

Outcomes and hospital admission patterns in patients with diabetes during Ramadan versus a non-fasting period

Abdulwahab Elbarsha,^{ab} Maisoon Elhemri,^a Sami A. Lawgaly,^a Ashraf Rajab,^a Badia Almoghrabi,^a Rafik Ramadan Elmehdawi^{ab}

From the ^aDepartment of Medicine, Benghazi Medical Center, Benghazi, Libya; ^bDepartment of Medicine, Faculty of Medicine, University of Benghazi, Benghazi, Libya

Correspondence: Dr. Abdulwahab Elbarsha · Department of Medicine, Benghazi Medical Center, Second Ring Road, Foyhat, Benghazi, Libya · elbarsha@hotmail.com · ORCID: <http://orcid.org/0000-0001-5973-308X>

Citation: Elbarsha A, Elhemri M, Lawgaly SA, Rajab A, Almoghrabi B, Elmehdawi RR. Outcomes in patients with diabetes admitted to the hospital during Ramadan versus a non-fasting period. *Ann Saudi Med* 2018; 38(5): 344-351. DOI: 10.5144/0256-4947.2018.344

Received: June 7, 2018

Accepted: September 12, 2018

Published: October 4, 2018

Copyright: Copyright © 2018, Annals of Saudi Medicine, Saudi Arabia. This is an open access article under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND). The details of which can be accessed at <http://creativecommons.org/licenses/by-nc-nd/4.0/>

Funding: None.

BACKGROUND: Fasting during Ramadan is a challenge for Muslim patients with diabetes and for their healthcare providers. However, data on the effects of Ramadan fasting on hospital admissions and outcomes in patients with diabetes are scarce.

OBJECTIVES: Evaluate the characteristics of patients with diabetes admitted during the fasting month of Ramadan compared with the non-fasting month of Dhu al-Qidah.

DESIGN: A retrospective cohort study medical record review.

SETTING: A university teaching hospital.

PATIENTS AND METHODS: We reviewed the records of all patients with diabetes admitted to the medical department at Benghazi Medical Center, including medical ward, intensive care unit and coronary care unit, during the months of Ramadan and Dhu al-Qidah, 2016. We compared differences in reasons for admission, length of stay and in-hospital mortality between patients admitted during Ramadan and Dhu al-Qidah and between patients who were fasting at time of admission during Ramadan and those who were not.

MAIN OUTCOME MEASURES: Main reason for admission, length of stay and in-hospital mortality rate.

SAMPLE SIZE: 402 patients with diabetes.

RESULTS: During Ramadan, 186 patients were admitted compared with 216 during Dhu al-Qidah. There was no statistically significant difference in reasons for admission, length of hospital stay, or in-hospital mortality (borderline for mortality, $P=.078$), between patients with diabetes admitted during Ramadan and Dhu al-Qidah. Of those admitted in Ramadan, 59.1% were fasting on admission. Fasting patients admitted during Ramadan had a significantly higher proportion of the diseases of the circulatory system when compared with non-fasting patients (39.4% vs. 23.6%, $P=.028$) while in-hospital mortality was higher in non-fasting patients (29.2% vs. 8.7%, $P<.001$). There was no significant difference in length of stay between fasting and non-fasting patients.

CONCLUSIONS: The frequency of admissions for most medical conditions were not changed during Ramadan but the frequency of acute coronary syndrome was higher in those who were fasting on admission. Patients with diabetes who were not fasting on admission had more high-risk features that prevented them from fasting and therefore are at increased risk of in-hospital mortality.

LIMITATIONS: Single center and retrospective.

CONFLICT OF INTEREST: None.

