Hyperglycaemic and hypoglycaemic emergencies among patients with diabetes mellitus who participated in pilgrims of the 2019/1440H Hajj season

Abdulaziz Alfadhly1, Hussain Darraj2, Basim Alamlki1, Saad Alfaez1, Mohammed Alzahrani1, Ali Mubarak1, Safar Albogami1, Daifallah Almalki1, khalid Alshehri1, Ali Alqarni1, Ali Azharni1, Hamzah khalid3, Rami Altwairiqi1, Adhari Alselmi1, Afnan Almajnouni1, Turki Kamal1, Mohammed Kamal1, Fahad Almatrfi1, Mugtaba Osman4, Abdulkareem Alotaibi1

1Diabetes Centre, Prince Mansour Military Hospital, 2Armed Forces Center for Psychiatric Care, Taif, 3Jazan Health Affairs, Jazan, Ministry of Health, 4Endocrinology Unit, Department of Internal Medicine, King Abdulaziz Hospital, Makkah, Saudi Arabia

ABSTRACT

Background: Diabetic emergencies are serious acute life-threatening complications of diabetes mellitus (DM). The Hajj season requires the health system in Saudi Arabia to prepare efficiently for the healthcare of millions of pilgrims, particularly for diabetic emergencies. Thus, diabetic emergencies need rapid recognition, diagnosis and treatment. This study aimed to explore the frequency and associated factors of diabetic emergencies among the pilgrim’s patients with DM during Hajj, Mecca 2019. Methods: This is a prospective study which was conducted on 153 patients with DM. They were selected from three major healthcare-providing facilities during Hajj, which are Arafat, Muzdelefah and Muna healthcare centres. The study was conducted from Aug 5 to 12, 2019. All the patients who presented with any of the hypoglycaemic or hyperglycaemic emergencies had their demographic and clinical characteristics recorded to estimate the prevalence of each emergency and identify its significant associated factors. Result: More than 90% of the study participants were patients with type 2 diabetes mellitus (T2DM), while around 7% had type 1 diabetes mellitus (T1DM). Diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS) and hypoglycaemia were presented in (n = 11, 7.2%), (n = 19, 12.4%) and (n = 28, 18%), respectively, of the participants. Moreover, the study found that “younger age” (odds = 30.4, P = 0.0115) and “type of medication” are significantly associated with DKA. Furthermore, “older age”, “type of medication”, “having Cardiovascular Disease (CVD)” and “diabetes duration” were found to have a significant association with HHS. Moreover, hypoglycaemia was associated with neuropathy complication (odds = 3.54948, P = 0.0187). Conclusions: Among the pilgrims with diabetes participating in Hajj, a considerable proportion with a range of diabetic emergencies present to the onsite medical facilities. Preparation is required in terms of logistics and health education about diabetic emergencies to meet the needs of pilgrims with DM, especially those who use insulin and have longstanding diabetes. Further research on DM and the creation of guidelines for health providers and patients with DM during Hajj are important focuses for the future.

Keywords: Diabetes mellitus, diabetic emergencies, diabetic ketoacidosis, hyperglycaemia, hypoglycaemia, type 1, type 2

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Introduction

Diabetes mellitus (DM) is considered a leading cause of disability worldwide and it is associated with more than 25 million deaths globally every year. In Saudi Arabia, over 4 million people live with diabetes, with an estimated prevalence of 18.3% in Saudi adults. The health system in Saudi Arabia needs to be prepared for DM prevention and treatment, as well as prevention and monitoring of its complications and related emergencies. The main diabetes-related emergencies dealt with in Saudi Arabia are hypoglycaemia, diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS). The responsibilities of the health sectors in Saudi Arabia extend beyond the patients with DM who are residents in the Kingdom and include caring for the pilgrims and visitors who come to Mecca for Hajj and/or Umrah. Hajj is the fifth pillar of Islam; every Muslim must participate in Hajj at least once in their life. The Hajj rituals last for about a week in the last month of the Islamic calendar. According to the Saudi General Authority for Statistics, approximately 2.5 million pilgrims participated in Hajj during the 1440 H season alone, of whom 1,855,027 came from outside Saudi Arabia. Participating in Hajj involves a remarkable change in physical activity, mental effort and diet. Therefore, pilgrims with DM are at an increased risk of diabetic emergencies, which include DKA, HHS and hypoglycaemia.

