Vol. 4 No. 1 (2025)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Assessment of Diabetic Ketoacidosis Awareness Among Diabetic Patients and Their Caregivers in Peshawar: A Cross-Sectional Study

Dr. Khayam
Resident, Medicine, CMH Peshawar Email: khayam756@gmail.com

Dr. Maryam Hussain
Classified Medical Specialist & Pulmonologist, CMH Peshawar
Email: maryamhussain2148@gmail.com

Dr. Faiza Gul
Resident Pediatrician, Lady Reading Hospital (LRH), Peshawar

Dr. Syed Sibtain Maqsood
General Physician (MBBS) (RMP) Email: sibtains419@gmail.com

Dr. Yaseen
Resident, Medicine, CMH Peshawar Email: yaseenpmdc@gmail.com

Dr. Shahnawaz
Resident, Medicine Email: fourmob5@gmail.com

Author Details

Keywords: Diabetic Ketoacidosis, Awareness, Knowledge, Caregivers, Sick-Day Rules, Ketone Testing, Peshawar, Pakistan.

Received on 5 January 2025
Accepted on 01 February 2025
Published on 15 February 2025

Corresponding E-mail & Author*:

Dr. Khayam
Resident, Medicine, CMH Peshawar Email: khayam756@gmail.com

Abstract

Background: Diabetic ketoacidosis (DKA) is a serious acute complication of diabetes resulting from insulin deficiency, leading to hyperglycaemia, ketone formation, and metabolic acidosis. Both adult and paediatric guidelines emphasize early recognition of symptoms, adherence to sick-day rules, and ketone monitoring during illness or persistent hyperglycaemia to prevent severe outcomes..

Methods: It is a cross-sectional study carried out in outpatient diabetic clinics/medical outpatient departments **of Combined Military Hospital (CMH), Peshawar.** A total of **162** participants (patients and caregivers) were recruited through]consecutive sampling. A structured interviewer-administered questionnaire measured knowledge of DKA definition/seriousness, triggers, symptoms, prevention, ketone testing, and first-response actions. A 20-item awareness score (0–20) categorized participants into poor, moderate, and good awareness. Associations were evaluated using chi-square tests and multivariable logistic regression.

Results: Among 162 respondents, 66.7% were patients and 33.3% were caregivers; 31.5% had good awareness. Major gaps were found in ketone testing knowledge (24.7%) and recognition of severe warning signs such as deep/rapid breathing (22.2%) and fruity breath (19.1%). Higher education, structured diabetes education, and prior DKA

exposure were independent predictors of good awareness.
Conclusion: DKA awareness appears suboptimal in key actionable areas. Routine clinic-based education and improved access to ketone testing are recommended in Peshawar.

Introduction

Diabetic ketoacidosis (DKA) is a medical emergency that causes hyperglycaemia, ketonaemia/ketonuria, and metabolic acidosis caused by absolute or relative insulin deficiency. DKA is among the significant hyperglycaemic crises in adults and is linked to a high level of morbidity, healthcare use, and avoidable mortality in case of delayed recognition and treatment [1]. DKA is one of the primary causes of diabetes-related hospitalization in children and adolescents and may result in severe complications, especially in cases of late presentation or in the case of dehydration and acidosis [2].

The importance of early recognition lies in the fact that clinical deterioration may develop quickly [3]. Typical presenting symptoms are polyuria, polydipsia, nausea/vomiting, abdominal pain, weakness, and unpredictable changes in mental status; severe DKA can be characterized by deep/rapid breathing (Kussmaul respirations) and fruity breath caused by acetone [4]. The common recommendations include that successful prevention requires patient and caregiver interventions in the face of intercurrent illness- keeping hydrated, checking glucose levels regularly, never discontinuing insulin without medical consultation, and regular testing of ketones in sickness and/or prolonged hyperglycaemia[5].

