



DIETARY HABITS AND NUTRIENTS INTAKE OF DIABETIC ADOLESCENTS DURING RAMADAN FASTING

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ABSTRACT

Purpose: the aim is to examine the effect of Ramadan fasting on the dietary habits and nutrients intake of Muslim adolescents with type 1 diabetes.

Design/methodology/approach: 54 adolescents with type 1 diabetes (13–18 years old) permitted by their physicians to fast and had no medical complications participated in the study. They were evaluated at three points; before, during and after Ramadan. Validated questionnaires and three days diet diary were filled. Anthro metrics were measured before and after Ramadan.

Findings: the participants fasted a mean of 21.767 days, had significant loss in weight (0.45 kg) and Body Mass Index (BMI) by the end of Ramadan, Energy and macro nutrients intake increased significantly during Ramadan.

Conclusion: changes in lifestyle, physical activity and dietary pattern are one of the characteristics of the month of Ramadan and it affects the diabetics as well as normal people. Adherence of diabetic adolescents to dietary and nutritional guidelines is vital but sometimes difficult to attain and maintain

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1 INTRODUCTION

Most of the world recognised and accepted religions recommend a period of fasting or abstinence from certain foods. Of those, the Islamic fast during the Muslim month of Ramadan which is strictly observed every year.

It is permissible for People with chronic diseases and illnesses not to fast during Ramadan. Diabetics are one of the groups who are exempted from fasting because their chronic metabolic disorder might expose them to high risk complications if the meal plan, food amount and fluid intake are extremely modified. Nevertheless, many patients with diabetes insist on fasting during Ramadan, thereby creating a medical challenge for themselves and their physicians.

Ramadan fasting is a regular pattern of fasting, eating and not starvation but it is known to affect diabetes control due to the changes in meal timings, frequency, types of food, and use of medication in addition to modified life style (Yarahamadi et al., 2003). In a population-based study about diabetes and its characteristics during fasting of Ramadan in 13 countries, it was found that during Ramadan 43% out of 1070 patients with type 1 diabetes and 79% out of 11,173 patients with type 2 diabetes fasted for at least 15 days and the population were relatively young (age 31 and 54 for types 1 and 2 diabetes, respectively) (Salti et al., 2004).

Few studies have demonstrated that fasting is safe among older diabetic adolescents. Of these studies, one found that Ramadan fasting is feasible in older children and those who have had diabetes for long time; it reflects that fasting does not alter short-term metabolic control. In spite of that, children and adolescents should not be encouraged to fast even if they have good glycaemic control and regular blood glucose monitoring at home (Salman et al., 1992).

During the period of this study, around 800 diabetic children and adolescents were followed regularly at King Khalid National Guard hospital. Participants were provided with proper diabetes education and management. Although there are specific evidenced-based medical and nutritional guidelines for diabetes with regards to

eating out, traveling, exercise... etc., there is no specific guidelines or recommendations to manage children and/or adolescents diabetics during Ramadan. The medical decisions for allowing fasting during Ramadan and for the mode of management for young diabetic patients are usually taken and planned-based on the assigned pediatric endocrinologist's experience. In addition, nutritional management and meal plans are designed by dietitians based on their experience. Therefore, the aim of this study is to investigate and evaluate the dietary habits and nutrients intake of diabetic adolescents during the month of Ramadan.

For a number of years, the health of adolescents has not been a major concern and research has consequently been limited, as they are less susceptible to disease and suffer from fewer life-threatening conditions than children and elderly people. Mortality and morbidity trends among adolescents are quite similar in developing and developed countries (WHO, 2005).

In the context of type 1 diabetes, many adolescents experience deterioration in metabolic control that is often attributable to some behaviours such as: extreme meal, exercise patterns, incompliance to treatment, risk-taking behaviours, eating disorders, and endocrine changes associated with puberty, which are leading to greater insulin resistance (Court et al., 2008).

The prevalence of diabetes in several countries with large Muslim populations appears to be similar to the rates observed in Western countries and increasing by 10% per year because of urbanisation and socioeconomic development (Salti et al., 2004).

A national large scale survey conducted in 2001–2007 in Saudi Arabia aiming to establish national growth charts, and defining the prevalence of some chronic childhood diseases such as diabetes mellitus, showed that the prevalence of type 1 diabetes is 109.5 per 100,000, with almost an equal male to female ratio. Children and adolescents were grouped by age into 5–6 (prevalence 100), 7–12 (prevalence 109), 13–16 (prevalence 243) and 17–18 (prevalence 150) (Al-Herbish et al., 2008).

2 WHAT IS RAMADAN?

Ramadan is the ninth month of the Muslim calendar and the month of fasting. Around 2 billion adult Muslims in the world celebrate Ramadan each year. The Arabic word 'sawm' is used for fasting. The word sawm literally means 'to refrain', but as an Islamic term, it means refraining from food, drinks and sexual activity from dawn to sunset.

Fasting month of Ramadan is compulsory for every adult Muslim. The month of Ramadan ranges between 29 to 30 days. The dates of observance differ each year because Ramadan is set to a lunar calendar. Fasting is from dawn until sunset during the whole month, a period that varies by geographical location and season. In summer months, the fast can last up to 18 hr or more, whereas in winter the fast is much shorter as days are shorter (Mohamed et al., 2002).