In recent decades, an increasing number of hospital admissions of patients with DM during the Hajj season have been reported. For instance, a study conducted at seven hospitals during the Hajj season reported that the hospital admissions for DM constituted 8.5% of the total admissions. The main reason for admission was DKA, followed by hypoglycaemia and uncontrolled DM. Moreover, DM was evident in 26% of all the admissions as a comorbid disease.

Several studies have examined the associated risk factors of DKA, HHS and hypoglycaemia. For example, a study conducted by Hekkala et al. showed that DKA was more common in the paediatric age group with type 1 DM (T1DM) but can occur in patients with type 2 DM (T2DM). Hypoglycaemia is more common in insulin-treated patients, particularly those with a longer duration of diabetes and lower glycosylated haemoglobin (HbA1c) readings. A meta-analysis indicated that DKA is more common with tight glycaemic control and that hypoglycaemia is more common with the use of insulin therapy. Furthermore, inadequate insulin use is one of the most important factors that contribute to the development of diabetic emergencies. Moreover, a study which included 18 pilgrims admitted to the hospital with DKA revealed that poor treatment adherence was reported in 94.5% of the patients and the mortality rate was around 6%. In HHS, osmotic diuresis induces combined states of hyperglycaemia and dehydration, which causes hyperviscosity and a hypercoagulable state. Therefore, HHS carries a huge risk of ischaemic stroke. Overall, diabetic emergencies have serious impacts on a patient’s life.

Given that there is an increased risk of diabetic emergencies during the Hajj season and a lack of data about the diabetic emergencies during this period, this study aimed to assess the diabetic emergencies and their associated factors among patients with DM who participated in Hajj 2019.

Methods

Study design and target population

This is a prospective study which was carried out in Mecca City. It is situated in the centre of the western area of Saudi Arabia. The study target population was patients with DM in Mecca City, who participated in Hajj 2019. The samples were selected from three emergency units at the healthcare-providing facilities of Arafat, Muzdalifah and Muna healthcare centres and they were asked to participate in the study. Ethical approval was granted on 11-9-2017 Registration number H-02-T-078.

Sample size

A total of 153 participants were included in the current study. The sample was selected from three emergency units at the healthcare-providing facilities of Arafat, Muzdelefah and Muna.

Recruitment of the participants

The participants were invited by the research team representative to take part in the study. They were informed that the data would be anonymous to ensure the privacy of the collected data. The participation was entirely voluntary, and all the individuals could withdraw from the study at any time without any consequences. Written informed consent was taken from the participants who agreed to be included in the survey.

Inclusion criteria

- Performance of pilgrimage during the 1440 H season.
- Consent of participation in the study.

Exclusion criteria

- Refused to sign consent.

Ethical considerations

Permission was obtained from the Ethical Committee in the Alhada Armed Forces Hospitals, Saudi Arabia.

Data collection and measurement tools

The study data were collected using a validated questionnaire filled by the research investigators which includes two parts. The first part includes sociodemographic variable, and the second part includes the clinical characteristics of the participants.

Statistical analyses

The analysis was performed by descriptive and inferential statistics. Any missing information was managed with multiple interpolations using chain equations. The normally distributed continuous variables were described using mean and standard
deviation. The continuous variables deviating from normality assumption are reported using the median and interquartile range. The data distribution was checked by the Kolmogorov–Smirnov method. The categorical variables were summarised by percentages and counts. Adjustment for the clinical and demographic covariates was conducted. The unadjusted association between the continuous variables was assessed by \( t \)-test or Mann–Whitney depending on the normality of the data. The categorical variables were assessed by a Chi-square test or Fisher's exact test. Multiple logistic regression was used to adjust for the potential confounders. A \( P \) value of less than 0.05 is assumed as the statistical significance level.

