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The incidence of diabetic ketoacidosis during Ramadan fasting: A 10-year single-centre retrospective study

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ABSTRACT

Context: There has been an increased interest in the potential metabolic derangements and acute complications of diabetes related to the Muslims' fasting during the month of Ramadan.

Objectives: We compared the incidence of admissions due to diabetic ketoacidosis (DKA) during Ramadan with the admissions during other months.

Methods: This is a retrospective electronic database and chart review study that included all Muslims who were admitted with DKA to Sheikh Khalifa Medical City in Abu Dhabi, United Arab Emirates. We explored the relationship of admissions to Ramadan over ten years (2005–2014).

Results: There were 432 episodes of DKA involving 283 patients. Of these, 370 episodes (85.6%) involved 231 patients (81.6%) with type 1 diabetes. The number of admission episodes was not different during Ramadan from the average calendar month [3.6 ± 2.6 (Range 0–15) episodes/month versus 3.3 ± 2.1 (Range 1–7) episodes/month respectively, P = 0.77]. No recurrences of admissions were observed during Ramadan. There was a non-significant numerical tendency for more episodes in March and September (4.6 episodes for both) and fewer episodes in July (2.6 episodes) than other months; P values were 0.06; 0.13, and 0.32 respectively. This seasonality was not related to the month of Ramadan.

Conclusions: The present study confirmed that DKA admissions during Ramadan were not significantly higher than the average monthly admissions over ten years. Seasonality trends were not related to Ramadan.

1. Introduction

Ramadan is the ninth month of the Islamic lunar calendar. Fasting during Ramadan is observed by Muslims worldwide. Ramadan lasts 29–30 days and Muslims fast for 14–18 h a day [1]. Fasting is obligatory for adult Muslims, but sick people, travellers, those who cannot tolerate it, or those who

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may have any considerable health risk from fasting are exempt from fasting [1].

Medical and religious institutions have recently come to common understanding and harmony on medical aspects of Ramadan fasting [2]. These have resulted in a widely-based consensus on the stratification of health risks from fasting to 3 or 4 levels [3–5]. However, many people with chronic illnesses like diabetes mellitus (DM) are so passionate about fasting that they may find it unacceptable not to observe the fast. In a large epidemiology study, 43% of type 1 DM and 86% of type 2 DM patients managed to fast a mean of 23 and 27 days respectively [6].

There are widely accepted expert opinions, and professional guidance's that patients with a recent history of DKA and hyperosmolar hyperglycaemic states within the three months before Ramadan and patients with poor glycaemic control are counted as a "high risk" group to avoid recurrence during Ramadan [3–5]. However, studies on the incidence of DKA leading to hospital admissions are limited in number and duration [7–11]. Therefore, we aimed to investigate the risk of DKA during Ramadan by comparing the incidence of hospitalizations due to DKA during Ramadan with the frequency of admissions during other months of the year as control data.

2. Materials and methods

The study was a retrospective analysis of electronic database and review of charts of all patients with DKA admitted to a single tertiary centre (Sheikh Khalifa Medical City, Abu Dhabi, UAE) over ten years (01/01/2005–31/12/2014) to capture admissions during the months of Ramadan occurring in the Hijri years 1426 to 1435. Patients were identified through electronic record search using ICD 9 codes 250.1, 250.11, 250.12, 250.13. The number of admissions per calendar month was determined. Also, the dates corresponding to the month of Ramadan were identified and the number of admissions occurring during the month of Ramadan was identified.

There were a total of 460 episodes of DKA during the study period. Of these, 432 incidents of DKA were related to Muslim patients (283) identified by their demographic and personal information. In a retrospective study, it was not possible to establish whether the Ramadan admissions were fasting or not with any level of confidence. We made the assumption that all the patients were fasting or socially following the lifestyle pattern of fasting individuals.

The 432 episodes and 283 patients formed the basis of the present study. Records were de-identified and analysed anonymously. Data were downloaded and exported as a spreadsheet (Microsoft Corp. USA), and the statistical calculation was done using descriptive analysis. Differences were explored using non-parametric analysis (Mann-Whitney *U* test) and a P value of <0.05 was considered significant. The seasonal trend was explored by calculating the average admissions per calendar month over the 10-years. The relationship of admissions to Ramadan fasting was examined by comparing the number of admissions during Ramadan to the number of admissions per calendar month over the ten years.