Fasting is obligatory for every adult Muslim who is sane, able to perform it without any harm to his/her health, and not travelling. If he/she cannot meet any one of these conditions, he/she is excused from the fast. During the day of fasting, Muslims are required not only to abstain from eating and drinking, but also from consuming oral medications and nutritional fluids. In case of acute medical situations the fasting person is allowed to end his/her fast and make it up later after Ramadan. According to Islam, fasting Muslims should eat a meal before dawn, called 'Sahur' before they start fasting for the following day. At sunset time, they break their fasting by having a main meal 'Iftar' which contains dates and water as starters then the rest of the meal. After fast breaking, there are no restrictions in what one can eat or drink until dawn of the next day (Mohamed et al., 2002).

2.1 Effect of Ramadan fasting on body weight

Review of the literature shows controversy data about the effect of fasting on weight. Many studies on healthy and diabetic subjects; mainly type 2 concluded that Ramadan fasting does not change body weight or Body Mass Index (BMI), while other studies reported reduction in body weight. Takruri (1989) reported in his study that overweight subjects lose more weight than normal weight subjects.

Changes in weight during Ramadan fasting could be due to the dietary intake changes mainly the energy intake. Since Ramadan is intermittent type of fasting, people can compensate

their food intake during the period between sunset and dawn, which might be the reason behind the static weight or in some cases slight weight gain during Ramadan (Benaji et al., 2006).

Another reason can be the decreased physical activity during Ramadan, Particularly during the day time. The EPIDIAR study showed that body weight was unchanged in 62.5% of the patients with type 1 diabetes and in 54.1% of the patients with type 2 diabetes (Salti et al., 2004). In a study comparing the metabolic changes during Ramadan among normal and diabetic adult subjects, it was found that there was a significant weight reduction in both groups by the end of Ramadan (Yousif et al., 2003).

2.2 Effect on food and nutrients intake

Changes in food habits, energy and macro nutrients intake among healthy subjects and adult diabetics were reported by many studies. Some studies reported that energy intake decreased or remained the same during Ramadan other studies reported that the intake increased during Ramadan due to the nature of the food cooked and special high sugar drinks prepared during Ramadan.

Frost and Pirani (1987) reported that the energy intake was higher during Ramadan than after Ramadan and the weight gain during Ramadan was significantly correlated to the energy intake. In another study, the total daily energy intake decreased during Ramadan and there was a significant reduced intake of proteins and carbohydrates while the fat intake increased (Bouhlel et al., 2006). Daily energy and water balance reported to be almost the same during Ramadan (Fehime et al., 2007).

2.3 Physical activity and Ramadan fasting

In general, lifestyle during Ramadan become more sedentary and sleeping pattern is changed. The decrease in daily physical activity was reported in most of the studies (Affi, 1997; Leiper et al., 2003; Meckel et al., 2008).

Affi (1997) studied the effect of the Ramadan fasting on daily practices, health and performance of 265 university students. The results reflected that high number of people was engaged in less stressing activities (watching TV, listening to the radio and visiting family and friends) and spiritual activities (prayers and reading Qur'an). Reduced activities reported by more than 50% of subjects.

Some studies have examined the effects of fasting on physical work capacity, and found a small reduction in cardio-respiratory responses to sub-maximal exercise in sedentary adults (Ramadan and Barac Nieto, 2000; Ramadan, 2002). Others found that maximal exercise capacity and walking efficiency were not influenced by the Ramadan fast (Ramadan, 2002; Sweileh et al., 1992).

3 METHODS

This is a prospective cohort study designed to investigate the effect of Ramadan fasting on the dietary habits and nutrients intake of the Saudi diabetic adolescents, in Jeddah city. The participants were diabetic adolescents aged between 13 and 18 years those attending King Khalid National Guard Hospital in Jeddah city for follow up in the Pediatric Endocrine Outpatient Clinic.

3.1 Sample recruitment

All eligible patients were approached 2–3 months before Ramadan during their routine visits to the pediatric endocrine clinic or by phone inviting them to join the study. A 60 adolescents and their parents or guardians agreed to participate in the study. Six dropped out and 54 continued the study.

Each participant served as self-control by comparing his/her result of after and during Ramadan with pre-Ramadan.

The study was approved by the University Graduate Committee at Ahfad University for Women, Omdurman, Sudan and the research committee at King Khalid National Guard Hospital, Jeddah; Kingdom of Saudi Arabia. Each participant and his/her guardian signed an informed consent form.

The participants were ensured both verbally and by informed consent form that all conversation and information provided to the researcher will be regarded as confidential and will only be used for the specified study.

Data collected around two weeks before Ramadan, during the four weeks of Ramadan and two weeks after Ramadan. Data included socio-demographic data, anthropometrics, history of diabetes, type of medical management, self-glucose monitoring, glycemic control, physical activities, dietary habits and the experience of Ramadan fasting.