**Results**

The total number of patients with DM included in the current investigation was 153. Of these, 11 patients (7.2%) (95% confidence interval [CI]: 5.1–9.3) developed DKA, 19 patients (12.4%) (95% CI: 9.5–15.1) presented with HHS, and 28 patients (18.3%) (95% CI: 15.2–21.4) presented with hypoglycaemia during the Hajj season.

In terms of the background demographic factors, 140 participants (91.4%) were aged over 30 years and only 13 participants (8.5%) were aged under 30 years. Furthermore, 139 participants (90.8%) suffered from T2DM, whereas 11 participants (7.2%) had T1DM. In addition, 82 participants (53.6%) had suffered from diabetes for over 10 years and 71 participants (46.4%) had lived with diabetes for under 10 years. Table 1 shows the full account of the sociodemographic characteristics of the study participants.

Regarding the patients’ random blood sugar (RBS) measurements, 89 (58.2%) were greater than 200 mg/dL (58.2%), 54 (35.3%) were between 100 and 200 mg/dL, and only 10 (6.5%) were less than 100 mg/dL. Furthermore, 74 participants were on oral hypoglycaemics (48.4%), 25 participants (16.3%) were on insulin, 43 participants (28.1%) were on a combination of oral hypoglycaemics and insulin and 8 participants (5.2%) were on no treatment.

More than 90% of the participants were patients with T2DM while around 7% had T1DM. In addition, 71 participants (46.4%) presented with hypoglycaemia.

Regarding microvascular complications among the participants, diabetic retinopathy, diabetic neuropathy and diabetic nephropathy were evident, with 23.5, 26.1 and 5.9%, respectively. CVD was reported in 18.3% of the participants. More than 48% of the participants had hypertension.

In the adjusted multiple regression analysis, DKA was exceedingly common in the younger individuals (odds ratio [OR] = 30.4, \( P = 0.0115 \)), as shown in Figures 1 and 2. Other clinical and demographic factors were not statistically significant. None of the background factors exerted a significant effect on the HHS likelihood. The patients with neuropathy were far more likely to present with a hypoglycaemic emergency (OR = 3.54948,

| Table 1: Sociodemographic and clinical characteristics of the study participants |
|---------------------------------------------|-----------------|-----------------|
| Frequency | Percent | Frequency | Percent |
|-----------------|-----------------|-----------------|-----------------|
| Overall | 153 | 100% | 153 | 100% |
| Age, years | | | | |
| 15–30 | 13 | 8.5% | >30 | 140 | 91.5% |
| RBS, mg/dL | | | | |
| <100 | 10 | 6.5% | 100–200 | 54 | 35.3% |
| >200 | 89 | 58.2% | | | |
| Type of DM | | | | |
| T1DM | 11 | 7.2% | T2DM | 139 | 90.8% |
| GDM | 1 | 0.7% | Others | 2 | 1.3% |
| HbA1c | | | | |
| No result | 121 | 79.1% | Good control | 9 | 5.9% |
| Poor control | 23 | 15.0% | | | |
| Diabetes duration | | | | |
| ≤10 | 71 | 46.4% | >10 | 82 | 53.6% |
| Diabetes complications | | | | |
| DR | | | | |
| Absent | 117 | 76.5% | Present | 36 | 23.3% |
| DN | | | | |
| Absent | 113 | 73.9% | Present | 40 | 26.1% |
| DNP | | | | |
| Absent | 144 | 94.1% | Present | 9 | 5.9% |
| CVD | | | | |
| Absent | 125 | 81.7% | Present | 28 | 18.3% |
| HTN | | | | |
| Absent | 79 | 51.6% | Present | 74 | 48.4% |
| Diabetes medication | | | | |
| Missing data | 3 | 2.0% | No medication | 8 | 5.2% |
| Oral | 74 | 48.4% | Insulin | 25 | 16.3% |
| Both | 43 | 28.1% | | | |
| Diabetic emergency | | | | |
| DKA | | | | |
| Absent | 142 | 92.8% | Present | 11 | 7.2% |
| HHS | | | | |
| Absent | 134 | 87.6% | Present | 19 | 12.4% |
| Hypoglycaemia | | | | |
| Absent | 125 | 81.7% | Present | 28 | 18.3% |