The burden of diabetes is high and increasing in Pakistan, which increases the level of concern regarding the significance of diabetes education in the population. According to the estimates by International Diabetes Federation (IDF) countries, Pakistan has a very high prevalence of diabetes among adults [6]. As diabetes become more common, more people are at risk of preventable acute complications like DKA—especially where diabetes education and access to ketone testing are limited or inconsistent. Peshawar has a high and heterogeneous catchment population and in most cases caregivers take the lead in seeking urgent care when a patient falls ill [7,8]. The baseline DKA awareness in patients and caregivers can be measured to implement specific education strategies that can decrease delay time, hinder extreme presentations, and enhance end-outcomes [9].

Also, the causes of DKA are frequently precipitated by preventable or modifiable factors like missed insulin doses, intercurrent infections, gastrointestinal diseases, and delayed healthcare-seeking that are affected by the knowledge of the patient and caregivers about diabetes self-management [10]. Limited health literacy, the high cost of glucose/ketone monitoring supplies, the absence of consistent follow-up and the use of non-standard advice mechanisms can be the obstacles to late presentation and acute DKA in most low and middle-income environments. Notably, caregiver knowledge is essential since when children, adolescents, older adults and patients develop vomiting, confusion or reduced consciousness in acute illnesses, the caregivers make decisions on their behalf [11,12].

Furthermore, DKA prevention is not confined to symptom recognition, but it should also be accompanied by practical knowledge of sick-day rules, when to do more monitoring, how to change insulin recommendations, and when to seek emergency care. The absence of knowledge about the ketone testing and misconception about the discontinuation of insulin in the case of poor appetite can cause metabolic decompensation and deteriorate the results. Thus, it is necessary to measure the level of DKA awareness in Peshawar to reveal the presence of certain knowledge gaps (e.g., triggers, severe warning signs, ketone testing, and emergency thresholds) and develop specific educational interventions that would fit local language and culture requirements. This evidence can be used to facilitate the provision of structured diabetes

counseling in outpatient clinics, enhance the involvement of caregivers, and eventually decrease avoidable hospitalization and mortality rates associated with DKA.

2. Methodology

It is a cross-sectional study carried out in outpatient diabetic clinics/medical outpatient departments of **Combined Military Hospital (CMH), Peshawar**. The study population comprised two respondent groups: adults (≥18 years) with a physician diagnosis of diabetes attending outpatient follow-up, and adult caregivers (≥18 years) who routinely supported a person with diabetes (e.g., spouse, parent, adult child) and were present during the clinic visit. Participants who needed emergency treatment at the recruitment date, those unable to provide informed consent, or those unable to participate due to cognitive/communication impairment were excluded. The sample size targeted was 162 which was attained by consecutive sampling where all suitable respondents who should have been interviewed during clinic hours were invited until the required sample size is attained.

The structured questionnaire that was used to collect the data was interviewer-administered and in Urdu and/or Pashto in order to reduce the literacy related barriers. The tool measured socio-demographic (age, sex, education, residence), glucose management (diabetes duration, treatment type, clinic follow-up frequency, and diabetes education previous experience with instrument where necessary), recollection of hyperglycaemic emergency (including previous DKA admission where appropriate), and understanding of DKA. Awareness items measured awareness of the seriousness of the condition and the overall understanding of the condition (e.g., how insulin is missed, how vomiting/poor intake may trigger the condition, how the signs and symptoms are recognized, as well as how the person undertakes preventive precautions during an episode, how he/she understands that ketone tests are necessary, and how he/she responds in an emergency. The contents of the questionnaires were consistent with the generally suggested sick-day education concepts, such as the necessity of ketone testing every 4- 6 hours when someone is unwell and the need to seek emergency treatment when they have the signs indicative of DKA. To measure awareness, scoring was done by giving 1 point to a correct response and 0 points to an incorrect response or a don't know response, making the total amount to 0 to 20. The awareness was classified into poor (<10), moderate (1014), and good (15). The standard statistical procedures were used to enter and analyze the data. Frequencies and percentages were used to summarize the categorical variables and the mean plus standard deviation (or median and interquartile range when necessary) was used to summarize the continuous variables. The initial assessment of associations between the awareness category and independent variables (education level, insulin use, prior diabetes education, prior exposure to DKA, etc.) was based on chi-square tests. The variables that were meaningfully related or theoretically significant were represented in a multivariate logistic regression analysis in which a dependant variable (good awareness) was used; adjusted odds ratio (AOR) with 95% confidence interval was provided, and significance was defined as $p<0.05$. Informed consent was taken and the relevant institutional review body gave ethical approval, the respondents were informed of their rights to withdrawal and anonymization of their responses and it was voluntary participation.