The second questionnaire included questions about length of fasting days, anthropometrics, and type of medical management, self-glucose monitoring, glycemic control, physical activities

and dietary habits during Ramadan. The tool was validated by a panel of experts, the reliability of the questionnaire was tested and the result was Cronbach's $\alpha=0.785$.

3.2 Anthropometrical data

Body weight was assessed before and after Ramadan using an electronic calibrated medical weighing scale (Seca, Germany).

Height was measured using a calibrated, wall mounted stadiometer (Seca, Germany).

The BMI was calculated at the beginning of the study and at the end using the following formula:

$$\frac{\text{Body weight in kg}}{\text{height in m}^2}$$

CDC National Center for Health Statistics (NCHS) BMI tables which is also adopted by WHO were used to classify the degree of overweight and obesity.

3.4 Dietary intake

All participants and their parents/guardians were trained to complete the dietary records describing the foods and amounts consumed, including the name of each food and drink item (brand name, if possible), preparation methods and portion sizes.

All participants visited the hospital two weeks After Ramadan to submit their records and to fill the post-Ramadan questionnaire. Anthropometric measurements were also taken and recorded during this time.

4 STATISTICAL ANALYSIS

The online USDA my pyramid tracker program used for nutrients analysis. Food and Agriculture Organization (FAO) for food composition tables were used to analyse traditional foods for each day.

The statistical analysis was performed using SPSS® software (version 16), SPSS Inc., USA.

All variables were checked for normality and residues. ANOVA was performed after checking data for normality and residuals. Student's *t* test was used for paired normally distributed data to compare and assess differences between data. Non-parametric Wilcoxon Signed Ranks test for ranked and none normally distributed data. Non-parametric Mann Whitney test was used to test the differences based on gender. Non-parametric Kruskal Wallis Test to compare the

differences between more than two none normally distributed groups. The Pearson correlation test for normally distributed data and Spearman non-parametric correlation test for ranked or none normally distributed data were used to assess correlations between data. All statistical tests were considered significant at 0.05 confidence interval.

5 RESULTS

About 54 out of 60 participants (90%) enrolled in the study and completed the study protocol, six participants discontinued early from the study at their own request.

5.1 Demographic characteristics of the participants

About 34 out of 54 (63%) were females and 20 (37%) were males. Mean age of participants was 15.4 ± 1.9 years with range of 13–18 years. Most of the participants were at the level of intermediate or high school education (81%) while the rest of participants were distributed equally between primary and university levels (11% for each group). Around 80% were from medium socioeconomic class and 20% were from high socioeconomic class.

Mean duration of diabetes was 7.9 ± 4 years and the mean age of diagnosis was 7.6 ± 3.5 years. A 30 out of 54 (55.6%) participants had family history of diabetes. The participants managed to fast 21.7 ± 7 days which, males fasted more days than females (23.4 ± 8.3 versus 20.8 ± 6.2 days; $P=0.002$). A 34 out of 54 (63%) participants managed to fast between 22 and 30 days, 15 (~28%) fasted for 15–21 days and only 5 (~9%) fasted less than seven days. Generally, it can be said that 72% of the participants managed to fast 15 days or more.

5.2 Effect of Ramadan fasting on body weight

Body weight and BMI decreased significantly. Mean weight after Ramadan was 59.08 ± 10.65 kg compared to 59.53 ± 10.65 kg before Ramadan with a difference of 0.46 ± 1.95 kg ($P=0.01$). BMI decreased significantly by the end of Ramadan (23.43 ± 4.08 versus 23.26 ± 4.02 kg/m²; $P=0.018$). Results also reflected that only two (3.7%) of the participants maintained their body weight although they fasted 22 to 30 days, 35 (65%) lost weight and most of them (32) fasted between 15 and 30 days. A 17 (19%) of the participants gained

weight and 10 of them were among the group who fasted between 22 and 30 days. The range of weight loss is between 0.15 and 5.6 kg while the increment is between 0.1 and 5.7 kg. On the other hand, the decrease in BMI is between 0.05 and 2.13 kg/m² and the increment is between 0.04 and 2.2 kg/m².

5.3 Effect of Ramadan fasting on diet and nutrients intake

Results reflected that Ramadan fasting had a negative effect on the dietary compliance ($P=0.001$). The number of participants who were non-compliant to the diabetic diet or healthy eating guidelines for diabetics increased from 12 out of 54 (22%) before Ramadan to 20 (37%) during Ramadan. On the other hand, the participants who were to some extent compliant with the diet decreased during Ramadan compared to before Ramadan.

Since fasting is very critical, it was expected that providing advices about Ramadan fasting by the members of the diabetes team will influence the 50 participants who received the advice to be more compliant with the diet but they were not ($P=0.177$). As shown in the Table 1, energy intake increased significantly from 1613 ± 582 kcal/d before Ramadan to 2137 ± 571 kcal/d during Ramadan ($P=0.001$). Furthermore, there was no significant difference in the change of energy intake between females and males.

Carbohydrate intake also increased significantly from 217.7 ± 86.7 g/d to 256.8 ± 69.2 g/d ($P=0.012$). This difference was affected more by the increased carbohydrate intake of females during Ramadan (198.6 ± 73.3 g/d versus 260.6 ± 74.7 , $P=0.008$).

