Introduction

Fasting as a religious ritual is as old as time. In Islam, however, it is one of the five pillars. All practicing Muslims who are healthy are obligated to fast in one of the holiest months in Islam, Ramadan; the ninth month in the Hijri calendar of Islam. Muslims during Ramadan abstain from food, water, and from engaging in coition from the crack of dawn until dusk. The only exceptions are people who are either mentally or physically unable to fast due to an underlying health condition. In the Holy book of Muslims, the Quran, God says: He wishes ease for people, not a difficulty. Hence, this leniency is for Muslims who are sick and cannot bear the rigors of fasting. People on a journey are also excluded, given the difficulties that traveling involves.

Incidence of diabetic ketoacidosis during Ramadan compared with non‑fasting months in King Saud Medical City, Riyadh, Saudi Arabia

Mohsin Alshahrani¹, Ahmad Alraddadi²

¹Department of Family Medicine, Ministry of Health, Riyadh, ²Consultant Internal Medicine, Alnoor Specialist Hospital, Makkah, Saudi Arabia

Abstract

Background: Ramadan in Islam is the ninth month of the Muslim calendar and the holy month of fasting. In the fasting state, there is the danger of the blood glucose levels becoming too high when normal levels of medication are not taken. This can lead to diabetic ketoacidosis (DKA). The risk of diabetic emergencies, including DKA, is thought to be higher during Ramadan fasting due to metabolic changes and alterations in food habits. We aim to assess the incidence of DKA during Ramadan and perform a comparison pre and post month of Ramadan. Methods: This is a retrospective study that involves all adults who were admitted with DKA to King Saud Medical City in Riyadh, Saudi Arabia. We explored the relationship of admissions to Ramadan and compared it to the month before (Sha’aban) and the month after (Shawwal). Results: During the duration of the study, 51 patients with DKA were admitted to the hospital. Nineteen patients in Ramadan (37.3%), eight patients in Sha’aban (15.7%), and 24 patients in Shawwal (47%). This shows a significant increment in Ramadan compared to Sha’aban, and more increment in Shawwal (P = 0.019). The most common precipitating factor for diabetic ketoacidosis during Ramadan and Sha’aban is missing insulin dose, while infections are considered the main stimulating agent in Shawwal. Conclusion: There was an increase in the incidence of DKA episodes in Ramadan compared with the preceding month, but fewer DKA events compared to Shawwal, which might indicate that Ramadan fasting is a potential risk factor for DKA.

Keywords: Diabetic ketoacidosis, fasting, incidence, KSA, Ramadan

How to cite this article: Alshahrani M, Alraddadi A. Incidence of diabetic ketoacidosis during Ramadan compared with non‑fasting months in King Saud Medical City, Riyadh, Saudi Arabia. J Family Med Prim Care 2022;11:3905‑8.
with fasting and developing a life-threatening condition called DKA, especially for people with type 1 DM, which can eventually cause death (if left untreated). Because fasting involves long hours without food and water, the body may run out of energy, thereby breaking down fat cells, producing ketones. The hormonal disequilibrium may also result in conditions such as hyperglycemia, lipolysis, and DKA. However, in the Epidemiology of Diabetes and Ramadan (EPIDIAR) study, 43% of type-1 diabetics and 86% of type-2 patients managed to fast for a mean of 23 and 27 days, respectively.[1] It is, therefore, of utmost importance that we identify people most at risk of developing this condition during Ramadan as it is generally thought to increase during the fasting month.[3]

For devout Muslims, fasting is a means to enable them to be pious and purify their souls. They neither drink nor eat, putting them at a greater risk of developing DKA. Our body, like a machine, requires fuel to run. Fuel for the body is insulin, which takes the glucose present in the blood and uses it as an energy source. During Ramadan, when diabetic people do not eat nor drink for long periods, their glucose levels go up, the insulin in their body is unable to use the glucose as fuel. Therefore, it starts breaking the fat cells in the body to use as energy, not requiring glucose, and then ketones are produced, making the blood acidic, leading to DKA. As it is a month-long practice, the usual belief is that the cases of DKA will rise during Ramadan. The reality is quite different. For instance, Kadiki reported that only 2.5% of Libyan diabetics in one study developed DKA during Ramadan fasting,[10] similarly in another study. Abusreiwil stated that 1.8% of type-1 patients developed DKA during Ramadan fasting figures that are comparable with non-fasting months.[4]

**Methodology**

To obtain knowledge of the effect of fasting on the occurrence of one of the acute complications of diabetes, which is diabetic ketoacidosis (DKA), we measured the frequency of DKA in the fasting month (Ramadan) and compared it to other months, and we took an example of that 1 month before Ramadan (Sha’aban) and 1 month after (Shawwal). The study was conducted at the level of King Saud Medical City for the year 1441 Hijri (2020); a retrospective study of the records of all adult patients admitted due to DKA in KSMC was done. The age of 15 years was chosen as the minimum age for those included in the study as it is the minimum age for adults expected to fast.