RBS: Random blood sugar; DM: Diabetes mellitus; HbA1c: glycosylated haemoglobin; DR: diabetic retinopathy; DNP: diabetic nephropathy; DN: diabetic neuropathy; HTN: hypertension; SD: standard deviation; n: sample size
Discussion

The current study showed that a considerable number of patients with DM had diabetic emergencies during the Hajj season. It showed that 7.2% of the participants had a DKA episode. This is considered high, as the reported rate of DKA is 1.3–5.4% in young patients with DM and 0.2–0.3% in patients who are aged over 30. However, a study conducted with a sample of 80 Moroccan pilgrims with DM found that 5% of them had had a DKA episode during the Hajj season. In the current study, age was the most significant factor, with younger adults (<30 years) 30 times more likely to have DKA than the older adults. Moreover, another explanation could be the improper use of insulin, as the current study found that insulin use is significantly associated with DKA. In line with the previous research, the current study found that DKA is more common in patients with T1DM (73%) than those with T2DM (27%). A small-scale study surveyed 18 patients with DKA who visited Al-Madinah during the 1998 Hajj season and found that poor compliance with diabetes medications was the most important factor in precipitating DKA. The paper by Sharif et al (2010) reported that diabetic pilgrims face a range of practical difficulties during the Hajj season, including acquisition and transport of oral hypoglycaemic medications and storage of insulin.

Figure 1: Age effect on DKA, HHS and hypoglycaemia among the pilgrims

Figure 2: Neuropathy effect on DKA, HHS and hypoglycaemia among the pilgrims
Regarding HHS, 12.4% of the participants had an HHS episode. In our sample, the HHS could be related to different factors. The first factor is T2DM, as most of the study participants had T2DM and all the cases of HHS were presented in patients with T2DM. Second, old age could be a factor, as most of the HHS episodes (68.4%) in our study occurred in the elderly patients. This result is consistent with that of the previous research which reported that HHS is mainly presented in the elderly.\cite{18} The third factor is CVD, as our

