=0.0000) after Ramadan.

By comparing between DTMF and DTMNF, we have noticed differences except for Hb1Ac (p=0.0948), LDL-cholesterol before Ramadan (p=0.2331) and TG for both periods (p=0.1138; p=0.0959).

Table 3. Biochemical parameters of diabetics before and after the month of Ramadan.

Parameters		Before Ramadan	After Ramadan	*p-value*
Fasting glucose (mmol/L)	DTMF (N=541)	8.64 ± 0.63[a]	7.06 ± 0.13[a]	0.0000
	DTMNF (N=358)	8.44 ± 0.39[a]	7.84 ± 0.02[a]	0.0000
Glycated hemoglobin (%)	DTMF (N=541)	7.25 ± 0.65	6.77 ± 0.66[a]	0.0000
	DTMNF (N=358)	7.31 ± 0.24	7.23 ± 0.78[a]	0.0640
Total cholesterol (mmol/L)	DTMF (N=541)	5.34 ± 0.63[a]	5.37 ± 0.12[a]	0.2768
	DTMNF (N=358)	5.87 ± 0.55[a]	5.47 ± 0.05[a]	0.0000
HDL-Cholesterol (mmol/L)	DTMF (N=541)	1.23 ± 0.37[a]	1.27 ± 0.43[a]	0.1013
	DTMNF (N=358)	1.11 ± 0.14[a]	1.13 ± 0.07[a]	0.0158
LDL-Cholesterol (mmol/L)	DTMF (N=541)	3.77 ± 0.78	3.54 ± 0.18[a]	0.0000
	DTMNF (N=358)	3.83 ± 0.67	3.76 ± 0.38[a]	0.0859
Triglycerides (mmol/L)	DTMF (N=541)	2.79 ± 1.88	2.69 ± 1.07	0.2825
	DTMNF (N=358)	2.63 ± 0.43	2.56 ± 1.25	0.3167

HDL: High density lipoprotein; LDL: Low density lipoprotein; DTMF: Diabetic fasters; DTMNF: Diabetics not fasting; p-value: significance of the comparison between the two periods; a: significant difference between DTMF and DTMNF ($p<0.05$)

Anthropometry

Anthropometric parameters for the three passages and for all subjects are presented in Table 4.

Diabetic subjects had an average BMI higher than control subjects (p=0.0000). The weight of DTMF decreased in the post-Ramadan period compared to the other two periods (p=0.0000). For DTMNF and healthy control subjects, their weight decreased during the T1 period with respectively p=0.3977 and p=0.0191.

Table 4. Anthropometric parameters of the subjects during the three periods.

Parameters		DTMF (N=541)	DTMNF (N=358)	Healthy control (N=905)
T0	Weight (kg)	87.5 ± 6.4	82.4 ± 8.3	76.4 ± 10.4
	BMI (kg/m^2)	29.6 ± 7.2	28.2 ± 2.4	23.8 ± 3.5
	Normo weight [N(%)]	155 (28.6)	171 (47.8)	676 (74.7)
	Overweight [N(%)]	207 (38.3)	101 (28.2)	185 (20.4)
	Obese [N(%)]	179 (33.1)	86 (24.0)	44 (4.9)
T1	Weight (kg)	82.4 ± 8.5	81.7 ± 3.5	75.3 ± 7.5
	BMI (kg/m^2)	27.6 ± 3.6	27.4 ± 2.1	22.4 ± 6.2
	Normo weight [N(%)]	188 (34.7)	191 (53.4)	684 (75.6)
	Overweight [N(%)]	212 (39.2)	105 (29.3)	174 (19.2)
	Obese [N(%)]	141 (26.1)	62 (17.3)	47 (5.2)
T2	Weight (kg)	81.3 ± 6.5	82.1 ± 7.9	75.8 ± 6.6
	BMI (kg/m^2)	26.8 ± 3.7	27.6 ± 3.6	24.3 ± 5.5
	Normo weight [N(%)]	194 (35.8)	184 (51.4)	657 (72.6)
	Overweight [N(%)]	210 (38.8)	107 (29.9)	200 (22.1)
	Obese [N(%)]	137 (25.4)	67 (18.7)	48 (5.3)

DTMF: Diabetic fasters; DTMNF: Diabetics not fasting; T0: Before Ramadan; T1: During Ramadan; T2: After Ramadan; BMI: Body mass index

Discussion

In our study, 60.2% of diabetics observed Ramadan fasting, including 6.5% of patients with T1DM. The work of Mohsin *et al.* [9] showed that individuals with T1DM who are stable can fast during this month, provided they comply with the management plan and are closely monitored.

The factors most associated with fasting interruption reported by diabetic patients are hypo and hyperglycemia, dehydration, high blood pressure and loss of consciousness.