Ramadan is the ninth month of the Islamic lunar calendar. During this month Muslims abstain from eating and drinking from dawn to sunset. Ramadan lasts for 29-30 days and depending on the season and geographical latitude the fasting hours range from 12-18 hours a day. Although acutely ill patients and patients with chronic diseases that can be affected by fasting are exempt from fasting, studies in patients with diabetes showed that the majority of these patients choose to fast.^{1,2} Ramadan fasting is particularly a challenge to patients with diabetes and their healthcare providers. Numerous studies have evaluated the effect of Ramadan fasting on patients with diabetes, particularly in relation to incidence of metabolic complications including hypoglycemia, hyperglycemia and diabetic ketoacidosis (DKA).¹⁻⁴ Data on the effects of Ramadan fasting on hospital admissions patterns and outcomes in patients with diabetes are scarce. Previous studies in patients with diabetes evaluated the effects of Ramadan fasting on emergency department visits and admissions for specific conditions including acute coronary syndrome (ACS), stroke, seizures, and hypertension as well as metabolic complications.^{5,6} However, data on the impact of Ramadan fasting in patients with diabetes on total admission patterns and in-hospital outcomes are lacking.

This study aimed to evaluate the changes in disease admission patterns in patients with diabetes during the month of Ramadan and the in-hospital outcomes in terms of in-hospital mortality and length of stay as compared with a non-fasting month. It also compared differences in these patterns and outcomes between fasting and non-fasting patients with diabetes during the month of Ramadan.

PATIENTS AND METHODS

We reviewed the records of all patients with diabetes admitted to the medical department (medical ward, intensive and coronary care units) during the months of Ramadan and Dhu al-Qidah for the Muslim year 1437. Ramadan (the ninth month of Islamic calendar) started on 6 June in 2016 and ended on 5 July 2016, and Dhu al-Qidah (the eleventh month of Islamic calendar) started on 4 August 2016 and ended on 2 September 2016. We allowed a one intervening month as a wash out period for any effects of Ramadan fasting and to avoid the fact that many Muslims fast extra days (6 or more) during the month of Shawwal (the tenth month of Islamic calendar). Data collection included age, gender, reason for admission, place of admission (ward, intensive care or coronary care), duration of hospital stay, type and duration of diabetes, type of anti-diabetic

medications, comorbid conditions, presence of microvascular complications (diabetic nephropathy, retinopathy and neuropathy), fasting status of the patient, any history of outpatient visits or hospital admission during Ramadan, and the outcome of hospitalization (discharge or death). Reasons for admissions were categorized according to the 10th revision of the International Classification of Diseases (ICD-10) coding system.⁷ We used the term "metabolic complications instead" of the ICD category of "Endocrine, nutritional and metabolic diseases" since hypoglycemia, hyperglycemia and diabetic ketoacidosis (DKA) were the only conditions under this category encountered in our patients.

We performed two sets of statistical analyses. First, we compared differences in reasons for admission, length of stay and in-hospital mortality between patients admitted during Ramadan and those admitted during Dhu al-Qidah. Since not all patients admitted during Ramadan were fasting at time of admission, we performed a second set of analysis in which we compared the previous outcomes between those who were fasting and those who were not fasting during Ramadan.

Descriptive statistics and statistical analyses were performed using by IBM SPSS version 23.0. The chi-square test was used to compare differences in categorical variables with the Fisher exact test used as an alternative if one cell had an expected count less than 5. For continuous variables an unpaired t test was used to compare differences for normally distributed variables and Mann-Whitney test as an alternative for the non-normally distributed variables. A *P* value <.05 was considered significant.

RESULTS

Of 560 patients were admitted to medical department during Ramadan, 186 (33.21%) patients had diabetes. During the month of Dhu al-Qidah, 734 patients were admitted and 216 (29.42%) had diabetes (*P*=.145), proportion with diabetes admitted during each month). There was no statistically significant difference in mean age, gender distribution, place of admission (ward, intensive or coronary care units), duration of diabetes, frequency of comorbid conditions, diabetic microvascular complications, or any type of anti-diabetic medication use between those admitted during Ramadan and Dhu al-Qidah (**Table 1**). The frequency of type 1 diabetes patients admitted during Ramadan was higher than during Dhu al-Qidah (10.8% vs. 4.2%, *P*=.011). During Ramadan 20 patients with type 1 diabetes were admitted to the hospital. Eight (40%) were admitted because of DKA compared with 5 patients with DKA

Table 1. Characteristics of patients with diabetes admitted during the months of Ramadan and Dhu al-Qidah.

