

EFFECT OF PRE-RAMADAN EDUCATION ON DIETARY INTAKE AND ANTHROPOMETRY-COMPARISON BETWEEN TWO GROUPS OF DIABETIC PATIENTS

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Abstract

Background and aims: Fasting of Ramadan leads to changes in dietary habits, physical activity, sleep and time of drug intake for diabetics. The objective of this study was to evaluate the effect of pre-Ramadan education on dietary intake and anthropometry of two groups of patients. *Material and methods:* The entire cohort was divided in a group (G1; n=86) which attended nutritional education sessions and group that did not attend these sessions (G2; n=72). The protocol included three visits before, during and after the month of Ramadan. *Results.* Total energy intake of the G1 did not differ significantly between visits, unlike the G2. Patients in the G1 reduced their carbohydrate intake during Ramadan with 32.5g, compared to the G2 which decreased their consumption with 17.2g. The intake of saturated fatty acids was significantly higher in the G2 ($p=0.001$) after Ramadan. The number of obese class 2 of the G1 decreased after Ramadan, however for the G2, the number increased. The waist-to-hip ratio and the body fat (%) were unchanged between the three periods. *Conclusion.* The management of diabetes should be multidisciplinary to ensure better continuity of care. Specialized and individual educational actions must be concrete in diabetics wishing to fast.

key words: Nutritional education; Type 2 diabetes; Ramadan; Energy intakes; Anthropometry

Background and aims

Ramadan-focused diabetes education is focused on empowering patients with the knowledge to make informed decisions regarding how to manage their condition during Ramadan [1]. Nutritional education of a diabetic patient makes the autonomy for a better management and a longer life expectancy [2].

Type 2 diabetes (T2DM) is a heterogeneous disease combining various proportions of peripheral insulin resistance and disorders of insulin secretion. It is an evolutionary disease with progressive worsening, even inevitable for insulin secretory deficiency [3]. The treatment of T2DM is rigorously based on a drug prescription, lifestyle and dietary rules including a balanced diet and physical activity [2].

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Ramadan fasting is one of the five pillars of Islam. It is not a simple individual act of piety, occasionally accomplished by some faithful piles, but an obligation prescribed at all the Muslim community, few exceptions like children, pregnant women or sick individuals. Ramadan occurs without transition and practitioners change their lifestyle rather abruptly. It leads to modifications of life style, and biological changes due to the adaptation of the body to the new state of fasting [4-7]. Despite the cases of exemption provided by religion, many diabetics are fasting regardless of the permission granted to them. In the Epidemiology of Diabetes and Ramadan (EPIDIAR) study conducted in 13 countries on 12 243 Muslim diabetics, it was found that 42.8% of type 1 diabetes and 78.7% of T2DM fast 15 days or more during Ramadan [8]. A pre-Ramadan medical assessment is helpful where advice can be given about management of diabetes and fasting [9]. Educational practices proposed to the people with chronic diseases such as diabetes are not described and rarely evaluated in Algeria. The objective of this study is to assess the role of a nutritional education program (NEP) of preparation for the fasting month of Ramadan, in the management of T2DM and to see the effect of this program on dietary intake and anthropometry of two groups of patients.

Material and methods

Recruitment of the patients and site of investigation

All patients were recruited at Public Health Institution (PHI) of Skikda (eastern Algeria). One month before Ramadan are organized days of nutritional education for patients with diabetes. The association of diabetics of this city takes part in the organization of these NEP which is organized by a multidisciplinary team.

Our study was composed by 2 groups. Group 1 (G1) was composed of patients participated to these NEPs proposed during the quarterly consultations at the PHI and group 2 (G2) which did not. The recruitment of the 2 groups was done between 1st and 29th of June 2013 corresponding to 1434 of the Hegira.

Inclusion criteria for the study

Any adult of both sexes with a T2DM longer than one year, which had the intention to observe the fasting of Ramadan and agreeing to comply to the three phases of protocol was enrolled. All participants gave their verbal consent at the recruitment. A total of 86 patients of G1 (45 women, 41 men), and 72 patients of G2 (37 women, 35 men) participated to the study.

Sessions of nutritional management

The aim of this nutritional management was to make the patient autonomous by learning the correct meal and the establishment of a personalized diet program especially during the fasting Ramadan period. It took place in 2 steps:

1. Lectures in a large hall about nutritional education by presenting its different axes, followed by a debate between a professor specializing in internal medicine, practicing physicians, dieticians and imams;

2. Tutorial sessions organized in several rooms where individual interviews have been conducted between the physician/dietician or imam and the diabetic. This session allowed for an understanding of the patient's living conditions, his financial situation, his eating habits and preferences and his nutrient requirement. A personalized diet program was then presented to the patient according to his choices and daily difficulties.

Study protocol

The patients attended the following visits: Before Ramadan (T0): between 1st and 29th June

2013; During the month of Ramadan (T1): between 10th July and 7th August 2013; After Ramadan (T2): between 2nd and 30th September 2013.

