

# Incidence of Diabetic Ketoacidosis during Ramadan Fasting in Benghazi-Libya

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## Abstract

**Objectives:** Ramadan is the ninth month on the lunar calendar and it is a holy month for Muslims during which all healthy adults must fast from dawn to sunset. The risk of diabetic ketoacidosis is thought to be higher during Ramadan fasting due to insulin and glucagon alterations.

**Methods:** A descriptive retrospective analysis of the records of all patients admitted with diabetic ketoacidosis to all Benghazi hospitals during the lunar year 1428 Hijri (2007-2008).

**Results:** Fifteen episodes occurred during Ramadan compared to a mean of 19.45 episodes/month during the other lunar months ( $p < 0.001$ ), and there was no significant difference in the mean age ( $37.6 \pm 10$  vs.  $38.3 \pm 19$ ,  $p = 0.8$ ), mortality rate (13.3% vs. 14.4%,  $p = 0.9$ ) or in the length of hospitalization during Ramadan. The commonest precipitating factor for diabetic ketoacidosis during

Ramadan was infection (46.6%) followed by miss dosing.

**Conclusion:** There was no increase in the incidence and mortality from DKA during Ramadan which might indicate that Ramadan fasting is not a significant risk factor for diabetic ketoacidosis.

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Received: 24 Dec 2008

Accepted: 12 Feb 2009

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Elmehdawi R, et al. *OMJ*. 24, 99-102 (2009); doi:10.5001/omj.2009.23

## Introduction

Ramadan is the ninth month on the lunar calendar and for Muslims it is a holy month during which all healthy (mentally and physically) adults must fast during day time. Fasting in Islam means absolute self-restraint from food, drink and sex from dawn to sunset which is not a very difficult duty for healthy subjects nevertheless, it might be difficult or impossible for sick people to cope with fasting, therefore by the mercy of Allah they were exempted from fasting Ramadan.

However, people with chronic illnesses like diabetes mellitus (DM) find it psychologically unacceptable not to fast and they do not agree to be considered as ill people, therefore they usually attempt to fast and on most occasions they succeed, for instance in Epidimiology of Diabetes and Ramadhan (EPIDIAR) study, 43% of type-1 diabetics and 86% of type-2 patients managed to fast a mean of 23 and 27 days respectively.<sup>1</sup> The risk of Diabetic Ketoacidosis (DKA) is thought to be higher during Ramadan (at least theoretically) as fasting will result in hypoinsulinemia and hyperglucagonemia, this hormonal disequilibrium favouring hyperglycemia, lipolysis and ketone body formation and eventually development of DKA.<sup>2</sup>

However, this remains just a speculation as there are no studies showing that the incidence of DKA is actually increased during Ramadan, as a matter of fact there are some evidence against this assumption. For instance, Kadiki reported that only 2.5% of Libyan diabetics in one study developed DKA during Ramadan fasting, similarly in another study; Abusreiwil reported that 1.8%

of type-1 patients developed DKA during Ramadan fasting figures that are comparable with non fasting months.<sup>3,4</sup>

## Methods

To address the study question, an estimate of the frequency of DKA during Ramadan was formulated in order to compare it with the frequency in other lunar months.

The study was carried out in Benghazi, the second largest city in Libya with an estimated 32,000 registered diabetics. A retrospective analysis of the records of all patients admitted with DKA to all Benghazi hospitals (3 governmental and 4 private hospitals) between Moharam (the 1st month on the lunar calendar) 1428 Hijri and Thulhajja (the last month on the lunar calendar) 1428 Hijri (January 2007 to January 2008) was performed. The age of 15 years old was chosen as a cut off to classify patients as adults "who are expected to fast during Ramadan".