### Table 2: DKA and its association with clinical variables

| Factor                  | Unadjusted Analysis | Adjusted Analysis |
|-------------------------|---------------------|-------------------|
|                         | Number with DKA     | Number without DKA| Chi-squared | P     | Estimate | Odds       | Standard error | P     |
| Age                     |                     |                   |             |       |          |            |                |       |
| 15-30                   | 8 (61.5%)           | 5 (38.5%)         | 54.305      | < 0.0001 | 3.4159   | 30.44344   | 1.6873         | 0.0115 |
| More than 30            | 3 (2.1%)            | 137 (97.9%)       |             |         |          |            |                |       |
| Diabetes Type           |                     |                   |             |       |          |            |                |       |
| Type 1                  | 8 (72.7%)           | 3 (27.3%)         | 64.676      | < 0.0001 | -2.4967  | 0.082356   | 2.0100         | 0.0832 |
| Type 2                  | 3 (2.2%)            | 136 (97.8%)       |             |         |          |            |                |       |
| Diabetes duration       |                     |                   |             |       |          |            |                |       |
| <10 years               | 7 (9.9%)            | 64 (90.1%)        | 0.767       | 0.3812  | -2.0139  | 1.7552     | 0.2637         |       |
| Over 10 years           | 4 (4.9%)            | 78 (95.1%)        |             |         |          |            |                |       |
| HbA1c                   | Mean=10.3%(89.1)    | Mean=8.5%(69.4)   | r=3.5294    | 0.08843 | 0.0455   | 1.046551   | 0.3945         | 0.9119 |
| RBS                     |                     |                   |             |       |          |            |                |       |
| 100-200 mg/dL           | 2 (3.7%)            | 52 (96.3%)        | 1.5335      | 0.4645  | -1.2527  | 3.615      | 0.7230         |       |
| <100 mg/dL              | 1 (10%)             | 9 (90%)           |             |         |          | 1.8490     | 0.9221         |       |
| >200 mg/dL              | 8 (9%)              | 81 (91%)          |             |         |          |            |                |       |
| Retinopathy             |                     |                   |             |       |          |            |                |       |
| Yes                     | 8 (6.8%)            | 109 (93.2%)       | 0           | 1       | -0.0262  | 1.6364     | 0.9899         |       |
| No                      | 3 (8.3%)            | 33 (91.7%)        |             |         |          |            |                |       |
| Neuropathy              |                     |                   |             |       |          |            |                |       |
| Yes                     | 10 (8.8%)           | 103 (91.2%)       | 0.96023     | 0.3271  | 0.3900   | 1.7256     | 0.8471         |       |
| No                      | 1 (2.5%)            | 39 (97.5%)        |             |         |          |            |                |       |
| Nephropathy             |                     |                   |             |       |          |            |                |       |
| Yes                     | 11 (7.7%)           | 131 (92.3%)       | 0.12418     | 0.7245  | 1.9742   | 2.3702     | 0.4758         |       |
| No                      | 0 (0%)              | 11 (100%)         |             |         |          |            |                |       |

RBS: Random blood sugar, DM: Diabetes mellitus, HbA1c: glycosylated haemoglobin, DR: diabetic retinopathy, DNP: diabetic nephropathy, DN: diabetic neuropathy, HTN: hypertension, SD: standard deviation, n: sample size, P: P<0.05 is the significance level, as tested by t-test, Chi-square and Fisher’s exact, where appropriate

### Table 3: HHS and its association with clinical variables

| Factor                  | Unadjusted Analysis | Adjusted Analysis |
|-------------------------|---------------------|-------------------|
|                         | Number with HHS     | Number without HHS| Chi-squared | P     | Estimate | Odds       | Standard error | P     |
| Age                     |                     |                   |             |       |          |            |                |       |
| 15-30                   | 13 (100%)           | 0 (0%)            | 0.95987     | 0.3272 | -17.07101 | 3.86      | 3228.25750   | 0.9958 |
| More than 30            | 121 (86.4%)         | 19 (13.6%)        |             |         |          |            |                |       |
| Diabetes Type           |                     |                   |             |       |          |            |                |       |
| Type 1                  | 11 (100%)           | 0 (0%)            | 0.70773     | 0.4002 | 17.9408  | 6.19      | 3761.7391   | 0.996 |
| Type 2                  | 120 (86.3%)         | 19 (13.7%)        |             |         |          |            |                |       |
| Diabetes duration       |                     |                   |             |       |          |            |                |       |
| <10 years               | 67 (94.4%)          | 4 (5.6%)          | 4.503       | 0.03383 | 0.81221  | 2.253     | 1.60714     | 0.6133 |
| Over 10 years           | 67 (81.7%)          | 15 (18.3%)        |             |         |          |            |                |       |
| HbA1c                   | Mean=8.5 (69.4)     | Mean=8.6 (72.2)   | r=0.31181   | 0.7612  | -0.02112 | 0.9791    | 0.40184     | 0.9581 |
| RBS                     |                     |                   |             |       |          |            |                |       |
| 100-200 mg/dL           | 8 (80%)             | 2 (20%)           | 3.7645      | 0.1522 | 23.33358 | 1.36      | 6522.63925  | 0.9971 |
| <100 mg/dL              | 51 (94.4%)          | 3 (5.6%)          |             |         |          |            |                |       |
| >200 mg/dL              | 75 (84.3%)          | 14 (15.7%)        |             |         |          |            |                |       |
| Retinopathy             |                     |                   |             |       |          |            |                |       |
| No                      | 105 (89.7%)         | 12 (10.3%)        | 1.3755      | 0.2409 |          |            |                |       |
| Yes                     | 29 (80.6%)          | 7 (19.4%)         |             |         |          |            |                |       |
| Neuropathy              |                     |                   |             |       |          |            |                |       |
| No                      | 100 (88.5%)         | 13 (11.5%)        | 0.08831     | 0.7663 |          |            |                |       |
| Yes                     | 34 (85%)            | 6 (15%)           |             |         |          |            |                |       |
| Nephropathy             |                     |                   |             |       |          |            |                |       |
| No                      | 126 (87.5%)         | 18 (12.5%)        | 1.1581      | 0.2819 |          |            |                |       |
| Yes                     | 8 (88.9%)           | 1 (11.1%)         |             |         |          |            |                |       |