3. Results

The demographic and clinical characteristics of the study population are summarised in Table 1. Of the 432 episodes of DKA involving 283 Muslim patients, 370 episodes (85.6%) included 231 patients (81.6%) with type 1 DM.

During the study period, Ramadan moved progressively forwards by an average of 10–11 days per the calendar year from 5.10.2005 - 2.11.2005 to 29.6.2014–27.7.2014 (based on https://habibur.com/hijri/). The temporal trend of the admissions (seasonality) over the calendar months are shown in Fig. 1. There was a numerical tendency for more episodes in March and September (4.6 episodes for both) and fewer episodes in July (2.6 episodes) than other months. However, this did not reach statistical significance with P values being 0.06; 0.13, and 0.32 respectively by Two-sample Mann–Whitney U Test. This seasonality was not related to the month of Ramadan.

The number of total admission episodes per year, number of DKA episodes admitted during Ramadan and the corresponding monthly average admissions per calendar month are shown for the individual ten years of the study period are shown in Fig. 2. There was a numerical trend of higher DKAs in total and during Ramadan as the years advanced. The Emirate of Abu Dhabi population also increased in the same duration from 1,374,169 (2005) to 2,656,448 (2014).

The number of admission episodes was not different during Ramadan from the average calendar month [3.6 ± 2.6 (Range 0–15) episodes/month versus 3.3 ± 2.1 (Range 1–7) episodes/month respectively; U-value 568, Z-score was 0.275, $P = 0.78$ by two-sample Two-tailed Mann–Whitney U Test]. Most patients (225) were admitted with DKA on a single occasion only during all the study period, whereas 31 were admitted twice, 15 were admitted three times and 12 were admitted between 5 and 15 times. However, no recurrences were observed during Ramadan.

4. Discussion

The present study aimed to compare the risk of DKA during Ramadan with that during other months using a different model from the previously reported studies. The study was conducted (a) over a substantially long duration, (b) in a single

Table 1 – The demographic and clinical characteristics of the study population.

Details	Number	Percentage or (range)
Mean age (years)	27.1	Range: 6–85
Gender (male/female)	192/240	44.4%/55.6%
Ethnicity:		
UAE nationals	274	63.4%
Non-UAE Arabs	112	25.9%
Asians	27	6.3%
Others	19	4.4%
Length of stay (days)	4.2	1–56

Data are presented for all the Muslim patients admitted in DKA during the ten year study period.

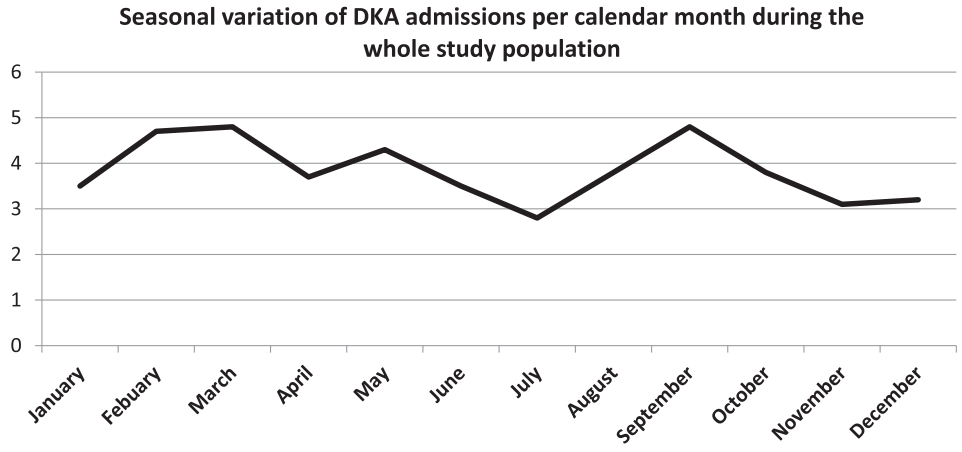

Fig. 1 – The seasonal relationship of admission for diabetic ketoacidosis per calendar month throughout the ten years of the study. X-axis shows the months of the calendar year and the Y axis shows the mean number of admissions per month.