Carbohydrate intake represented $47.5 \pm 7.7\%$ of the total energy consumed during Ramadan, with no significant difference compared to before Ramadan.

Protein intake increased from 67.7 ± 23.4 g/d before Ramadan to 81.4 ± 32.5 g/d ($P=0.026$). It represents $15.1 \pm 4.4\%$ of the total energy consumed during Ramadan with insignificant difference compared to before Ramadan. Females' protein intake increased significantly (60.1 ± 22.4 g/d versus 75.8 ± 18.1 g/d, $P=0.006$) compared to males who had insignificant increased protein intake (79 ± 20.6 g/d versus 89.9 ± 45.8 , $P=0.478$) during Ramadan.

Again, this difference in protein intake contributed to the total change in the intake of all

Table 1 Effect of Ramadan fasting on energy and nutrients intake of the participants ($n=50$)

Variable	Before Ramadan	During Ramadan	P-value	Target*
Energy (kcal/d)	1613 \pm 582	2137 \pm 571	0.000	Varies according to age, sex, activity
Carbohydrates (g/d)	217.7 \pm 86.7	256.8 \pm 69.2	0.012	
Carbohydrates (% kcal)	49.7 \pm 8.7	47.5 \pm 7.7	0.458	50–55%
Protein (g/d)	67.7 \pm 23.4	81.4 \pm 32.5	0.026	
Protein (% kcal)	16 \pm 3.9	15.1 \pm 4.4	0.775	10–15%
Fat (g/d)	67.4 \pm 31.1	90 \pm 37.8	0.001	
Fat (% kcal)	34.2 \pm 6.6	37.4 \pm 6.1	0.244	30–35%
Fiber (g/d)	14.6 \pm 8	17.3 \pm 5.9	0.002	25–35
Cholesterol (mg/d)	301.5 \pm 268.6	305.2 \pm 174.2	0.702	<300

Note: Data are means \pm SD, and percentages (%) unless otherwise indicated.

*P-value indicates the significance of difference in nutrients and energy intake.

P-value is significant at ≤ 0.005 .

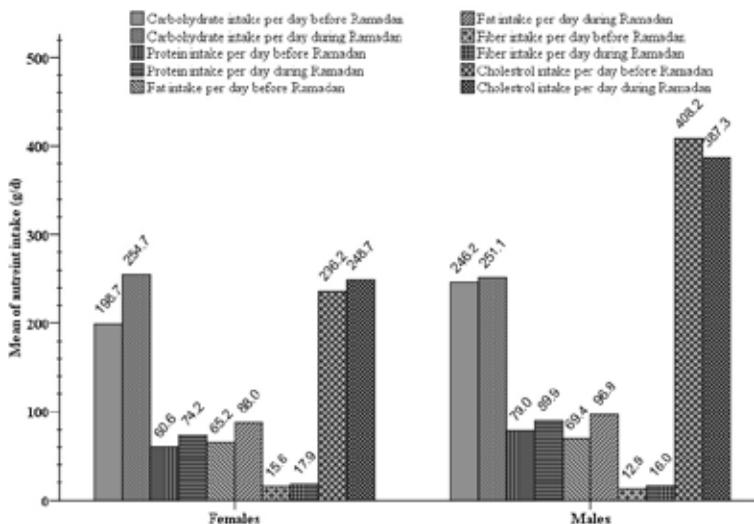
*ISPAD Clinical Practice Consensus Guidelines 2006 2007: Nutritional management (Aslander-van Vliet et al., 2007).

participants. Fat intake increased dramatically during Ramadan up to 90 ± 37.8 g/d compared to 67.4 ± 31.1 g/d before Ramadan ($P=0.001$). Males' fat intake increased significantly during Ramadan from 69.4 ± 18.6 g/d to 96.8 ± 33.3 g/d ($P=0.004$), compared to females who had insignificant increment (66.1 ± 37.5 versus 85.5 ± 40.4 , $P=0.086$).

Total fat intake contributed to the energy intake during Ramadan by $37.4 \pm 6.1\%$ with no significant change compared to before Ramadan ($34.2 \pm 6.6\%$).

Results also reflected that the fiber intake increased significantly during Ramadan (14.6 ± 8 g/d versus 17.3 ± 5.9 g/d, $P=0.002$). There was no significant difference between females and males fiber intake neither before nor during Ramadan.

There is no significant change in the cholesterol intake. Females' cholesterol intake increased insignificantly during Ramadan but remained within there commended level, while males' intake decreased but also insignificantly and the intake was also higher than recommended.

**Figure 1** Nutrients intake of females and males before and during Ramadan

5.4 Effect of Ramadan fasting on physical activities

The number of participants who used to practice exercises and physical activity at least once a week decreased significantly during Ramadan from 41 out of 54 (~76%) to 24 out of 54 (~44%); $P=0.000$ (Table 2). Results also showed no

significant difference between females and males physical activities during Ramadan. Although it was expected that there would be a decrease in the duration of physical activity, but the participants who kept on performing physical activity during Ramadan spent almost the same time exercising compared to before Ramadan.