	Ramadan n=186	Dhu al-Qidah n=216	P
Age (mean, SD)	60.9 (15.7)	63.1 (14.9)	.119
Gender			
Females	107 (57.5)	126 (57.8)	.419
Place of admission			
Ward	115 (61.8)	140 (64.8)	.535
ICU	23 (12.4)	21 (9.7)	.397
CCU	48 (25.8)	55 (25.5)	.937
Length of stay (days) (mean, SD)	6.6 (4.8)	7.2 (5.1)	.255
Type of diabetes			
Type 1	20 (10.8)	9 (4.2)	.011
Type 2	163 (87.6)	205 (95.3)	.005
Gestational diabetes	2 (1.1)	1 (0.5)	.481
Secondary	1 (0.5)	0 (0)	.282
Duration of diabetes in years (mean, SD)	13.1 (10.2)	13.5 (10.0)	.621
Fasting patients	104 (59.1)	1 (0.5)	<.001
Pre-existing comorbidities			
Hypertension	112 (60.5)	136 (63.0)	.619
Coronary artery disease	46 (24.9)	61 (28.2)	.446
Heart failure	6 (3.2)	15 (6.9)	.097
Stroke	27 (14.6)	28 (13.0)	.636
Renal disease	25 (13.5)	28 (13.0)	.871
Asthma/COPD	7 (3.8)	9 (4.2)	.845
Liver cirrhosis	8 (4.3)	14 (6.5)	.344
Hypothyroidism	10 (5.4)	17 (7.9)	.326
Malignancy	7 (3.8)	13 (6)	.305
Pre-existing diabetic microvascular disease	14 (7.6)	8 (3.7)	.090
Mortality rate (%)	16.7	10.6	.078
Type of anti-hyperglycemic treatment at time of admission			
Insulin	90 (48.4)	95 (44.0)	.377
OHA	54 (29.0)	56 (25.9)	.486
OHA+insulin	18 (9.7)	21 (9.7)	.988

Values are number (percentage) unless indicated otherwise. CCU= coronary care unit, COPD= chronic obstructive pulmonary disease, ICU=intensive care unit, OHA=oral hypoglycemic agents, SD=standard deviation.

in 9 cases (55.6%) of type 1 diabetes admitted during Dhu al-Qidah ($P=.436$). During Ramadan, metabolic complications (hypoglycemia, hyperglycemia and DKA) were the most frequent reason for admission accounting for 32.8% of total admissions followed by diseases of the circulatory system which constitute 32.3% of total admissions. In Dhu al-Qidah, diseases of the circulatory system were the most frequent reason for admission (28.2%) followed by metabolic complications. Admissions due to ACS accounted for 63.3% and 49.2% of diseases of circulatory system during Ramadan and Dhu al-Qidah, respectively ($P=.116$). No statistically significant difference was found when comparing the frequency of different reasons for admission according to ICD-10 categories between Ramadan and Dhu al-Qidah (**Table 2**). There was also no statistically significant difference in length of hospital stay or mortality rate between those admitted during Ramadan and those admitted during Dhu al-Qidah (**Table 1**).