The following parameters were analyzed: age, gender, duration of diabetes, precipitating factors, duration of symptoms before seeking medical advice, laboratory findings at presentation including; plasma glucose, serum Urea, sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), urine acetone, arterial blood pH, and bicarbonate (HCO<sub>3</sub><sup>-</sup>). The length of hospitalization and the outcome were also noted. Patients were classified as having type 1 or type 2 diabetes based on their previous diagnosis. The criteria used to diagnose DKA in the study patients was; hyperglycemia =250mg/dl, pH<7.3, and/or serum bicarbonate =18mmol/l as well as the presence

of ketonuria (2+ or more).<sup>5,6</sup> The severity of DKA was defined according to the American diabetes association (ADA) criteria as; mild: pH 7.25-7.30, moderate: pH 7.24-7, and severe: pH<7.<sup>5,6</sup> The data was statistically analyzed using the Statistical Package for the Social Sciences (Windows version 11.0; SPSS Inc, Chicago [IL], US). Differences between groups were tested statistically using the Chi squared test and independent-samples t-test. Differences were considered statistically significant when the p-value was less than 0.05.

## Results

During the lunar year 1428, there were 270 admissions in Benghazi due to DKA episodes, 217 (80.37%) of them were adults (15 years or older), from which 15 episodes occurred during Ramadan (4.6 episode/10 000 diabetics) which is significantly less than the mean of 19.45 episodes/month (6 episode/10,000 diabetic/month) during the other lunar months (p-value<0.001) (table 1). The male and female ratio did not vary during Ramadan compared to other

lunar months. There was no significant difference in the mean age (37.6±10 vs. 38.3±19, p=0.8), mortality rate (13.3% vs.14.4%, p=0.9) or the length of hospitalization during Ramadan. However, DKA patients during Ramadan had a slightly higher rate of co-morbidity (33.3% vs. 22%, p=0.2) and more severe episodes. The commonest precipitating factor for DKA during Ramadan was infection (46.6%) followed by miss dosing (33.3%) while in other lunar months the commonest precipitating factor was miss dosing while infection ranked 3rd (table 2). The commonest encountered infection was upper respiratory tract infection (42.2%), followed by urinary tract infection (26.6%) and lower respiratory tract infection (13.3%). There was no significant difference between DKA episodes during Ramadan and DKA episodes during other lunar months with regards to pulse rate, respiratory rate, blood pressure, plasma glucose, serum sodium, serum potassium, urea, and blood pH (table 1) although DKA patients during Ramadan presented a slight “non-significant” increase in plasma glucose, serum sodium and urea.

**Table 1:** Characteristics of adult DKA episodes during the lunar year 1428

Findings	Ramadan	Other months	p-value
Number of episodes/month	15	202 (19.45/month)	<0.001
Number of episodes/day	0.5	0.61	<0.001
Mean age ± SD (years)	37.6±10	38.3±19	0.8
Mean DM duration ± SD (years)	8.5±6	6.6±6	0.3
Male : female ratio	1.1:1	1.05 :1	0.8
Rate of Type-1 DM	71 %	65 %	0.6
Rate of Co-morbidity	33.3 %	22 %	0.3
ICU admission rate	25%	37%	0.18
Rate of severe DKA	26.6%	16.8%	0.3
Mortality rate	13.3%	14.4	0.9
Mean duration of symptoms ± SD (days)	3.9±3.1	4.9±4	0.6
Mean hospitalization ± SD (days)	6.2±4.2	5.7±5.2	0.7
Mean PR ± SD (beat/minute)	95±17	101±16	0.2
Mean SBP ± SD (mmHg)	116±22	116±29	0.9
Mean DBP ± SD (mmHg)	71±14	71±18	0.8
Mean RR ± SD (cycle/minute)	32±10	29±9	0.3
Mean plasma glucose ± SD (mg/dl)	532±112	499.5±105	0.25
Mean serum sodium ± SD (mmol/l)	136±10	133±7.7	0.23
Mean serum potassium ± SD (mmol/l)	4.5±0.7	4.6±1	0.5
Mean serum Urea ± SD (mg/dl)	55±48	46±33	0.3
Mean arterial pH ± SD	7±0.14	7.1±0.13	0.3

SD= Standard Deviation; DM= Diabetes Mellitus; ICU= Intensive Care Unit; DKA= Diabetic Ketoacidosis; PR= Pulse Rate; SBP= Systolic Blood Pressure; DBP= Diastolic Blood Pressure; RR= Respiratory Rate.