RBS: Random blood sugar, DM: Diabetes mellitus, HbA1c: glycosylated haemoglobin, DR: diabetic retinopathy, DNP: diabetic nephropathy, DN: diabetic neuropathy, HTN: hypertension, SD: standard deviation, n: sample size, P: P<0.05 is the significance level, as tested by t-test, Chi-square and Fisher’s exact, where appropriate
study showed that CVD was significantly associated with HHS. This result is in line with that of the previous research which reported that CVD was associated with HHS.[16] Moreover, ‘use both oral medication and insulin’ and ‘diabetes duration for >10 years’ were significantly associated with the development of HHS. The Hajj season is often quite warm, and thirst develops quickly among the diabetic pilgrims, thereby increasing the risk of HHS. Hydration advice should be given to all the diabetic patients participating in Hajj and the risk of HHS should be explained to them. These results are relevant for all the family physicians practising during the Hajj season and caring for pilgrims with diabetes.

The current study found that 18.3% of the pilgrims with DM presented with hypoglycaemia. This is close to the 13% figure reported by Khogeer et al.[19] during the period of staying in Mina in the 1439 Hajj season. Probable reasons for this high rate are the increased physical effort and diet change during Hajj.[20]

### Recommendations and Conclusion

This study aims to shed light on hyperglycaemia emergencies, hypoglycaemia, and its associated factors among patients with DM who participated in a pilgrimage at Mecca in 2019. Our sample of patients with DM comprised 7.2% with DKA, 12.4% with HHS and 18% with hypoglycaemia attacks. Further efforts are needed to promote awareness by holding health education sessions for patients with DM who wish to participate in Hajj, especially those who use insulin treatment and have longstanding diabetes. Furthermore, guidelines for health providers and patients with diabetes participating in Hajj are needed to prevent and manage the expected diabetes complications. Future research should be large-scale, involving collaboration with all medical missionaries, and be planned well before the arrival of the pilgrims.

### Data Availability

Data can be provided by the corresponding author upon formal written request.

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### Conflicts of interest

There are no conflicts of interest.

### References

1. International Diabetes Federation. IDF Diabetes Atlas. 11th ed. Brussels, Belgium; 2020. Data about Saudi Arabia are available
freely. Available from: https://www.idf.org/our-network/regions-members/middle-east-and-north-africa/members/46-saudi-arabia.html.

2. General Authority of Statistics, Hajj Statistics 2019. Available from: https://www.stats.gov.sa/sites/default/files/haj_40_en.pdf. [Last accessed on 2020 Sep 23].

3. Harding JL, Pavkov ME, Magliano DJ, Shaw JE, Gregg EW. Global trends in diabetes complications: A review of current evidence. Diabetologia 2019;62:3-16.