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human patients were approved by the ethics committee of physicians of the PHI of Skikda. Verbal informed consent was obtained from all patients. Verbal consent was witnessed and formally recorded.

Data questionnaire

The survey questionnaire was proposed to patients during the three periods (T0, T1, T2). It included general information of patients, food record for three days, anthropometric measurements including weight, height, waist circumference (WC), hip circumference (HC), mid arm circumference (MAC) and skinfolds.

General information of patient

Concerning age, duration of diabetes, family history of diabetes and presence of the diabetes comorbidity. In T2, the patients have been asked about how many days fast during the month of Ramadan.

Food tracking

The patients mentioned their consumption for three successive days in a table recording the foods possibly taken during the three principal meals of the day and 2 snacks (morning and evening), by indicating the quantities ingested in both periods outside of Ramadan (T0 and T2). During T1, it concerned meal of breaking the fast (*Iftar*), evening snack and the predawn meal (*S'hour*). These records were checked during interviews with the patient. The conversion of quantities of food into nutrients was done using a compilation of food composition tables of French [10] and German [11].

Anthropometry

Measurements were repeated during the three periods. Weight and height were measured to calculate the Body Mass Index (BMI). These measurements were carried out according to the international recommendations [12]. To evaluate the nutritional status of the patient, WHO's classification was followed [13]. The perimeters were carried out. The waist-to-hip ratio (WHR) and WC only, gave a reflection of the anatomical distribution of body fat and to assess metabolic and cardiovascular risk (even in the absence of obesity). MAC is associated with the measurement of triceps skinfold (TSF); which it represents twice the thickness of the skin and subcutaneous fat, giving the mid arm muscular circumference (MAMC), under the following formula [14]: $MAMC (cm) = MAC (cm) - [\pi \times TSF (mm)]$. MAMC gave an indirect reflection of the muscular mass of the patient and therefore its protein reserves and nutritional status. The skinfolds were measured according to a standardized technique using Harpenden skinfold calipers at four sites: biceps, triceps, subscapular and iliac crest. The sum of the four skinfolds were calculated according to standard procedures [15], and also for calculating the body fat percentage (%FAT) [16].

Statistical analysis

The R software for Windows (Version 3.2.4) was used for data analyses. The results were expressed as means and standard deviations. The Student test was used for the comparison between two means, the Chi² test for the comparison between two percentages and the analysis of variance for the comparison between several means. $p < 0.05$ were considered statistically significant.

Results

General characteristics of patients

The general characteristics of the participants of the two groups are presented in [Table 1](#). The patients of G1 had similar ages and

the diabetes duration compared to G2 ($p>0.05$). Three out of four patients had a family history of diabetes. The diabetics suffered from hypertension and/or dyslipidemia. The patients in G2 fasted more days than the G1 ($p=0.000$).

Table 1. General characteristics of the two groups of diabetic patients by gender.

Variables	Group 1			Group 2			
		Mean	SD		Mean	SD	<i>p-values</i>
Age (years)	Total (n=86)	50.1	6.4	Total (n=72)	51.2	4.7	0.228
	Women (n=45)	48.8	6.0	Women (n=37)	46.4	4.8	0.052
	Men (n=41)	51.5	6.4	Men (n=35)	50.1	4.8	0.291
Duration of diabetes (years)	Total (n=86)	7.6	3.3	Total (n=72)	6.9	3.2	0.180
	Women (n=45)	5.8	3.2	Women (n=37)	5.0	3.2	0.263
	Men (n=41)	7.7	4.0	Men (n=35)	7.4	3.8	0.740
Family history of diabetes (%)	Total n(%)	59(68.6)		Total n(%)	53(73.6)		0.502
	Women n(%)	34(75.6)		Women n(%)	34(91.9)		0.100
	Men n(%)	25(61.0)		Men n(%)	19(54.3)		0.625
Comorbidity (%)	Total n(%)	41(47.7)		Total n(%)	20(27.8)		0.164
	Women n(%)	22(48.9)		Women n(%)	7(18.9)		0.218
	Men n(%)	19(46.3)		Men n(%)	13(37.1)		0.618
Hypertension (%)	Total n(%)	15(36.6)		Total n(%)	11(55.0)		0.496
	Women n(%)	2(9.1)		Women n(%)	7(100)		0.496
	Men n(%)	13(68.4)		Men n(%)	4(30.8)		0.321
Dyslipidemia (%)	Total n(%)	13(31.7)		Total n(%)	2(10.0)		0.321
	Women n(%)	11(50.0)		Women n(%)	0(0.0)		/
	Men n(%)	2(10.5)		Men n(%)	2(15.4)		/
Hypertension (%) + Dyslipidemia (%)	Total n(%)	13(31.7)		Total n(%)	7(35.0)		0.682
	Women n(%)	9(40.9)		Women n(%)	0(0.0)		/
	Men n(%)	4(21.1)		Men n(%)	7(53.8)		0.688
Number of day fasting (d)	Total (n=86)	17.6	2.2 ^a	Total (n=72)	19.9	3.7 ^a	0.000
	Women (n=45)	17.6	2.1 ^a	Women (n=37)	21.0	3.4 ^a	0.000
	Men (n=41)	17.8	2.2	Men (n=35)	18.8	3.7	0.150