Among patients with diabetes admitted during Ramadan, 104 (59.1%) were fasting at the time of admission and 72 (40.9%) were not. The fasting status in 10 patients could not be verified and therefore they were excluded from the analysis. Patients who were not fasting were significantly older, more likely to be female, and have higher frequency of previous stroke, renal disease, liver cirrhosis, hypothyroidism, and malignancy than those who were fasting (**Table 3**). Non-fasting patients were also more likely to have recurrent admissions during Ramadan than fasting patients. There are no significant differences in reasons for admissions between patients who were fasting and those who were not except for the diseases of the circulatory system which were significantly higher in fasting patients (39.4% vs. 23.6%, $P=.028$) (**Table 4**). During Ramadan 30 fasting patients were admitted with ACS (28.8% of total admissions in fasting patients) compared to 8 non-fasting patients (11.1% of total admissions in non-fasting patients) ($P=.005$). The percentage of patients admitted to coronary care unit (CCU) was also higher in the fasting patients (**Table 3**). There was no statistically significant difference in the frequency of type 1 diabetes admissions between those who fast and those who did not, but in the 13 patients with type 1 diabetes who were fasting at the time of admission there was 8 cases of DKA compared with no cases in the non-fasting patients. There was no statistically significant difference in length of hospital stay between those who were fasting and those who were not (**Table 3**). The hospital mortality rate was higher in patients who were not fasting at time of admission compared to those who were fasting (**Figure 1**).

DISCUSSION

The current study evaluates potential changes in medical admission patterns and outcomes in patients with diabetes during Ramadan fasting. We found no statistically significant difference in reasons for admissions, length of hospital stay and in-hospital mortality during the month of Ramadan compared to Dhu al-Qidah. Admissions due to metabolic complications (hyperglycemia, hypoglycemia, DKA) and cardiovascular diseases (coronary artery disease and heart failure) were the most prevalent reasons for admissions in patients with diabetes both during Ramadan and Dhu al-Qidah. The frequency of these admissions did not differ between the two months. Previous studies that evaluated the impact of Ramadan fasting on specific illnesses showed

Table 2. Reasons for hospital admission during Ramadan and Dhu al-Qidah.

	Ramadan	Dhu al-Qidah	P
Diabetes-related	61 (32.8%)	57 (26.4%)	.160
Diseases of the circulatory system	60 (32.3%)	61 (28.2%)	.381
Diseases of the digestive system	25 (13.4%)	22 (10.2%)	.311
Diseases of the respiratory system	8 (4.3%)	18 (8.3%)	.101
Diseases of the genitourinary system	7 (3.8%)	14 (6.5%)	.222
Certain infectious and parasitic diseases	7 (3.8%)	8 (3.7%)	.975
Malignant neoplasms	5 (2.7%)	10 (4.6%)	.306
Diseases of the skin and subcutaneous tissue	4 (2.2%)	12 (5.6%)	.082
Diseases of the nervous system	4 (2.2%)	6 (2.8%)	.471
Diseases of the musculoskeletal system and connective tissue	1 (0.5%)	2 (0.9%)	.556
Diseases of the blood	4 (2.2%)	5 (2.3%)	.592
Injury, poisoning and certain other consequences of external causes	0 (0.0%)	1 (0.5%)	.537

Values are number (percentage).

Table 3. Characteristics of patients with diabetes admitted during the month of Ramadan according to their fasting status.