Table 2 Effect of Ramadan fasting on physical activity of the participants

Variable	Before Ramadan	During Ramadan
Frequency of exercise per week*		
None	13 (24.1)	30 (55.6)
Once	10 (18.5)	2 (3.7)
Two–Three times	10 (18.5)	4 (7.4)
Four–Five times	7 (13)	3 (5.6)
Daily	14 (25.9)	15 (27.8)
Duration of activity each attempt:**	$n = 41/54$ (75.6%)	$n = 24$ (44.4%)
Half an hour	20 (48.8)	12 (50)
1 hr	14 (34.1)	8 (33.3)
2 hr	5 (12.2)	2 (8.3)
More than 2 hr	2 (4.9)	2 (8.7)

*Data are n (%) unless otherwise indicated, *P-value=0.000, **P-value=0.130. P-value is significant at ≤ 0.005 .*

6 DISCUSSION

In this study, participants intention to observe fasting derived by a desire to be perceived the same as peers and the rest of the society. Nevertheless the participants were encouraged by their care givers to fast considering that fasting is a religious issue for which the participants make their own decision after receiving appropriate advice from religious bodies and from their own health care providers.

Eating habits and nutrients intake data showed that the adherence to dietary advices and healthy eating guidelines is to some extent difficult to be tackled on daily bases in this age group. In general, the in compliance on dietary and medical advices among the adolescents with diabetes might be due to their tendency to ignore their vulnerability to the potential consequences of their disease (Hanna and Guthrie, 2000). In addition, there are other barriers to healthy eating including wide spread availability of unhealthy foods, preparation time, social situations and parental

behaviours; including monitoring of food choices and positive modelling (Gellar et al., 2007).

In a study by Hanna, only one-fifth of the diabetic adolescent participants felt that they complied fully with what they thought they were expected to do about diabetes management. The desire for more independence was one of the barriers to compliance identified by these adolescents (Hanna and Guthrie, 2000). In the current study, only 4% stated that they are always compliant with the guidelines to control diabetes.

Nutrients and energy analyses of the three days diet records before Ramadan reflected an average daily intake of 1613 ± 582 kcal with a significant difference between females and males' energy intake. Total energy intake was higher by males (1850 ± 516 versus 1456 ± 578 ; $P=0.009$), which is consistent with the findings of Helgeson et al. (2006).

The percentage of energy from carbohydrate intake represented $49.7 \pm 8.7\%$ with insignificant difference between females and males. This intake

is slightly less than the ISPAD¹ nutrition recommendations [40]. ISPAD recommends an energy intake of 10–15% from protein while the intake of the participants in this study is $16 \pm 3.9\%$; males' protein intake was significantly higher than females.

There was no significant difference between females and males intake of fat and it represented $34.2 \pm 6.6\%$ of the total energy intake on the other there is a significant difference between males and females in regards to cholesterol intake, males cholesterol intake was higher than females intake ($P=0.013$).

Males' fiber intake was not significantly different from females. Total fiber intake of the 50 Participants was 14 ± 7.8 g/day which is also far below the recommendations of ISPAD (Aslander-van Vliet et al., 2007). The fact that most of the nutrients intake did not meet the nutrition recommendations, is consistent with findings of the SEARCH study group (Mayer-Davis et al., 2006), who found that the overall nutrients intake across subgroups of age (10 to 14 years, >15 years) in a cohort of 1697 youth with diabetes (89% type 1 diabetes, 11% type 2 diabetes), failed to meet the nutrition recommendations.

6.1 Previous Ramadan fasting experience

Beshyah et al. (2007) stated, "Many patients would have developed their own opinions and established their practices of mending their diabetes care management plans from previous personal experience". About 45 out of 54 (83.3%) participants experienced Ramadan fasting before, 38 of them sought medical consultation about Ramadan fasting and they received all related information and education including management of any arising problems and complications, and that's why most of them (35 participants) did not seek medical advice prior to the current season of fasting. The rest of the sample was advised by the researcher to seek medical consultation specially the seven participants were about to fast for the first time.

In general, 50 out of 54 (~93%) participants received an advice about Ramadan fasting by a health care professional; either at this time of fasting or prior to previous seasons of fasting, this is higher than the findings of the EPIDIAR study group who found that recommendations from

healthcare providers about fasting and diabetes during Ramadan were provided to 68% of the patients with type 1 diabetes (Salti et al., 2004). Probably because of the availability and access to patient self-management support and education at the hospital for this group of patients either by attending the outpatient clinic or phoning the members of the diabetes team during duty hours, which has been shown in several studies to improve the outcomes of diabetes care (Skovlund and Peyrot, 2005).

6.2 Current Ramadan fasting

All participants managed to fast 21.7 ± 7 days, males fasted more days than females (23.4 ± 8.3 versus 20.8 ± 6.2 days; $P=0.002$) which might be because females are excused from fasting during the days of menstrual cycle.