Dietary energy intake and macronutrient

The total energy intake of diabetics that followed the NEP did not differ during and outside of Ramadan ($p<0.05$). The opposite was observed in G2. At T0, the energy intake of the patients of G1 was higher than in those of G2

($p=0.013$), while in T2, it was lower ($p=0.000$). These differences were observed especially in men. The contributions in carbohydrates, protein and fat in absolute value ([Table 2](#)) differ between the three survey periods in patients of G1. In G2, the difference was observed only for the contribution of fat in total energy intake.

At T0, the contribution of carbohydrates in absolute value was higher in diabetics of G1 than those G2. The opposite was observed in T1 and T2 and it is the same for the contribution of simple sugars in these two periods.

An increase in the fiber contribution was observed in both groups at period T1 compared to the two other periods, although there was a predominance of fiber contribution for diabetics of G1.

Table 2. Dietary energy intake and macronutrient of both groups of diabetic patients by gender before, during and after Ramadan.

Nutrient		Before Ramadan (T0)					
		Total		Women		Men	
		Mean	SD	Mean	SD	Mean	SD
Total Energy (kJ/d)	G1	4854.3	1623.4 ^a	4423.3	1351.0	5327.9	1784.9 ^a
	G2	4244.5	1386.6 ^{a,b}	4182.7	1304.6	4309.1	1466.5 ^{a,b}
Carbohydrate (g/d)	G1	186.3	60.3 ^{a,b}	170.8	51.3 ^{a,b}	203.3	67.5 ^{a,b}
	G2	158.4	58.2 ^a	145.8	51.5 ^a	171.6	64.7 ^a
Simple sugars (g/d)	G1	38.3	19.6 ^b	34.1	15.9 ^b	42.9	22.7 ^b
	G2	35.9	17.2 ^b	31.6	13.1 ^b	40.5	20.6
Fibre (g/d)	G1	13.8	4.7 ^{a,b}	13.9	4.8 ^{a,b}	13.6	4.6 ^b
	G2	11.7	4.7 ^{a,b}	11.4	4.6 ^{a,b}	11.9	4.8
Protein (g/d)	G1	41.4	15.3 ^{a,b}	38.1	13.6 ^b	45.1	16.6 ^{a,b}
	G2	36.3	15.4 ^b	36.1	14.3	36.6	16.5 ^a
Fat (g/d)	G1	27.7	17.1 ^a	24.6	15.7 ^b	31.1	17.9
	G2	23.0	13.3 ^a	24.1	15.4 ^b	21.9	11.0 ^b
SFA (g/d)	G1	12.3	9.2	9.5	6.8 ^b	15.3	11.5
	G2	13.6	8.6 ^a	10.6	5.3 ^b	16.7	12.4
MFA (g/d)	G1	10.0	8.0 ^a	7.7	5.9 ^b	12.5	10.3 ^b
	G2	11.4	6.9 ^a	9.3	6.2 ^b	13.6	7.6 ^b
PFA (g/d)	G1	4.1	3.2 ^{a,b}	4.2	3.3 ^{a,b}	4.1	3.0 ^{a,b}
	G2	8.4	5.7 ^{a,b}	8.1	5.0 ^{a,b}	8.7	6.5 ^{a,b}
Cholesterol (mg/d)	G1	112.9	111.0	85.0	86.0	143.5	133.6
	G2	139.6	115.7	114.7	96.9	165.8	136.4
		During Ramadan (T1)					
Total Energy (kJ/d)	G1	4746.7	1473.2	4387.8	1314.2	5140.9	1551.8
	G2	4741.3	1465.7 ^b	4453.9	1279.0	5045.1	1617.9 ^b
Carbohydrate (g/d)	G1	153.8	58.6 ^{a,b}	137.5	53.0 ^{a,b}	171.6	62.3 ^b
	G2	175.6	60.2 ^a	166.3	49.0 ^a	185.4	69.5
Simple sugars (g/d)	G1	31.7	19.5 ^{a,b}	28.5	16.0 ^{a,b}	35.2	23.2 ^{a,b}
	G2	48.8	18.3 ^{a,b}	50.5	19.4 ^{a,b}	47.0	17.4 ^a
Fibre (g/d)	G1	18.1	5.1 ^{a,b}	18.4	5.7 ^{a,b}	17.8	4.5 ^{a,b}
	G2	13.8	5.3 ^{a,b}	14.7	5.4 ^{a,b}	11.8	4.9 ^a
Protein (g/d)	G1	56.6	16.6 ^{a,b}	54.0	16.1 ^{a,b}	59.5	16.3 ^{a,b}
	G2	40.7	13.8 ^a	40.7	12.6 ^a	40.7	15.3 ^a
Fat (g/d)	G1	33.9	16.5 ^b	34.0	16.8 ^b	33.8	16.1
	G2	31.3	15.8 ^b	29.2	15.4 ^b	33.5	16.1 [*]
SFA (g/d)	G1	14.5	10.9	10.8	7.6 ^b	18.5	13.8
	G2	15.8	9.1 ^b	11.7	5.8 ^b	20.1	13.2
MFA (g/d)	G1	16.8	12.9 ^{a,b}	11.4	8.4 ^b	22.6	16.1 ^{a,b}
	G2	13.0	5.4 ^{a,b}	11.9	5.3 ^b	14.1	5.5 ^{a,b}
PFA (g/d)	G1	6.0	3.3 ^{a,b}	6.1	3.4 ^{a,b}	5.8	3.1 ^{a,b}
	G2	9.4	4.0 ^{a,b}	10.0	3.5 ^{a,b}	8.7	4.4 ^{*†}
Cholesterol (mg/d)	G1	127.6	110.0	96.3	84.0	160.6	137.1
	G2	130.1	92.1	105.2	67.8	157.5	117.3