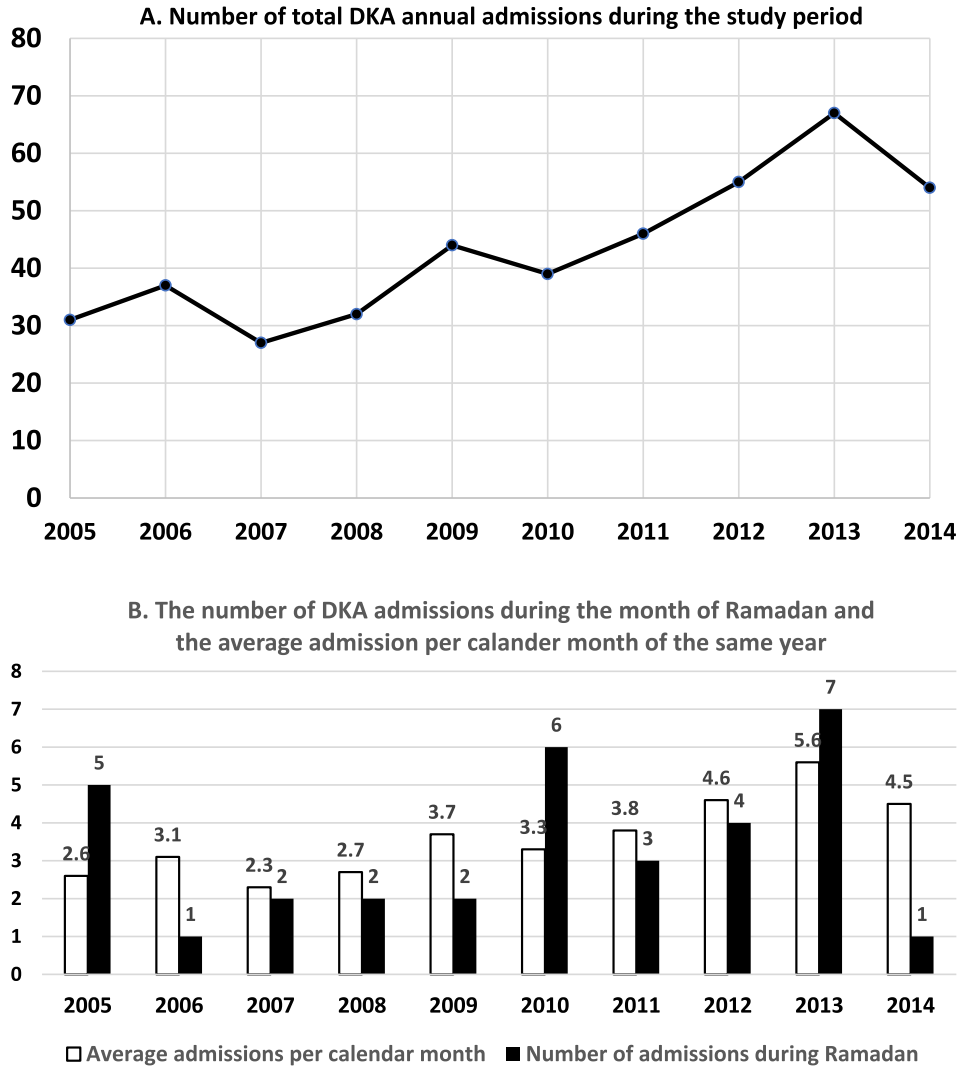

Fig. 2 – The frequency of DKA admissions during the study period: (A) all DKA are shown per calendar year and (B) number of DKA admissions during the month of Ramadan contrasted to the average DKA admission episodes per calendar month of the same year.

centre with rigorous documentation of all admission processes, and (c) in a region with a prevalent native Muslim population and high prevalence of diabetes. Such differences enrich the literature and lend support to the previously published studies suggesting the lack of substantial evidence of enhanced risk of DKA by the changes in lifestyle and medication during Ramadan [7–11]. The results are plausible with the fact that the pathogenesis of DKA requires more than a modest reduction of doses of inulin [12,13], particularly when new insulin preparations of better action profiles [14–16] and more modern modes of delivery such insulin pumps which showed favourable results in children and adults [16–21]. Notwithstanding, pre-Ramadan management education on insulin dose reduction and avoidance night over-eating remains the main focus of pre-Ramadan clinic visits emphasized in the recent guidelines (3–5).