Results

Participant characteristics

A total of **162 respondents** were included: **108 (66.7%)** diabetic patients and **54 (33.3%)** caregivers. The mean age was **44.2 ± 13.8 years** (range **18–75**). Females constituted **92 (56.8%)**. Education levels were: no formal/primary **48 (29.6%)**, secondary **47 (29.0%)**, and above secondary **67 (41.4%)**. Urban residents comprised **101 (62.3%)**. Among patients (n=108), **46 (42.6%)** were on insulin therapy (with/without oral agents), and **14 (13.0%)** reported prior DKA hospitalization.

Table 1. Socio-demographic and clinical characteristics

Variable	Category	n (%)
Respondent type	Patient	108 (66.7)
	Caregiver	54 (33.3)
Sex	Male	70 (43.2)
	Female	92 (56.8)
Age group (years)	18–29	26 (16.0)
	30–44	52 (32.1)
	45–59	56 (34.6)
	≥60	28 (17.3)
Education	No formal/Primary	48 (29.6)
	Secondary	47 (29.0)
	Above secondary	67 (41.4)
Residence	Urban	101 (62.3)
	Rural/peri-urban	61 (37.7)
Structured diabetes education	Yes	72 (44.4)
	No	90 (55.6)
Treatment (patients only)	Insulin (± OAD)	46 (42.6)
	Oral agents only	62 (57.4)
Prior DKA admission (patients only)	Yes	14 (13.0)
	No	94 (87.0)

Awareness score and categories

The mean DKA awareness score (0–20) was **12.1 ± 4.2**. Using predefined cutoffs, **64 (39.5%)** had poor awareness, **47 (29.0%)** moderate awareness, and **51 (31.5%)** good awareness.