Table 2. Continued

Nutrient		After Ramadan (T2)					
		Total		Women		Men	
		Mean	SD	Mean	SD	Mean	SD
Total Energy (kJ/d)	G1	4458.1	1456.9 ^a	4216.2	1389.9	4723.3	1482.4 ^a
	G2	5357.6	1484.9 ^{a,b}	4769.8	1359.8	5978.5	1554.4 ^{a,b}
Carbohydrate (g/d)	G1	137.5	55.7 ^{a,b}	118.1	48.4 ^{a,b}	158.8	59.6 ^{a,b}
	G2	175.6	59.4 ^a	163.0	48.9 ^a	188.8	68.2 ^a
Simple sugars (g/d)	G1	27.0	15.8 ^{a,b}	23.5	12.6 ^{a,b}	30.9	19.0 ^{a,b}
	G2	50.3	18.3 ^{a,b}	52.1	19.4 ^{a,b}	48.5	17.4 ^a
Fibre (g/d)	G1	18.0	5.3 ^{a,b}	17.7	5.5 ^{a,b}	18.2	5.1 ^{a,b}
	G2	11.9	5.2 ^{a,b}	12.8	5.1 ^{a,b}	10.9	5.2 ^a
Protein (g/d)	G1	43.2	15.0 ^{a,b}	41.5	14.0 ^b	45.0	15.6 ^b
	G2	38.5	13.8 ^z	38.4	12.5	38.6	15.2
Fat (g/d)	G1	35.3	15.5 ^{a,b}	35.7	15.1 ^{a,b}	34.9	15.9 ^a
	G2	55.7	16.4 ^{a,b}	53.8	16.6 ^{a,b}	57.7	15.7 ^{a,b}
SFA (g/d)	G1	14.3	10.5 ^a	11.3	7.0 ^{a,b}	17.6	13.9 ^a
	G2	19.8	9.8 ^{a,b}	16.0	6.9 ^{a,b}	23.9	13.6 ^a
MFA (g/d)	G1	16.3	12.8 ^b	11.1	8.2 ^{a,b}	22.1	16.1 ^{a,b}
	G2	1.3	6.7 ^b	16.8	6.1 ^{a,b}	17.9	7.2 ^{a,b}
PFA (g/d)	G1	5.6	3.5 ^{a,b}	5.6	3.6 ^{a,b}	5.6	3.4 ^{a,b}
	G2	13.2	4.1 ^{a,b}	13.9	3.2 ^{a,b}	12.5	4.9 ^{a,b}
Cholesterol (mg/d)	G1	123.3	87.9	93.2	60.7	15.2	116.7
	G2	131.0	110.5	98.9	83.9	165.0	138.3

G1, group 1 of patients; G2, group 2 of patients; SFA, saturated fatty acids; MFA, monounsaturated fatty acids; PFA, polyunsaturated fatty acids;

^a significant difference between group 1 and group 2 (p<0.05);

^b significant difference between T0, T1 and T2 (p<0.05)

Table 3. Ratio of nutritional balance of both groups of diabetic patients by gender before, during and after Ramadan.