About 72% of the participants managed to fast 15 days or more and this percentage is much higher than the findings of Salti et al. (2004) who found that 42.8% of patients with type 1 diabetes reported fasting at least 15 days during Ramadan but the average number of fasting days was higher (23 days). According to the same study, the minimum number of fasting days was among the Turkish participants (18 days) and the highest was in Saudi Arabia where the patients with type 1 diabetes managed to fast an average of 25.6 days (Salti et al., 2004). In our opinion, patient education is one of the main factors that empowered and helped the patient with type 1 diabetes through fasting.

Furthermore looking at the parameters that can be affected by Ramadan fasting starting with body weight and BMI, it was found that there is a statistically significant decrease in both; body weight and BMI. Although a mean change of 0.46 ± 1.95 kg/month among a group of 54 adolescents is not significant clinically but two participants had a loss of 5.6 kg which is risky and can be attributed to the uncontrolled diabetes or low energy intake or both. About 65% of the participants lost weight and 22 of them lost more than 1 kg, the same applies to the decrease in BMI.

In the EPIDIAR study; weight was unchanged in 562 out of 1070 (62.5%), decreased in 176 (19.9%) and increased in 161 (17.9%) of the patients with

¹ The International Society for Pediatric and Adolescent Diabetes.

type 1 diabetes (age=31.0±12.7 years) (Salti et al., 2004). The difference between the results of the current study and the findings of the EPIDIAR might be due to the fact that the EPIDIAR study was retrospective study and the response about weight change was based on the personal judgments of the participants not an actual measurement, in addition to the age deference between the participants in two studies.

The significant weight loss of the participants in this study can be attributed to the uncontrolled diabetes and. For the participants who gained weight; the significant high energy intake and decreased physical activity during Ramadan compared to before Ramadan are the main reasons behind their weight change.

In contrast, lack of adherence to medical and nutritional advices, guidelines and plan of treatment is the problem not the Ramadan fasting *per se*.

Results reflected that the dietary habits of the participants during Ramadan fasting had a negative effect on the dietary compliance ($P=0.001$). The increase in the mean energy intake during Ramadan was expected due to the nature of food items prepared regardless the number of meals and snacks during Ramadan, which are less compared to before Ramadan. In a study conducted by Frost, the energy intake was significantly higher during Ramadan than post-Ramadan (3680 versus 2425 kcal/d) (Frost and Pirani, 1987).

In Saudi Arabia like the rest of the Islamic world people tend to prepare special dishes and drinks during Ramadan, and most of the time these dishes are rich in fat and carbohydrates, drinks also contains high amounts of sugar.

The participants increased intake of carbohydrates in this study is in disagreement with the results of a study done by Bouhlel et al. (2006) that included nine healthy males (19±2 years old) fasting during Ramadan and they consumed less carbohydrates during fasting days compared to before Ramadan. Moreover, as mentioned earlier energy and nutrients intake of diabetic adolescents is not expected to be different from healthy peers' intake.

Carbohydrate intake represented 47.5±7.7% of the total energy consumed during Ramadan, which was also less than before Ramadan but the difference was insignificant. This percentage of carbohydrate intake is slightly less than the recommended.

Protein intake of all participants increased from 67.7±23.4 g/d before Ramadan to 81.4±32.5 g/d ($P=0.026$). It did represent 15.1±4.4% of the total energy consumed during Ramadan with insignificant difference compared to before Ramadan. This percentage is considered acceptable and within the recommended intake.

Fat intake increased dramatically during Ramadan up to 90±37.8 g/d compared to 67.4±31.1 g/d before Ramadan ($P=0.001$). Males' fat intake increased significantly during Ramadan from 69.4±18.6 g/d to 96.8±33.3 g/d ($P=0.004$) compared to females who had insignificant increment (66.1±37.5 versus 85.5±40.4, $P=0.086$) which is in agreement with the findings of Bouhlel et al. (2006).

Total fat intake contributed to the energy intake during Ramadan by 37.4±6.1% with no significant change compared to before Ramadan (34.2±6.6%) but higher than the recommended. The significant increase in energy, carbohydrate, fat and protein during Ramadan is consistent with the findings of Frost and Pirani (1987) and as they mentioned that although the number of meals were significantly less during Ramadan but the intake of energy and macro nutrients were significantly higher during Ramadan among the 15 young Saudis who joined the study.

The increment of fiber intake during Ramadan might be due to the daily consumption of some special Ramadan dishes and food items consumed on daily basis like broad beans, oats and whole shredded wheat soup, green salad and samosa filled with vegetables in addition to dates.

One of the main finding of the present study was that observing Ramadan fast reduced physical activity of the diabetic adolescents. Normally, the main possible factor for this reduction is the change in life style during Ramadan.

The number of participants who used to perform exercises and physical activity at least once a week decreased significantly during Ramadan and this is consistent with the findings of Afifi (1997); Leiper et al. (2003) and Meckel et al. (2008).

Maughan et al. (2008) investigated the effect of Ramadan fasting on some biochemical and hematological parameters in 78 Tunisian healthy youth soccer players undertaking their usual training and competition schedule; they were

16–19 years old. Results revealed that Ramadan fasting together with the continuation of normal training load, has no marked effect on the blood profile of these adolescents.