We analyzed these parameters: age, gender, type of diabetes, presence of severe DKA, duration of diabetes, precipitating factors, duration of symptoms before attending to emergency, length of hospitalization, biochemical findings at presentation (plasma glucose level, presence of ketones in urine, venous blood PH, and bicarbonate (HCO₃⁻)).

The serum potassium and sodium levels were measured. In addition, vital signs were analyzed (pulse rate, respiratory rate, systolic and diastolic blood pressure, temperature, and O₂ saturation).

The diagnostic criteria used to diagnose DKA in our study was the same as is mentioned in American guidelines: plasma glucose concentration of >250 mg/dL, pH of <7.30, bicarbonate of ≤18 mEq/L, and presence of ketonuria (2+ or more).[1] The severity of DKA was defined as follows: mild DKA can be categorized by a pH level of 7.25–7.3 and a serum bicarbonate level of 15–18 mEq/L; moderate DKA can be categorized by a pH of 7.0–7.24 and a serum bicarbonate level of 10–15 mEq/L; and severe DKA has a pH of <7.0 and a serum bicarbonate level of <10 mEq/L.[1]

The data were analyzed using SPSS 25.0 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) and Med Calc for Windows, version 15.0 (Med Calc Software, Ostend, Belgium). The categorical variables were presented for 3 months in frequency and percentage, and Chi-square test was used to test the association among the proportions of Sha’aban and Ramadan and Shawwal. The continuous variables were presented as mean and standard deviation, and t test was used to find if the mean difference between the months were statistically significant at 5% level.

**Results**

The total number of admitted patients with DKA in King Saud Medical City during 3 lunar months in 1441 were 51 patients as adults (15 years and above). Nineteen DKA episodes (37.3%) occurred during Ramadan, 8 DKA episodes (15.7%) occurred 1 month before Ramadan (Sha’aban), and the remaining 24 episodes (47%) happened 1 month after (Shawwal). When we compared the frequency of DKA events between Sha’aban and Ramadan and Shawwal, we found a significant increase in the number of DKA patients in Ramadan compared with Sha’aban but with fewer DKA episodes in Ramadan compared to Shawwal ($P < 0.019$) [Table 1]. The highest number of events was in Shawwal [Table 1]. The gender of the patients did not alter between male and female ratio in Ramadan compared with other months. Also, more people with DKA during the 3 months had type 1 diabetes compared to type 2. Severe DKA events occurred in Ramadan and Shawwal, in close rates compared to Sha’aban, which was less, reflected by the fact that the hospital stay during Ramadan and Shawwal was significantly higher compared with Sha’aban [Table 2].

There was no mortality among all DKA patients in our study.

Regarding the other parameters, there were no significant differences during the three months, which included the blood glucose, PH, HCO₃⁻, serum sodium, serum potassium, and vital signs (pulse rate, respiratory rate, BP, O₂ sat, and temperature).

The most common precipitating factor for DKA during Ramadan was missed insulin dose (47.4%), followed by
Alshahrani and Alraddadi: Incidence of diabetic ketoacidosis during Ramadan compared with non‑fasting months

Infection (31.6%), with a similar situation in Sha’aban. The most common precipitating factor for DKA in Shawwal was infection and significantly differed compared with other months [Table 3]. The number of DKA patients precipitated by infection in Shawwal reached 16 (66.8%) \((P = 0.002)\). The most commonly encountered infection was COVID-19 (54.2%), followed by bacterial pneumonia and upper respiratory infection and urinary tract infection as (4.2%) for each of them.

**Discussion**

During the period of our study, there was a significant increment in DKA cases in Ramadan compared to Sha’aban cases (more than double), and even more increment in Shawwal. This significant increment during Ramadan may support the argument that prolonged fasting increases the risk of DKA as dehydration is more common during Ramadan, especially if Ramadan is in the summer months. However, the increase in the cases during Shawwal is a sign of the presence of some other important factors that could increase DKA cases, especially as the most common trigger agent of DKA in Shawwal was COVID-19.

When looking at other studies, we find that in the EPIDIAR study, the number of severe hyperglycemia episodes with or without ketoacidosis per month showed a significant difference between Ramadan and preceding year only for patients with type-2 DM and higher incidence of DKA during Ramadan but not statistically significant.[1]

A similar study was conducted in UAE and published in 2015 with similar findings. That study found that DKA frequencies at Ramadan were significantly higher than the average frequency of DKA cases the prior six months \((P = 0.05)\), and DKA frequencies of Shawwal were even higher than Ramadan DKA frequencies. Moreover, it was noticed that the average hospital stay period during Ramadan was significantly longer than that during Shawwal \((P = 0.04)\). Infection was the main precipitating factor for ketoacidosis during their study period.[6] It is worth mentioning that fasting in Ramadan may have caused glycemic uncontrolled to some extent. However, carelessness and non‑adherence to diet and treatment plan at the beginning of Shawwal (Eid time) may explain the reason why Shawwal was higher cases than Ramadan. To be more confident about this point, more extensive studies must be conducted in the future to find out to what extent poor glycemic control is leading to other complications, such as DKA.