Ratio		Before Ramadan (T0)					
		Total		Women		Men	
		Mean	SD	Mean	SD	Mean	SD
AP/PP	G1	0.7	0.6 ^b	0.6	0.5 ^{a,b}	0.8	0.7
	G2	0.9	0.9	0.8	0.6 ^a	0.9	1.1 ^b
AF/PF	G1	1.4	1.4 ^a	1.4	1.5 ^a	1.3	1.3 ^{a,b}
	G2	0.9	0.4 ^{a,b}	0.9	0.4 ^{a,b}	0.9	0.5 ^{a,b}
PFA/SFA	G1	0.6	0.4 ^{a,b}	0.7	0.6 ^{*z}	0.4	0.2 ^{a,b}
	G2	1.4	1.1 ^{a,b}	1.6	1.5 ^a	1.2	1.0 ^{a,b}
		During Ramadan (T1)					
AP/PP	G1	1.0	0.7 [*]	0.9	0.6 ^b	1.1	0.7
	G2	0.9	0.5	0.8	0.5	0.9	0.5 ^b
AF/PF	G1	1.0	0.6 ^{a,b}	0.7	0.3 ^{a,b}	1.3	0.8 ^{a,b}
	G2	1.6	1.4 ^a	1.3	1.0 ^a	1.9	1.6 ^{a,b}
PFA/SFA	G1	1.1	1.0 ^b	1.5	1.4 ^b	0.7	0.5 ^b
	G2	1.0	0.6 ^b	1.3	0.7	0.8	0.5 ^b
		After Ramadan (T2)					
AP/PP	G1	0.8	0.5 ^b	0.8	0.4 ^b	0.8	0.6
	G2	0.9	0.6	1.0	0.6	0.9	0.6 ^b
AF/PF	G1	1.2	0.8	1.2	0.7	1.2	0.8 ^b
	G2	1.2	0.5 ^b	1.1	0.4 ^b	1.3	0.7 ^b
PFA/SFA	G1	0.8	0.7 ^{ab}	1.0	0.8 ^b	0.6	0.5 ^{ab}
	G2	1.0	0.5 ^{ab}	1.1	0.5	0.8	0.4 ^{ab}

G1, group 1 of patients; G2, group 2 of patients; AP, animal protein ; PP, plant protein ; AF, animal fat; PF, plant fat; SFA, saturated fatty acids; PFA, polyunsaturated fatty acids

^a significant difference between group 1 and group 2 (p<0.05); ^b significant difference between T0, T1 and T2 (p<0.05)

The part of protein was significantly higher in G1 than in G2 for the three periods. Significant differences were noted between the three periods for all diabetics of G1 and especially for women and diabetic men of G2. The ratio of animal protein to plant protein (AP/PP) was significantly different between the two groups (Table 3) only during T0 for the total population (p=0.001) and in diabetic men (p=0.005).

The fat intake was significantly different between the three periods but it remains unchanged for diabetic men of G1 (Table 2). At T2, the part of fat was higher in patients of G2 than G1 (p=0.000). The ratio of animal fat to plant fat (AF/PF) was not the same among the three periods for diabetic men of G1 and patients of G2 (Table 3). Significant differences between the two groups, for the same ratio of nutritional balance, were observed at T0 and T1 periods for all patients and specifically for women.

The intake of saturated fatty acids (SFA) was significantly higher in patients in G2 than in G1 at T2. The intake of monounsaturated fatty

acids (MFA) was significantly predominant at T1 for patients of G1 and specifically for diabetic men and at T2 for men only. The contribution in polyunsaturated fatty acids (PFA) on G2 was higher than the G1 during the three periods and for both gender (Table 2). The ratio PFA/SFA was higher in G2 than in G1 to outside periods of Ramadan (Table 3). The cholesterol intake did not change between the three survey periods.

Anthropometry

Anthropometric parameters (weight, BMI, WHR, BMC and FAT%) did not undergo any significant changes during T1 (Table 4). Only significant differences of WC were observed in diabetic of G1 and men of G2. Moreover, in T1 and T2, patients who followed the NEP have significantly lower WC values to another group of patients. The BMC women's of G1 was significantly different and predominant than the diabetic women of G2. This was related to the daily intake of protein brought during the three periods (Table 4).

Table 4. Anthropometry of both groups of diabetic patients before, during and after Ramadan.

Parameters		Before Ramadan (T0)					
		Total		Women		Men	
		Mean	SD	Mean	SD	Mean	SD
Weight (kg)	G1	76.3	8.9	72.8	7.9	80.2	9.9
	G2	75.4	11.3	70.6	9.9	80.6	11.9
BMI (kg/m ²)	G1	28.6	3.3	29.3	3.1	27.9	3.5
	G2	28.0	4.3	28.0	4.5	28.1	4.1
WC (cm)	G1	94.4	7.3 ^b	96.9	9.6 ^b	91.8	3.1 ^b
	G2	94.4	6.3	96.3	8.6	92.5	3.2 ^b
WHR	G1	0.9	0.1	0.9	0.0	0.9	0.1
	G2	0.9	0.1	0.9	0.1	0.9	0.1
MAMC (cm)	G1	21.2	3.1	18.6	1.7 ^a	24.1	2.0
	G2	20.7	4.2	16.7	2.7 ^a	24.9	2.2
Body fat (%)	G1	34.6	10.1	44.2	3.1	24.1	2.0
	G2	33.4	8.6	41.8	2.0	24.6	2.2