4. Madani TA, Ghabrah TM, Albarrak AM, Alhazmi MA, Alazraqi TA, Althaqafi AO, et al. Causes of admission to intensive care units in the Hajj period of the Islamic year 1424 (2004). Ann Saudi Med 2007;27:101-5.

5. Hekkala A, Reunanen A, Koski M, Knip M, Veijola R, Finnish Pediatric Diabetes Register. Age-related differences in the frequency of ketoacidosis at diagnosis of type 1 diabetes in children and adolescents. Diabetes Care 2010;33:1500-2.

6. Kalscheuer H, Serfing G, Schmid S, Lehnert H. Diabetic emergencies: Hypoglycaemia, ketoacidotic and hyperglycemic hyperosmolar nonketotic coma. Internist (Berl) 2017;58:1020-8.

7. Newton CA, Raskin P. Diabetic ketoacidosis in type 1 and type 2 diabetes mellitus: Clinical and biochemical differences. Arch Intern Med 2004;164:1925-31.

8. Stefenon P, Silveira ALMD, Gareta LS, Leitão CB, Bauer AC. Hypoglycaemia symptoms and awareness of hypoglycaemia in type 1 diabetes mellitus: Cross-cultural adaptation and validation of the Portuguese version of three questionnaires and evaluation of its risk factors. Diabetol Metab Syndr 2020;12:15.

9. Wang PH, Lau J, Chalmers TC. Meta-analysis of effects of intensive blood-glucose control on late complications of type 1 diabetes. Lancet 1993;341:1306-9.

10. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. Diabetes Care 1993;32:1335-43.

11. Yusuf M, Chaudhry S. Diabetic ketoacidosis in pilgrims visiting Madinah Al-Munawarah, Saudi Arabia. Int Diabetes Digest 1998;8:14-16.

12. Fadini GP, de Kreutzenberg SV, Rigato M, Brocco S, Marchesan M, Tiengo A, et al. Characteristics and outcomes of the hyperglycemic hyperosmolar non-ketotic syndrome in a cohort of 51 consecutive cases at a single center. Diabetes Res Clin Pract 2011;94:172-9.

13. Wang JY, Wang CY, Huang YS, Chen PF, Huang KY, Chou P, et al. Increased risk of ischaemic stroke after hyperosmolar hyperglycemic state: A population-based follow-up study. PLoS One 2014;9:e94155.

14. Harris MI. Diabetes in America. Diabetes Res Clin Pract 1995;30:75.

15. Lahoussaine A, Eljadi H, Elhadri S. Clinical characteristics, and diabetes complications among Moroccan diabetic pilgrims. Endocrinol Metab Int J 2018;6:349-51.

16. Gosmanov AR, Gosmanova EO, Kitabchi AE. Hyperglycemic Crises: Diabetic Ketoacidosis (DKA), and Hyperglycemic Hyperosmolar State (HHS). Endotext. South Dartmouth (MA): MDText.com, Inc.; 2018.

17. Sharif MA, Mahmood A, Rehman JU, Vaseem M, Ansari KS, Munir S. Diabetic profile of Pakistani pilgrims in Makkah during Hajj season 2007-2008. Saudi Med J 2010;31:328-30.

18. Desai R, Singh S, Syed MH, Dave H, Hasnain M, Zahid D, et al. Temporal trends in the prevalence of diabetes decompensation (diabetic ketoacidosis and hyperosmolar hyperglycemic state) among adult patients hospitalized with diabetes mellitus: A nationwide analysis stratified by age, gender, and race. Cureus 2019;11:e4353.

19. Khogeer Z, Alnifaee R, Atyamani S, Alharbi K, Hanbzaza S, Mashhor A, et al. Acute complications of diabetes among pilgrims during Hajj 2017: A brief report. Diabetes Ther 2020;11:747-51.

20. Beshyah SA, Sherif IH. Care for people with diabetes during the moslem pilgrimage (hajj) an overview. Libyan J Med 2008;3:39-41.