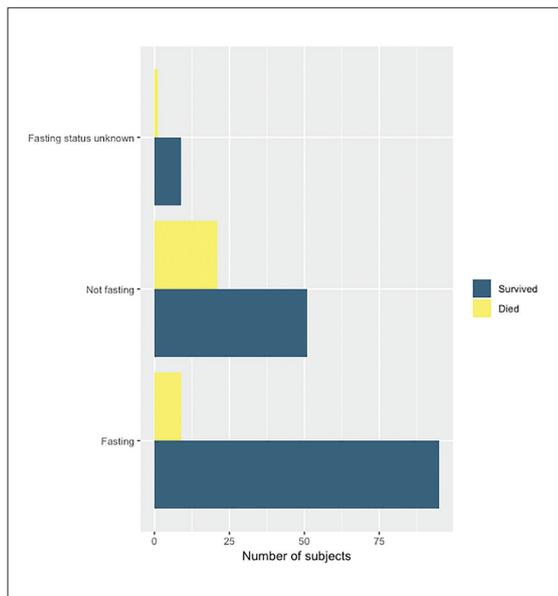
	Fasting n=104	Not fasting n=72	P
Age (mean, SD)	58.4 (16.4)	64.2 (14.8)	.018
Gender			
Females	53 (51.0)	50 (69.4)	.014
Place of admission			
Ward	62 (59.6)	(65.3)	.447
ICU	8 (7.7)	12 (16.7)	.065
CCU	34 (32.7)	13 (18.1)	.031
Length of stay (days) (mean, SD)	6.7 (4.9)	6.5 (5.1)	.791
Type of diabetes			
Type 1	13 (12.5)	7 (9.7)	.568
Type 2	89 (85.6)	64 (88.9)	.522
Gestational diabetes	1 (1.0)	1 (1.4)	.793
Secondary	1 (1.0)	0	.404
Duration of diabetes in years mean (SD)	12.0 (9.7)	14.6 (10.7)	.166
Previous OPD visits during Ramadan	4 (3.8)	5 (6.9)	.359
Previous admissions during Ramadan	2 (2.6)	6 (11.5)	.039
Pre-existing comorbidities			
Hypertension	64 (62.1)	43 (59.7)	.747
Coronary artery disease	28 (27.2)	16 (22.2)	.457
Heart failure	1 (1.0)	4 (5.6)	.073
Stroke	7 (6.8)	16 (22.2)	.003
Renal disease	9 (8.7)	14 (19.4)	.039
Asthma /COPD	4 (3.9)	3 (4.2)	.925
Liver Cirrhosis	1 (1.0)	7 (9.7)	.006
Hypothyroidism	2 (1.9)	6 (8.3)	.046
Malignancy	1 (1.0)	6 (8.3)	.014
Pre-existing diabetic microvascular disease	6 (5.8)	7 (9.7)	.333
Mortality rate (%)	8.7	29.2	<.001
Type of anti-hyperglycemic treatment at time of admission			
Insulin	47 (45.2)	37 (51.4)	.418
OHA	35 (33.7)	16 (22.2)	.100
OHA+insulin	11 (10.6)	7 (9.7)	.854

Values are number (percentage) unless indicated otherwise. CCU=coronary care unit, COPD=chronic obstructive pulmonary disease, ICU=intensive care unit, OHA=oral hypoglycemic agents, SD=standard deviation.

Table 4. Reasons for hospital admission between fasting and non-fasting patients during Ramadan.

	Fasting	Non-fasting	P
Diabetes-related	35 (33.7)	21 (29.2)	.530
Diseases of the circulatory system	41 (39.4)	17 (23.6)	.028
Diseases of the digestive system	12 (11.5)	13 (18.1)	.223
Diseases of the respiratory system	2 (1.9)	5 (6.9)	.101
Diseases of the genitourinary system	4 (3.8)	2 (2.8)	.525
Certain infectious and parasitic diseases	4 (3.8)	3 (4.2)	.603
Malignant neoplasms	1 (1.0)	4 (5.6)	.091
Diseases of the skin and subcutaneous tissue	1 (1.0)	3 (4.2)	.187
Diseases of the nervous system	1 (1.0)	2 (2.8)	.364
Diseases of the musculoskeletal system and connective tissue	0 (0.0)	1 (1.4)	.409
Diseases of the blood	3 (2.9)	1 (1.4)	.458
Injury, poisoning and certain other consequences of external causes	0	0	

Values are number (percentage).

**Figure 1.** Number of deaths for fasting and nonfasting during Ramadan.

that there is no increased frequency of cardiovascular events, stroke, or kidney diseases.^{5,6,8-10}

In our study, the percentage of patients who were fasting at the date of admission during Ramadan was 59.1%. The large number of non-fasting patients during Ramadan may be the reason for no differences between Ramadan and Dhu al-Qidah observed in our

study. Therefore, we performed a second set of analysis in which we compared those who were fasting at date of admission during Ramadan to those who were not. In our study males were more likely to be fasting at time of admission than females. In a previous study of Ramadan fasting in patients with type 2 diabetes, males were also more likely to fast more days during Ramadan than females.² During Ramadan, patients with diabetes who were fasting at the time of admission had a higher frequency of ACS than those who were not fasting (28.8% vs. 11.1%, $P=.005$).