The decrease in physical activity among the participants of the current study was explained by some of them who stated that they do not have time at night because they were busy by other different social and religious activities and they did not exercise during the day while they were fasting to avoid the occurrence of any abnormal glycaemic events.

According to Kobeissy et al. (2008) diabetics should be counseled against strenuous physical activity to avoid hypoglycemia, particularly during the fasting hours, although regular physical activity can be maintained.

7 CONCLUSION

Fasting is a common practice in many religions. In Islam sick people are exempted from fasting. However, many patients might fast against medical advice. Ramadan fasting is observed by many diabetic Muslims and it was well documented that it is achievable especially among adult diabetics either with type 1 or type 2 diabetes.

The results of this study indicate that fasting by diabetic adolescents mainly with type 1 diabetes is feasible provided that they receive proper related education and medical advices in addition to dietary and healthy eating guidelines. Changes in lifestyle, physical activity and dietary pattern are one of the characteristics of the month of Ramadan. The change in life style and dietary habits from active to sedentary and from less energy consumption to higher consumption did not contribute or promote weight as expected, but instead of that, the participants lost weight, which might be due to hyperglycemia and insufficient amount of insulin dose during Ramadan.

Finally it appears that the proper medical management and diabetes education services provided by the members of the pediatric diabetes team in addition to the free access to such service enabled the participants to overcome the acute complications that could result from fasting.

8 RECOMMENDATIONS

Until further evidence and evidence-based recommendations become available, health care providers should follow general guidelines in counseling their patients who wish to fast, without overlooking the need for individualised care.

- Diabetic adolescents who wish to fast during Ramadan should seek medical advice concerning the risks involved.
- Patients who insist on fasting should undergo pre Ramadan assessment and receive appropriate comprehensive education at least one month before Ramadan from all the members of the diabetes team.
- Promoting education programs that enhance self-efficacy by incorporating personal health care goals and social and peer support.
- The importance of compliance with lifestyle recommendations should also be emphasised.
- Proper dietary education and individualise meal plan by trained dietitian is highly recommended to ensure adequate balanced diet during Ramadan.
- They should be encouraged to eat a healthy, balanced diet during the non-fasting hours, limiting high fat and carbohydrate food.
- Consumption of complex carbohydrates at the Sohur meal is advisable because of their slow digestion and absorption; simple carbohydrates can be considered at the Iftar meal.
- Delaying Sohur meal as late as possible before the start of the daily fast.
- In case of long non-fasting time, it is recommended to include healthy snacks especially for very active persons.

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BIOGRAPHICAL NOTES

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QUESTIONNAIRE 1**Baseline data (Before Ramadan fasting)****Serial No.** _____**A. Socio-demographic data:**

1. Age _____ years
2. Gender:
 - a. Female _____
 - b. Male _____
3. Level of education:
 - a. None _____
 - b. Primary _____
 - c. Intermediate _____
 - d. High secondary _____
 - e. University _____
4. Socio-economic status:
 - a. Low _____
 - b. Medium _____
 - c. High _____

**B. Anthropometrics measurements:
(to be filled by the research team)**

5. 1. Body weight _____ kg 5.2 _____ %
6. 1. Body height _____ cm 6.2 _____ %
7. 1. Body Mass Index _____ kg/cm² 7.2 _____ %

C. Medical (diabetes) history:

8. Duration of diabetes _____ years
9. Age at diagnosis _____ years
10. Type of diabetes:
 - Type I _____
 - Type II _____
 - Other _____ Specify _____
11. Any family history of diabetes:
 - a. Yes _____
 - b. No _____

D. Drug management:

12. Insulin: (what is the type of insulin that you are using?)
 - a. Lispro _____
 - b. Lispro and NPH _____
 - c. Lispro and Glargine (Lantus) _____
 - d. Regular and NPH _____
 - e. Regular and Glargine (Lantus) _____

If you are using the insulin pump skip the following question.

13. Number of shots per day:
 - a. 2 _____
 - b. 3 _____
 - c. 4 _____
 - d. More than 4 _____
14. Total insulin dose _____ units/day
15. Method of Insulin delivery
 - a. Pen _____
 - b. Syringe _____
 - c. Pen & Syringe. _____
 - d. Pump. _____
16. Oral hypoglycemic drug:
 - a. None _____
 - b. Glucophage. _____
 - c. Other _____ Specify _____
17. Episodes of hypoglycemia:
 - a. Rarely _____
 - b. Some times _____
 - c. Most of the time _____
 - d. Always _____
 - e. None _____
18. Have you been hospitalised because of severe hypoglycemia in last 3 months:
 - a. Yes _____
 - b. No _____
19. Episodes of hyperglycemia:
 - a. Rarely _____
 - b. Some times _____
 - c. Most of the time _____
 - d. Always _____
 - e. None _____
20. Have you been hospitalised because of severe hyperglycemia in last 3 months?
 - a. Yes _____
 - b. No _____
21. Have you been hospitalised because of diabetes ketoacidosis in last 3months?
 - a. Yes _____
 - b. No _____