Our study is in line with the DKAR international study that included more than one country in 2016. This study showed an increase in the number of DKA cases of Ramadan

| Table 1: Characteristics of adults DKA events during the study duration |
| --- |
| **Factor** | **Level** | **Month** | **P** |
| | | Sha’aban | Ramadan | Shawwal |
| Number/month | Episodes/month | 8 | 19 | 24 | 0.019 |
| Gender | Male | 5 | 14 | 15 | 0.804 |
| | Female | 3 | 5 | 9 | |
| Type of DM | Type I | 7 | 17 | 17 | 0.269 |
| | Type II | 1 | 2 | 7 | |
| Severe DKA | No | 5 | 11 | 15 | 0.832 |
| | Yes | 3 | 8 | 9 | |

| Table 2: Other parameters of adults DKA events during the study duration |
| --- |
| **Factor** | **Month** | **P** |
| | Sha’aban Mean±SD | Ramadan Mean±SD | Shawwal Mean±SD |
| Duration of DM | 6±2.63 | 4.95±1.14 | 4.21±0.9 | 0.461 |
| Duration of symptoms | 2.889±2.421 | 2.444±1.977 | 2.583±2.358 | 0.889 |
| Length of hospitalization | 2.88±0.5 | 5.42±1.47 | 8.2±1.5 | 0.001 |
| Glucose | 474.889±108.879 | 432.833±138.419 | 437.125±94.781 | 0.639 |
| PH | 7.104±0.113 | 7.064±0.281 | 7.111±0.159 | 0.756 |
| HCO₃ | 11.3±3.613 | 10.161±3.512 | 9.833±3.639 | 0.581 |
| Na | 134.444±4.304 | 136.556±6.896 | 135.542±9.017 | 0.700 |
| K | 4.678±0.959 | 4.784±0.987 | 4.234±1.126 | 0.221 |
| P | 115±6.4 | 113.778±4. | 118.333±3.7 | 0.705 |
| RR | 22.111±3.79 | 22.711±4.27 | 24.167±4.249 | 0.356 |
| SBP | 137.444±23.265 | 131.889±21.644 | 125.75±17.696 | 0.302 |
| DBP | 83.667±11.779 | 82.278±11.524 | 78.208±13.108 | 0.416 |
| O₂ sat | 96.778±2.728 | 94.889±6.48 | 94.542±8.632 | 0.725 |
Limitation
Although King Saud Medical City is the largest hospital in Riyadh affiliated with the Ministry of Health, the sample of the study is relatively small. The scope and time range of future studies must be expanded to include most Riyadh hospitals for several years to compare the incidence of ketoacidosis in Ramadan to the rest of the lunar months.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References
1. Salti I, Bénard E, Detournay B, Bianchi-Biscay M, Le Brigand C, Voinet C, et al. A population-based study of diabetes and its characteristics during the fasting month of Ramadan in 13 countries: Results of the epidemiology of diabetes and Ramadan 1422/2001 (EPIDIAR) study. Diabetes Care 2004;27:2306-11.
2. Sulimani RA, Famuyiwa FO, Laajam MA. Diabetes mellitus and Ramadan fasting: The need for a critical appraisal. Diabet Med 1988;5:589-91.
3. Kadiki O, Moawad S, Khan Z, Reddy M, Marzoug A. Diabetes mellitus and Ramadan. Garyounis Med J 1989;12:32-4.
4. Zabeen B, Nahar J, Ahmed B, Islam N, Azad K, Donaghue K. High HbA1c is not a reason not to fast during Ramadan in children, adolescents and young adults with type 1 diabetes-An observational study in Bangladesh. Diabetes Res Clin Pract 2021;173:108673.
5. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. Diabetes Care 2009;32:1335-43.
6. Abdelgadir E, Hafidh KA, Bashier A, Afandi B, Alawadi F, Rashid F, et al. Comparison of incidences, hospital stay and precipitating factors of diabetic ketoacidosis in Ramadan and the following month in three major hospitals in United Arab Emirates. A prospective observational study. J Diabetes Metab 2015;06. doi: 10.4172/2155-6156.1000514.
7. Tong CV, Yow HY, Noor NM, Hussein Z. Diabetes emergencies around Ramadan study (DEARS)-A multi-center study of diabetes emergencies admitted before, during and after Ramadan in Malaysia. Diabetes Res Clin Pract 2021;175:108854.
8. Elmehdawi R, Elmhida M, Elmagrehi H. Incidence of diabetic ketoacidosis during Ramadan fasting in Benghazi-Libya. Oman Med J 2009;24:99-102.
9. Beshyah AS, Beshyah SA. The incidence of diabetic ketoacidosis during Ramadan fasting: A 10-year single-centre retrospective study. Diabetes Res Clin Pract 2019;150:296-300.