Table 4. Continued

Parameters		During Ramadan (T1)					
		Total		Women		Men	
		Mean	SD	Mean	SD	Mean	SD
Weight (kg)	G1	76.0	8.9	73.0	8.3	79.3	9.3
	G2	75.2	11.4	70.4	10.0	80.3	11.9
BMI (kg/m ²)	G1	28.5	3.3	29.3	3.1	27.5	3.3
	G2	27.9	4.3	27.9	4.5	28.0	4.1
WC (cm)	G1	92.6	6.7 ^{a,b}	92.4	9.0 ^{a,b}	90.9	3.3 ^{a,b}
	G2	95.0	6.4 ^a	96.9	9.0 ^a	93.0	3.2 ^{a,b}
WHR	G1	0.9	0.1	0.9	0.1	0.9	0.1
	G2	0.9	0.1	0.9	0.1	0.9	0.1
MAMC (cm)	G1	21.2	3.0	18.8	1.8 ^a	23.8	2.0
	G2	20.2	4.6	16.1	2.8 ^a	24.7	2.3
Body fat (%)	G1	34.5	10.0	44.0	3.0	24.0	19.0
	G2	34.6	8.5	41.9	2.0	24.8	2.1
		After Ramadan (T2)					
Weight (kg)	G1	75.1	8.8	72.1	8.1	78.4	9.5 ^a
	G2	77.1	11.5	72.0	10.0	8.5	11.8 ^a
BMI (kg/m ²)	G1	28.1	3.3	29.0	3.1	27.2	3.3
	G2	28.6	4.3	28.6	4.5	28.7	4.0
WC (cm)	G1	91.3	6.8 ^{a,b}	9.8	9.1 ^{a,b}	89.6	3.6 ^{a,b}
	G2	96.4	6.1 ^a	98.1	8.6 ^a	94.6	3.2 ^{a,b}
WHR	G1	0.9	0.1	0.9	0.1	0.9	0.1
	G2	0.9	0.1	0.9	0.1	1.0	0.1
MAMC (cm)	G1	20.8	3.0	18.6	2.3 ^a	23.2	2.2 ^a
	G2	20.5	4.6	16.8	3.5 ^a	24.4	2.3 ^a
Body fat (%)	G1	33.9	10.0	43.4	2.8	23.4	1.9
	G2	33.7	8.1	41.5	2.2	25.4	2.0

G1, group 1 of patients; G2, group 2 of patients (n=72); BMI, body mass index; WC, waist circumference; WHR, waist-to-hip ratio; MAMC, mid arm muscular circumference

^a significant difference between group 1 and group 2 (p<0.05); ^b significant difference between T0, T1 and T2 (p<0.05)

Furthermore, the number of cases of obese class 2 of G1 decreased from 7 cases at T0 to 6 cases at T1 and T2. For G2 at T0 and T1, the number was 8 cases and it increased to 10 cases at T2 and the appearance of two new cases (2 diabetic women). The number of cases of obese class 1 was 25 for G1 at T0, 24 cases at T1 and 23 cases at T2, and thus a reduction in the number of 2 cases of obese to overweight. While in diabetic patients of G2, they counted 18 cases at T0, 17 cases at T1 and 18 cases at T2. For G1, there is a stabilization in the number of cases of overweight at T0 (35 cases), T1 (36 cases) and T2 (35 cases). In contrast, patients of G2 have seen an increase in cases of overweight at T0

and at T1 with 19 cases and at T2 with 23 cases, either 4 new cases of obesity ([Figure 1](#)).

Discussion

NEP allows diabetics to acquire the knowledge and skills needed to better manage and accept the disease. Should be the application of lifestyle and dietary rules be practical and not difficult for any diabetic. The diabetes management plan is specific to each patient and highly individualized as suggested by the American Diabetes Association [[17](#)].

Patients of G1 were probably agreed to follow the NEP in view of the fact of their seniority of diabetes compared to G2. The question that arises diabetic patients usually on

the arrival of Ramadan, should I do fasting or not? During the NEP organized on PHI of Skikda, the patients of G1 were informed of the international recommendations for a diabetic who wants fast. Each patient had one or more interviews with a specialist to discuss the conditions authorizing him to fast and the risks to which he is exposed. If the patient meets the

criteria, the physician will tell him that he needs to monitor himself throughout the period of Ramadan and he must interrupt the fast at the first sign of weakness. This justifies may be the fact that the number of days which the patients of G1 fasting is more reduced than patients of G2. Recalling that the latter did not agree to follow the NES.