Although previous studies showed no increase in incidence of acute cardiac events during Ramadan,¹¹⁻¹³ one should interpret their findings with caution since in all these studies investigators did not ascertain whether the patient was fasting or not at time of admission. However, our study was not population-based, and therefore one cannot with certainty conclude that the ACS rate increases with Ramadan fasting. The mortality rate was significantly higher in those who were not fasting at date of admission (29.2% vs 8.7%, $P<.001$). This observed difference in mortality cannot be attributed to any protective effects of fasting or harmful effects of non-fasting. Instead it is more likely due to the fact that patients who were not fasting at the date of admission were high-risk patients with comorbid conditions and other high-risk conditions that had probably prevented them from fasting. Non-fasting patients have a higher frequency of pre-existing stroke, liver

cirrhosis, renal disease, malignancy and hypothyroidism. The American Diabetes Association (ADA) and the International Diabetes Federation (IDF)-Diabetes and Ramadan (DAR) International Alliance guidelines on diabetes and Ramadan recommend against fasting in patients who are in the "very high risk" and "high risk" categories.^{14,15} These include old age with ill health and patients with uncontrolled diabetes, a history of recurrent hypoglycemia, hypoglycemia unawareness, a recent history of hyperglycemic emergencies, type 1 diabetes, macrovascular complications, CKD stages 3 to 5, and other comorbid conditions. In our study patients who were not fasting at date of admission were older, had a higher history of previous hospitalizations during Ramadan, and were more likely to have history of pre-existing kidney disease, stroke, liver disease and malignancy. They also had more recurrent admissions during Ramadan than non-fasting patients.

The only notable difference between Ramadan and Dhu al-Qidah was the higher percentage of patients with type 1 diabetes admitted during Ramadan compared to Dhu al-Qidah (10.8% vs 4.2%, $P=.011$). Furthermore, the frequency of DKA was higher among patients with type 1 diabetes who were fasting at the date of admission than in those who were not. Existing guidelines on management of diabetes during Ramadan fasting consider patients with type 1 diabetes as high-risk patients even if they are well-controlled, and recommend against fasting.^{14,15} These recommendations are mainly based on findings of the Epidemiology of Diabetes and Ramadan (EPIDIAR) study, a large multi-country epidemiological study that showed increased risk of meta-

bolic complications (hypoglycemia, hyperglycemia and DKA) during Ramadan.¹ However subsequent studies of type 1 diabetes and Ramadan failed to show similar results.^{4,16,17} Our study is a hospital-based and the higher frequency of DKA observed in those who were fasting at time of admission may not represent a true increase in incidence of DKA in these patients. An incidence study from the same city showed no increase in the total DKA rate during Ramadan.⁴ However, this study did not compare the incidence rate between those who fasted and those who did not. Therefore, further studies designed to make such comparison are required. Our study evaluated the impact of Ramadan fasting on the patterns and outcomes of medical admissions; it did not assess the effect of metabolic control on these variables. Whether the degree of metabolic control at time of admission has any effects on admission patterns or outcomes in fasting patients needs to be evaluated.

In conclusion, there was no difference in the proportion of patients with diabetes admitted to the hospital during Ramadan and Dhu al-Qidah. The number of admissions for most medical conditions were unchanged during Ramadan. However, admission frequency for ACS was higher in those who were fasting and therefore it is recommended that patients with cardiovascular disease and cardiovascular risk factors be monitored closely if they decide to fast. Patients with diabetes who were not fasting at the time of admission were more likely to have conditions or diseases that prevented them from fasting and therefore may be at increased risk of in-hospital mortality.