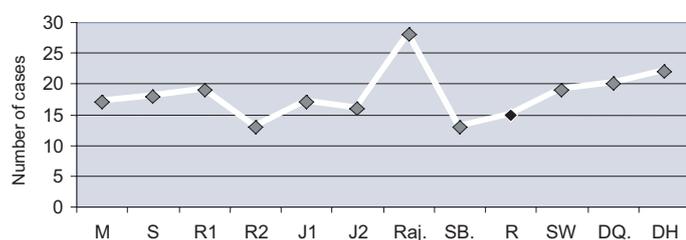
**Table 2:** Frequency of different precipitating factors

Precipitating factors	Ramadan	Other months	p-value	All months
Infection	7 (46.6%)	37 (18.3%)	0.008	20.2%
Miss dosing	5 (33.3%)	80 (39.6%)	0.5	39.2%
No obvious cause	2 (13.3%)	30 (14.8%)	0.9	14.7%
1 <sup>st</sup> presentation	1 (6.6%)	42 (20.8%)	0.2	19.8%
Others	0%	13(6.4%)	0.3	6%
Total	15	202	217	100%

## Discussion

DKA episodes in adults during the lunar year 1428 Hijri accounted for about 80% of all DKA episodes in Benghazi. Contrary to the general belief that DKA is expected to increase during Ramadan, particularly in those with type-1 DM, this study showed that there is no increase in the incidence of DKA during Ramadan (figure 1), as a matter of fact the incidence during Ramadan was significantly lower than the incidence during the other lunar months.<sup>1,2</sup> The reason behind this is not clear, however one explanation might be because the diabetics prefer not to lose a day of fasting so they try to improve their glycemic control during Ramadan and this was reflected by the frequency of DKA recorded. Moreover, the mortality rate and the length of hospitalization during Ramadan did not differ from those during other lunar months despite that, the two groups of patients were of equivalent mean of age, and both groups presented a similar rate of co-morbidity and an equal chance of being managed at an intensive care unit (table 1).

M= Moharam, S= Safar, R1= Rabie-1, R2= Rabie-2, J1= Jumada-1, J2= Jumada-2, Raj=Rajab, SB= Shaban, R= Ramadan,



SW= Shawal, DQ= Dhulqada, DH= Dhulhajja

**Figure 1:** Distribution of the episodes according to the lunar months

One might argue that there was no increase in DKA incidence during Ramadan simply because most diabetics do not fast during Ramadan, but this was not the case as Libyan diabetics fast for a mean of 28.5±4.6 out of the 30 days.<sup>7</sup> Similarly, Abusrewil et al reported from Libya that 87% of type-1 patients finished 30

days of fasting during Ramadan.<sup>4</sup> Surprisingly the most common precipitating factor for DKA during Ramadan was concurrent infection not dose reduction as one might expect, however dose reduction could still be an important cofactor even in those with infection as it would not be unusual for diabetics to reduce their doses during Ramadan in order to avoid hypoglycemia during day time.<sup>1,7</sup> The dose reduction alone may not be enough to precipitate DKA during ordinary conditions but when such patients have an acute infection, their usual doses become insufficient to meet the stress demands induced by raised catecholamines and steroids, therefore if these patients fail to adjust their insulin requirements they slide into DKA. Despite not being statistically significant DKA episodes during Ramadan were more frequently severe and patients had a higher serum sodium and urea indicating a tendency towards a more severe degree of dehydration. Nevertheless these differences did not generally affect the outcome adversely.

## Conclusion

Contrary to the general belief that DKA is expected to increase during Ramadan, this study showed that there was no increase in the incidence of DKA during Ramadan. Furthermore, the current study demonstrated that neither the mortality nor the length of hospital stay was increased during Ramadan. These findings suggest that diabetics can safely fast during Ramadan without an increased risk of diabetic ketoacidosis provided that they are well educated and their insulin doses and blood glucose levels are properly adjusted and monitored during fasting.

## Study limitations

The small number of episodes during Ramadan made it difficult to compare the minor differences between means to assess the significance. Hence, studies with larger number of patients are recommended.

## Acknowledgments

The authors reported no conflict of interest and no funding has been received on this work.

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