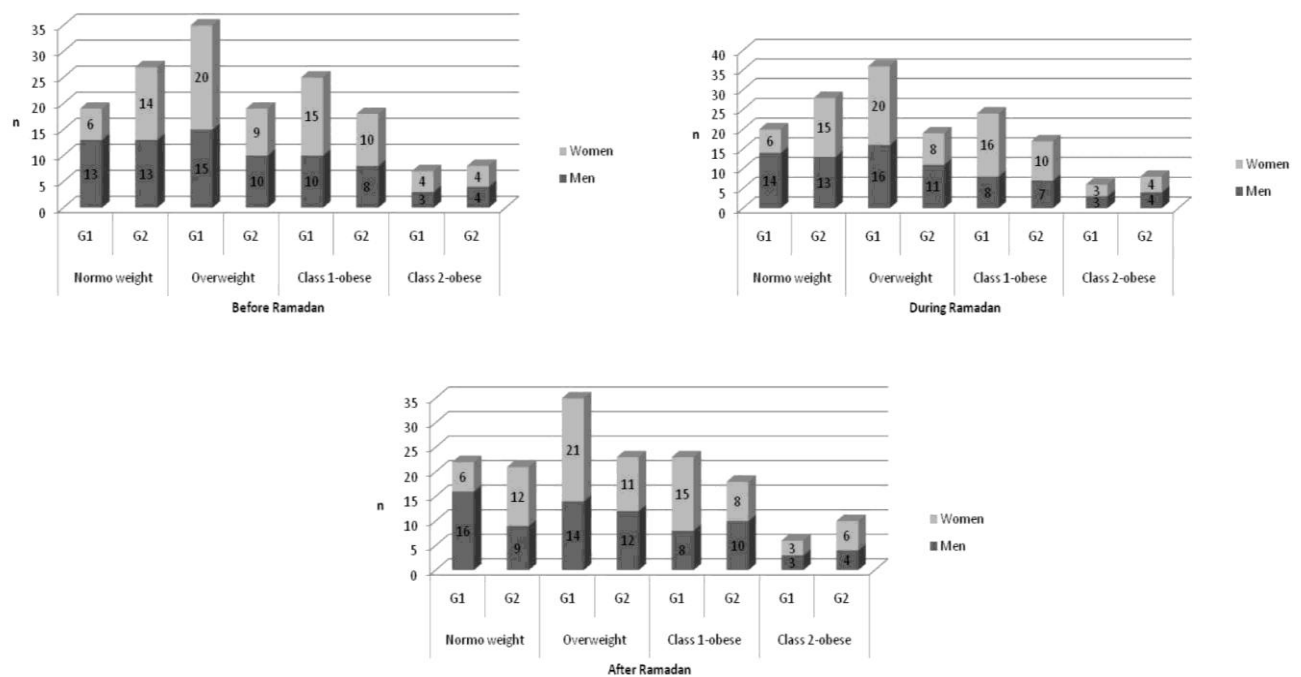


Figure 1. Weight status of both groups of diabetic patients before, during and after Ramadan G1: group 1 of patients (n=86), G2: group 2 of patients (n=72)

In an observational study, structured training sessions specific to Ramadan have proven themselves to be effective. In point of fact, diabetics who fasted without attending these meetings had been a risk of hypoglycemia quadrupled, while those who attended these sessions have seen a significant reduction of hypoglycemic event [18].

In a retrospective observational study of the management and outcomes of patients with diabetes during Ramadan (CREED) performed in line with the recommendations of the study group EPIDIAR, reports that 94% of patients make fasting of Ramadan over 15 days compared to 78.7% of patients in the study EPIDIAR [19]. According to these authors,

many changes that have occurred since 2001 could certainly have influenced the ability of a patient to complete his fast, but are unable to establish a causal relationship with a specific change.

Total energy which remained stable during the three survey periods (T0, T1, T2) of patients in the G1 and insufficient to meet the recommendations [20]. Those G2 have seen an increase in energy intake during each execution. The diabetes is a chronic disease for which the respect for a balanced diet, for a physical activity and for a medical treatment is central in the care of patients. The meals become nocturnal, their frequency decreases in number compared to a period outside of Ramadan [21,22]. Managing

Muslim people with diabetes during Ramadan continues to be a challenge. It is important that healthcare professionals should be able to offer advice, guidance and change of medications as required during pre-Ramadan counseling to enable individuals to fast safely if they wish to do so [23].

The G1 patients had a decrease in their carbohydrates intake during T1 of about 32.5g from 65.7% to 58.0%. They continued to reduce their carbohydrates intake after T2 with an average of 16.3g (57.7%). Contrary to the control group that increased their consumption of about 17.2 g during T1 and even in T2 period's. While carbohydrates intake from G1 were significantly higher in G2 at T0 with 27.9g, but after the NEP that was the opposite was found with significant differences at T1 (21.8g) and T2 (38.1g), and this difference was especially in the form of simple sugars. In the literature, the researchers reported an increase of the daily energy intake associated with an increase in the intake of simple sugars, or decrease in these contributions, or no significant variation in energy intake [24-26]. These variations of results can be due to the methods of estimation of dietary, the season of realization of survey, the socio-economic level, the dietary habits and customs of each population during Ramadan and the festive period (*Aid El Fitr*).