REFERENCES

1. Salti I, Bénard E, Detournay B, Bianchi-Biscay M, Le Brigand C, Voinet C, et al. EPIDIAR study group. 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 Oct;27(10):2306-11.
2. Elmehdawi RR, Mukhtad NA, Allaghi NI, Elmajberi SJ. Fasting of Ramadan in peoples with diabetes in Benghazi, Libya: an exploratory study. *Libyan J Med*. 2010 Mar 4;5.
3. Jabbar A, Hassanein M, Beshyah SA, Boye KS, Yu M, Babineaux SM. CREED study: Hypoglycaemia during Ramadan in individuals with Type 2 diabetes mellitus from three continents. *Diabetes Res Clin Pract*. 2017 Oct;132:19-26.
4. Elmehdawi R, Ehmida M, Elmagrehi H. Incidence of Diabetic Ketoacidosis during Ramadan Fasting in Benghazi-Libya. *Oman Med J*. 2009 Apr;24(2):99-102.
5. Al Assaad RG, Bachir R, El Sayed MJ. Impact of Ramadan on emergency department visits and on medical emergencies. *Eur J Emerg Med*. 2017 Jul 12.
6. Topacoglu H, Karcioglu O, Yuruktumen A, Kiran S, Cimrin AH, Ozucelik DN, et al. Impact of Ramadan on demographics and frequencies of disease-related visits in the emergency department. *Int J Clin Pract*. 2005 Aug;59(8):900-5.
7. World Health Organization. International Statistical Classification of Diseases and Related Health Problems 10th Revision; 2016. [cited 18 March 2018]. Available from: <http://www.who.int/classifications/icd/en/>
8. el-Mitwalli A, Zaher AA, Mohamed MA, Elmenshawi E. The effect of Ramadan fasting on cerebral stroke: a prospective hospital-based study. *Eur J Neurol*. 2009 Apr;16(4):e80.
9. Turin TC, Ahmed S, Shommu NS, Afzal AR, Al Mamun M, Qasqas M, et al. Ramadan fasting is not usually associated with the risk of cardiovascular events: A systematic review and meta-analysis. *Family Community Med*. 2016 May-Aug;23(2):73-81. doi: 10.4103/2230-8229.181006.
10. Bragazzi NL. Ramadan fasting and chronic kidney disease: A systematic review. *J Res Med Sci*. 2014 Jul;19(7):665-76.
11. Pekdemir M, Ersel M, Yilmaz S, Uygun M. No significant alteration in admissions to emergency departments during Ramadan. *J Emerg Med*. 2010 Feb;38(2):253-6. doi: 10.1016/j.jemermed.2008.03.013.
12. Al Suwaidi J, Bener A, Suliman A, Hajar R, Salam AM, Numan MT, et al. A population based study of Ramadan fasting and acute coronary syndromes. *Heart*. 2004 Jun;90(6):695-6.
13. Temizhan A, Dönderici O, Ouz D, Demirbas B. *Int J Cardiol*. Is there any effect of Ramadan fasting on acute coronary heart disease events? 1999 Jul 31;70(2):149-53.
14. Al-Arouj M, Assaad-Khalil S, Buse J, Fakhil I, Fahmy M, Hafez S, et al. Recommendations for management of diabetes during Ramadan: update 2010. *Diabetes Care*. 2010 Aug;33(8):1895-902.
15. Hassanein M, Al-Arouj M, Hamdy O, Bekbakar WMW, Jabbar A, Al-Madani A, et al. International Diabetes Federation (IDF), in collaboration with the Diabetes and Ramadan (DAR) International Alliance. *Diabetes and Ramadan: Practical guidelines*. *Diabetes Res Clin Pract*. 2017 Apr;126:303-316.
16. Musleh A, Beshyah S, Abu Awad S, Kahwathih M, Al Jubeh J. Experience with diabetic adolescents observing Ramadan fasting. *Ibnosina J Med BS*. 2015;7(6):223-7.
17. Elbarsha A, Elmehdawi R, Eljazwi I, Buzaid N, Mahgob N, Elhemri M. Feasibility of Ramadan fasting in adults with type 1 diabetes: an observational study. *Int J Diabetes Dev Ctries*. 2018 Apr 1;38(2):191-4.