The risk of severe hyperglycaemia and DKA has long been thought to be greater during Ramadan [5–7]. This was proposed in the early writings [22,23] and reiterated ever since. Perhaps, this was suggested from first principles due to an overzealous reduction in insulin doses in the daytime, compensatory overeating in the night time, and the hormonal disequilibrium precipitated by related illnesses in an unfavourable metabolic environment. However, limited actuarial data are showing an increase in the incidence of DKA during Ramadan. Indeed, the evidence so far suggests the opposite. For instance, Kadiki et al. [7]. from Benghazi, Libya reported that only 2.5% developed DKA during Ramadan. Similarly, Abusreiwil et al. [8] from Tripoli, Libya, reported that 1.8% of diabetic children and adolescents developed DKA during Ramadan, a rate similar to that observed in non-Ramadan months in their institution. Another study from Libya concluded that the incidence of DKA during Ramadan was significantly less than during other lunar months [9]. More recently, the “DKA Ramadan International” found higher rates of DKA during Ramadan when compared to preceding Lunar month. However, the rates of DKA admission in the following lunar month were higher than the average monthly DKA admissions [10]. The authors provided no clear explanation for their observation. Al-Alwan et al. found no cases of DKA patients with type 1 DM aged 8–14 years who fasted Ramadan [11].

We presented our data based on the average per year. Other workers chose to compare between Ramadan and the months around it [9,10]. In a long study period like the present study, it may be argued that a difference of DKA between winter and summer may occur. However, in an area like the UAE, a differences in weather is hardly evident. It is a mere quantitative rather than qualitative difference. We have chosen to focus on the Ramadan versus the whole calendar year rather than the short term model that was used in other studies and may be complicated by the smaller numbers. The greater DKA rates in March and September compared to other months albeit not statistically significant, are intriguing. Whereas September rates could be related to the return of many youngsters to schools after the summer holiday by many expatriates, we have no plausible explanations for the March rates since there are no changes in weather or lifestyle over this period.

The present study has some noteworthy limitations. It included patients from a single center thus participants may not be representative of others elsewhere. However, this allowed uniformity of the study population. Also, it was a retrospective study where it was assumed that all adult Muslims would be observing the fasting during Ramadan. This assumption is very likely to be a safe one based on several previous studies demonstrating the high passion to observe the fast. Attempting to extract actual information from the present study on this issue would have produced patchy data, and non-verifiable conclusions not supported by this study design. However, the large sample size and the long duration make it the most extended study ever that evaluated the incidence of DKA in Ramadan. We have concentrated on investigating the numerical scale of the problem and the time relationships of DKA to Ramadan fasting. We did not engage in studying the metabolic changes in detail as this would not have been reliable nor readily feasible.

In conclusion, the present study demonstrated that the rates of admission due to DKA were not significantly different from the average monthly DKA admissions over a very long period. However, the mere number of cases calls for more intensive and focused education during and outside Ramadan targeting both patients and health care professionals [24–27]. However, to elucidate responsible risk factors and pathogenic mechanisms, prospective studies that capture detailed information on clinical, and social factors before, during and after Ramadan are required to identify patients at risk of DKA during Ramadan. These projects should be undertaken by committed and research fellows/assistants who should interview patients, families and capture all minute details to enable developing hypotheses and testing them. There is a clear evidence that Ramadan fasting research is still in its infancy both in volume and depth [28]. Initiatives of such culturally-sensitive research should be led by academic institutions in Muslim-majority regions in collaboration with researchers with long track record of research and expertise in the subject [29,30].

5. Authors’ contribution

Study concept and design: SAB and ASB; Data collection and analysis and drafting of the manuscript: ASB; Review of data and further development of the Manuscript: SAB.

Both authors approved the final manuscript.

6. Compliance with ethical principles

Ethical approval was granted by the Institutional Review Board of SKMC, Abu Dhabi, UAE. Data were extracted and analysed anonymously.

7. Availability of data and materials

All de-identified data are available in an excel spreadsheet (MS Office). Please contact the corresponding author for data requests.

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Nil.

Conflict of interest

ASB has no conflicts of interests. SAB received speaker's honoraria from several industrial and professional bodies (AACE Gulf Chapter, Novo Nordisk, Eli Lilly, MSD, Novartis, Pfizer, Servier). None of which are related to this research even remotely.

SAB and ASB are father and son working in the same institution in a trainer-trainee relationship.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2019.01.018.

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