The fiber contribution increased significantly during T1 compared with T0 for both groups, however, in G2 the contribution was significantly low compared to the G1 whatever the period. Despite this, the fiber intake remains low compared to recommended dietary allowances of 30g/day [20]. For a diabetic type 1 or type 2, the diet must be generally high in fiber, avoiding massive carbohydrates intake. A greater consumption of foods rich on fibers is associated with the increase fat absorption capacity. These foods

also constitute a good source of antioxidants, vitamins and minerals, which can play a protective role in front of 2TDM [27].

Protein intakes were higher in both groups during the period T1 with regard T0 and T2, although it is not significant for the patients of G2. This increase participated in the improvement of the ratio AP/PP and covering the recommended daily intake of 1 for G1 and approaching this value for the G2. In general, the consumption of the Algerian population as regards animal proteins is dominated by eggs (0.43 times/day), then comes the meat (0.19 times/day) and the poultry (0.15 times/day) [28]. During the month of Ramadan and in an exceptional way (festive period) in comparison to a normal period, the traditionally cooked Algerian dishes are with red meat (sheep, beef), and/or of white meat (chicken, turkey). The richness in animal proteins from these foods may explain this increase. The proteins associated with carbohydrate foods would decrease their hyperglycemic effect, the advice concerns the maintenance of a satisfactory protein intake. However, the dietary prescription has to ensure a recommended protein contribution, at least from 0.8 to 1 g of proteins per kilogram of ideal weight and per day, that is approximately 15% of the total energy intake, to avoid a muscular wasting and allows a normal physical activity [20].

For total fat intake, before the follow-up of NEP in the period of recruitment of the patients (T0), the G1 had equal contributions to G2. However, during T1, there has been a light increase for both groups without being a significant difference. At T2, the G2 has seen a significant increase compared to G1 ($p=0.000$) in the order of 24g per day. At the meal of breaking the fast (*Iftar*), it is usual to consume traditional dishes rich in saturated fats and carbohydrates fast assimilation [21]. In these dishes, there is an

important use of oil and thus of high fat intake. The increase of these contributions at T2 could be the habit taken during Ramadan or the fasting (not required) outside of Ramadan. In addition, these last years, we are faced to a new dietary habit on the street; many Algerian people, especially men, eat grilled meat seasoned with spicy sauce (*H'rissa*) and olive oil as like the predawn meal. This phenomenon happens also every night of the year. It is recommended to reduce the consumption of the fat while adapting to the specific dishes. Often, a daily decrease in fat, as well contained in food can be enough to rebalance the ration towards the recommendations. The ratio AF/PF was close to the recommended dietary allowances (equal to 1) for patients to the G1, while it is 1.6 for G2 what means an excessive consumption on animal fat during the month of Ramadan. The intake of SFA, MFA and PFA must respectively cover 25%, 60% and 15% of the daily fat intake [20]. In both groups, regardless the period, the intake of MFA depends on that in SFA whereas this last represents nearly 50% of the total fat intake. The PFA on SFA report is close to 1 only during the period of the month of Ramadan. Without significant difference, the G1 of diabetics kept stable their cholesterol intake, while the G2 has a higher cholesterol intake than those of G1 regardless the period. If dyslipidemia is proven as a risk factor of cardiovascular disease, the role of dietary cholesterol (which is only a minority share of intestinal cholesterol) in the occurrence of these diseases remains controversial in the literature [29]. A diet high in fat contributes to the risk of gain a weight and therefore a risk of increased insulin resistance, especially if fat is mainly in the form of SFA. The fat induced a time of draining that does not affect the glycemic response. The notion of index remains true during a mixed meal [30]. On the other hand, if the contribution of PFA is enough, a rate of the

fat approaching 36% can have a beneficial effect on the prevention of the increase of blood cholesterol [31].

The stability observed of the anthropometric parameters (weight, BMI, WHR, FAT%) of the patients of G1 is associated with the absence of significant variation of the total energy during the three periods of survey. However, the change of the energy intake of the patients of G2 did not have influence on these same anthropometric measures. In this present research, the value of WC was significantly reduced after Ramadan fasting in the patients of G1, but the opposite for those of G2. In the literature the results are discordant, while some authors report anthropometric changes [32-34], others have found some modifications [26,35] or none [21,36,37].

The presence of overweight in the population surveyed represents the general case of the patients with T2DM. The management reveals of caloric reduction. This strategy must be much more active when energy intake is above the recommended intakes [38]. For patients of both groups, the management strategy must include the physical activity in order to reduce excess weight. A weight loss of 5 to 10% improves the glycemia, blood lipids and blood pressure, it is justified when the BMI is greater than 25 kg/m². Often, the correction of the bad dietary habits, with the resumption of regular physical activity, allows a loss of weight. In some cases, the stabilization of the weight, without aggravation of the overweight, can be sufficient [39].

The limit of this study was to exploit more depth clinical and psychological aspects of patients. A study to the religious beliefs and socio-cultural values of Ramadan will be the subject for further study in order to see the link between success in the treatment of diabetes and

psychological dimensions related to the observance of fasting.

Conclusion

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.

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