Fasting in the month of Ramadan presents an increased risk of hypo and hyperglycemia for patients with diabetes [2]. Our study showed that patients with diabetes were at risk of having at least one complication during Ramadan fasting. While patients with a T1DM had a higher risk of complications from 2 to 5 times more than those with a T2DM. According to Al-Arouj *et al.* [5], hypo and hyperglycemia may also occur in patients with T2DM, but generally less frequent and have less severe consequences than in patients with TMD1. Depending on Consoli *et al.* [10], risk factors are still insufficiently known. If hypoglycemic symptoms occur during fasting, the patient is advised to refrain from doing so promptly and to contact the treating physician. Often the dose before the pre-dawn meal (*Souhour*) can be reduced by up to 50% [11]. Monitoring the diet of diabetics is essential during the month of Ramadan to avoid the risk of hyperglycemia [12].

Study of the association of fasting related complications in diabetics showed that dehydration may be a risk in overweight DTMNF, probably to some oral diabetic who are responsible for the diuretic effect and the dehydration [13]. On the other hand, fasting outside Ramadan seems to be a protective factor, this can be explained by the habit of making healthy choices, or in relation to the limited number of days, or the rhythmicity of a normal period compared to the period of abrupt change in Ramadan.

According to the results of our study, protective effect factors are: fasting outside of Ramadan, the discussion around food, changes in eating habits, the glycemic monitoring and follow-up nutrition education sessions. Anyone with diabetes who wishes to fast the Ramadan must be seen by his physician or diabetologist one to two months before the beginning of the month of fasting [14]. This will allow the fasting patient to apply to the physician's advice so that as the holy month approaches, the metabolic profile of the patient is suitable for fasting. However, consultations during the month of Ramadan did not show any association. The study of Bencharif [15] performed on 2708 diabetics (9.8% T1DM, 90.2% T2DM) from 13 cities in Algeria showed the same result. This may be due to the limited time required to prepare the patient for fasting. Patients who insist on fasting should be assessed before Ramadan and receive appropriate education and instructions about physical activity, in the planning of meals, glycemic monitoring and the dosage and the time of medication [10].

Nutritional education sessions are also a protective factor for any complications that may occur during fasting. Three main results were observed by Hassanein *et al.* [16] for patients who have followed an education program: they have lost weight, they were 4 times less likely to develop hypoglycemic episodes, they were significantly more empowered to manage their diabetes independently during the month of Ramadan. According to Khaled *et al.* [17], the frequency of hypoglycemia was 9 times lower due to nutrition education sessions, which allowed an ideal reconciliation of dietary information, whether in groups or at the individual level. The work of Zainudin *et al.* [18]

showed that there were decreased complications of hypoglycemia from 13.8% to 10.3% and several-fold improvement in hyperglycemia from 31.0% to 3.5% during Ramadan fasting when compared with pre-Ramadan. Muslims with diabetes were able to self-manage when fasting using telemonitoring support and intervention, with decreased complications during Ramadan compared with pre-Ramadan. McEwen *et al.* [11] found serious hypoglycemic events in the control group who did not receive individualized education. The works realized by Bencharif *et al.* [19] have shown that the nutritional education proved a positive effect on the management of the diabetic. It should be part of a personalized and adapted to the diabetic patient's lifestyle, not an occasional educational approach. It must be organized months before the approach of the month of Ramadan and spread over the whole year. The multiplicity of medical and other professional's stakeholders will improve the patient's living conditions. The development of diabetes care networks is a necessity. The first step in their implementation is to upgrade their knowledge, followed by a commitment from network affiliates to implement practice recommendations in the field [20].

The effect of fasting Ramadan showed improvements in the biochemical balance values occurred after Ramadan. This is a positive observation because for every 1% decrease in HbA1c, there is a 35% decrease in the risk of microvascular complications [4]. The HbA1c values showed a marked improvement during and after Ramadan, this may be due to the decrease in the number of meals. According to Khaled *et al.* [17], serum glucose and HbA1c values dependedon diet composition, energy metabolism and energy consumption. Regarding the increase of HDL-Cholesterol, El Aroudj *et al*. [5] justified the possibility of a decrease by the lipolytic effect of prolonged fasting.

The diet during Ramadan should not differ significantly from a healthy and balanced diet. It should aim to maintain a constant body mass. In most studies, 50 to 60% of the fasting individuals maintained their body weight during the holy month, while 20-25% had weight gain or loss [4]. In our study, the DTMF decreased their weight significantly after the month of Ramadan. The results of Khaled and Belbraouet [21] study's also noted a significant decrease in body weight during Ramadan and a resumption of weight one month after Ramadan. The results on the effect of Ramadan on anthropometry are also quite discordant. Some studies reported changes in energy intake during the fasting period and have found changes in anthropometric measurements that go in the same direction [22].

Conclusions

The fast of Ramadan had an influence on the variables studied in diabetics. The effect of fasting in diabetics has been seen in particular in the improvement of the biochemical balance and the decrease in weight. Despite the protective effect of dialogue around diabetes and Ramadan, it remains to be confirmed by longitudinal cohort studies and further investigation of biochemical and clinical parameters. Furthermore, if diabetic patients wish to fast, they are obligated to conduct rigorous self-monitoring, to respect the hygienic-dietetic rules, to adapt the therapeutics and to break the fast in the event of hypo or hyperglycemia or other complication.

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