E. Diet:

22. Do you follow the healthy eating guidelines for diabetics?
- No ___
 - Rarely ___
 - Some times ___
 - Most of the time ___
 - Always ___
23. How many meals you used to consume per day?
- One
 - Two
 - Three
 - More than three
24. How many snacks you used to consume per day?
- None
 - One
 - Two
 - Three
 - More than three

F. Exercise:

25. How many times per week you used to perform exercise:
- None ___
 - Once ___
 - Two-three times ___
 - Four-five times ___
 - Daily ___
26. What is the approximate duration of the exercise?
- Half an hour ___
 - One hour ___
 - Two hours ___
 - More than 2 hours ___

G. Blood Glucose Self-monitoring:

27. How many times you used to do self-blood testing?
- None ___
 - Daily ___
 - Three times per week ___
 - Five times per week ___

H. Ramadan fasting:

28. Did you consult your physician about Ramadan fasting this year?
- Yes ___
 - No ___

If no go to question no 31

29. Did you receive any advices about Ramadan fasting?
- Yes ___
 - No ___
30. If yes by whom?
- Physician ___
 - Diabetese educator ___
 - Dietitian ___
 - Nurse ___
 - Others ___
31. Have you practiced Ramadan fasting before?
- Yes ___
 - No ___

If no, do not answer the following questions.

32. Did you consult your physician about the fasting of the previous Ramadan
- Yes ___
 - No ___
33. Did you receive any advices about Ramadan fasting at that time?
- Yes ___
 - No ___
34. If yes by whom?
- Physician ___
 - Diabetes educator ___
 - Dietitian ___
 - Nurse ___
 - Others ___

QUESTIONNAIRE 2**After Ramadan fasting**

Serial No. _____

1. How many days did you fast during Ramadan?

----- days

- a. Less than 7 days ___
- b. 7-14 days ___
- c. 15-21 days ___
- d. 22-30 days ___

A. Anthropometrics measurements:

- 2. 1. Body weight ___ kg 2.2. ___%
- 3. 1. Body height ___ cm 3.2. ___%
- 4. 1. Body Mass Index ___kg/cm² 4.2 ___%

B. Drug management during Ramadan:

- 5. Insulin: (what is the type of insulin that you are using?)
 - a. Lispro___
 - b. Lispro and NPH ___
 - c. Lispro and Glargine (Lantus) ___
 - d. Regular and NPH___
 - e. Regular and Glargine (Lantus) ___

**In case that you are on Insulin pump therapy skip Q.6*

- 6. Number of shots per day:
 - a. 2 ___
 - b. 3 ___
 - c. 4 ___
 - d. More than 4 ___
- 7. Total daily insulin dose _____units/day
- 8. Method of Insulin delivery
 - a. Pen ___
 - b. Syringe ___
 - c. Pen & Syringe ___
 - d. Pump ___
- 9. Oral hypoglycemic drug:
 - a. None ___
 - b. Glucophage ___
 - c. Other ___ Specify _____

C. Blood Glucose Self-monitoring:

10. How many times you used to do self-blood testing during Ramadan?

- a. None ___
- b. Daily ___
- c. Three times per week ___
- d. Five times per week ___

D. Blood glucose control during Ramadan:

11. Episodes of hypoglycemia during Ramadan compared to before Ramadan:

- a. The same ___
- b. Decreased ___
- c. Increased ___

12. If there was any episodes hypoglycemia during Ramadan, at what time usually?

- a. Morning ___
- b. Noon ___
- c. Afternoon ___
- d. Night time ___
- e. After midnight___

13. What did you do to manage your hypoglycemia?

- a. Breaking the fast ___
- b. Continued the fasting ___
- c. Stop any kind of activity and took rest ___

14. Have you been hospitalised because of severe hypoglycemia during the month of Ramadan?

- a. Yes ___
- b. No ___

15. Episodes of hyperglycemia during Ramadan compared to before Ramadan:

- a. The same ___
- b. Decreased ___
- c. Increased ___

16. If there was any episodes of hyperglycemia during Ramadan, at what time usually?
- Morning ___
 - Noon ___
 - Afternoon ___
 - Night time ___
 - After midnight ___
17. In case of hyperglycemia (more than 250 mg/dl) did you use to check urine for ketones?
- Yes ___
 - No ___
18. If yes what was the result of the test?
- No ketones (negative) ___
 - Rarely positive ___
 - Most of the time positive ___
 - Always positive ___

If the answer is number 1. No ketones (negative) skip next question.

19. What did you do to manage the ketoneuria?
- Took rest ___
 - Drinking fluids ___
 - Administer insulin ___
 - All of the above ___
 - Nothing.

20. Have you been hospitalised because of severe hyperglycemia during the month of Ramadan?
- Yes ___
 - No ___
21. Have you been hospitalised because of diabetes ketoacidosis during the month of Ramadan?
- Yes ___
 - No ___

E. Exercise:

22. How many times per week you used to perform exercise during Ramadan?
- None ___
 - Once ___
 - Two-three times ___
 - Four-five times ___
 - Daily ___

If you choosed number 1. None, skip next question.

23. What was the approximate duration of the exercise?
- Half an hour ___
 - One hour ___
 - Two hours ___
 - More than 2 hours ___