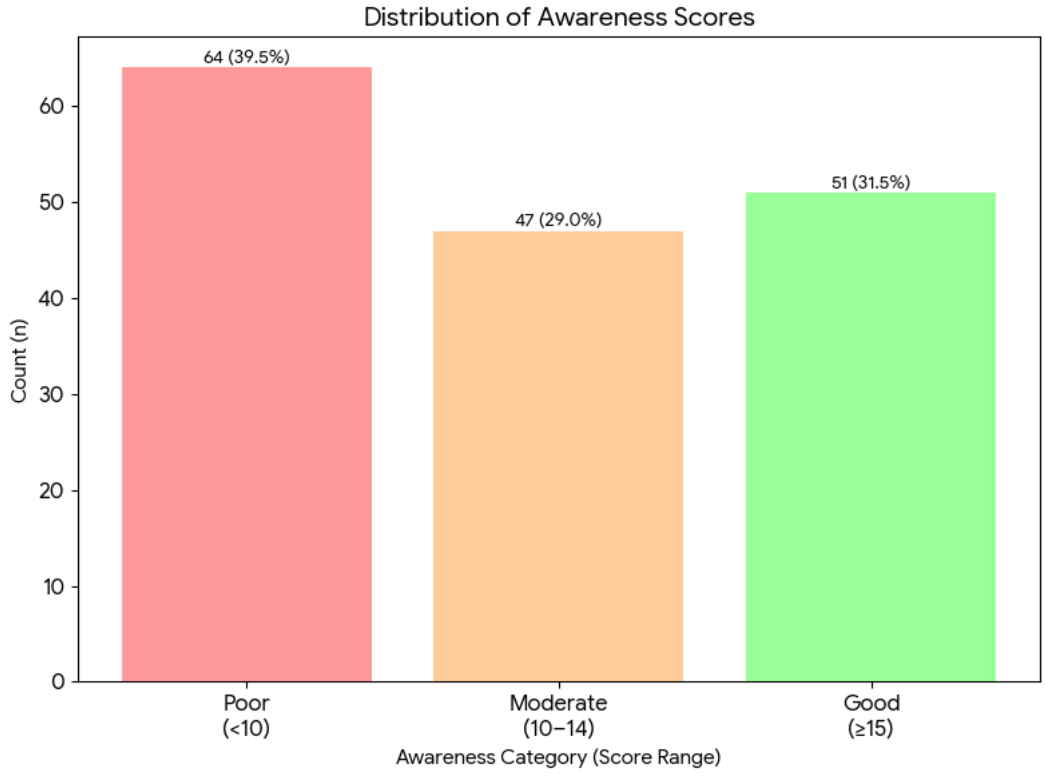

Figure. 1. showing the distribution of participants categorized into poor (<10), moderate (10–14), and good (≥15) awareness levels.

Domain-specific awareness

Most respondents recognized that DKA can be life-threatening (**121, 74.7%**). However, fewer understood the underlying concept of insulin deficiency leading to ketone buildup

and acidosis (**58, 35.8%**). Missed insulin (**60.5%**) and infection (**50.6%**) were recognized triggers more often than vomiting/poor intake (**40.7%**). Symptom recognition was highest for polyuria/polydipsia (**71.6%**) and nausea/vomiting (**56.8%**). Recognition of severe warning signs remained low: deep/rapid breathing (**22.2%**) and fruity breath (**19.1%**). Knowledge of ketone testing was limited (**24.7%**) and only **13.0%** reported having ketone strips at home.

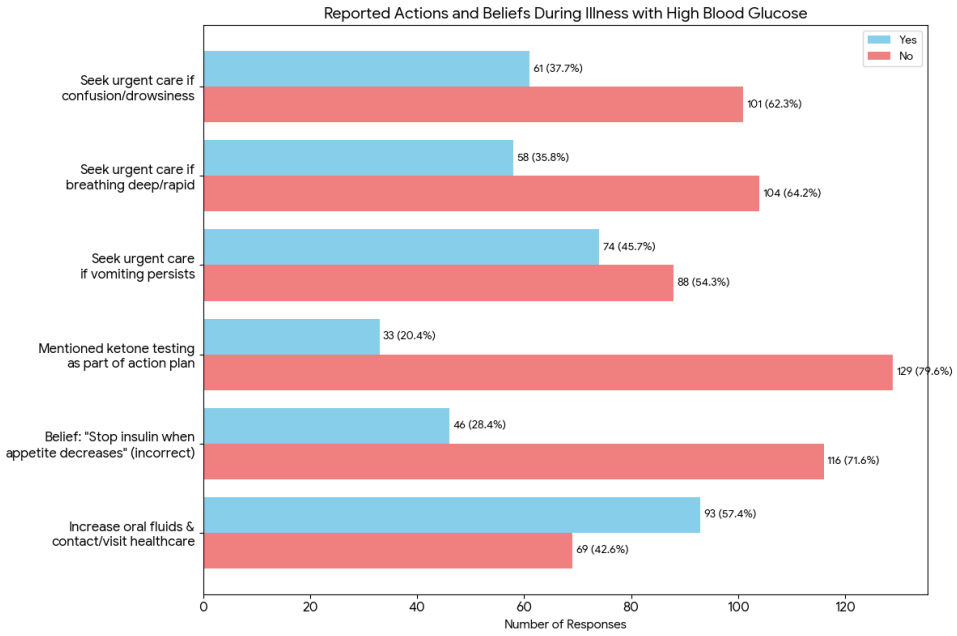

Figure.2. Graph showing reported actions and beliefs regarding sick-day management in patients with high blood glucose

Sick-day actions and misconceptions

When asked about actions during illness with high glucose, **93 (57.4%)** stated they would increase fluids and contact/visit a healthcare facility. However, **46 (28.4%)** believed insulin should be stopped if appetite decreases, and only **33 (20.4%)**explicitly mentioned ketone testing or urgent evaluation if vomiting or breathing difficulty develops.

Table 4. Reported actions during illness with high blood glucose

Response item (during illness + high glucose)	**Yes n (%)**	**No n (%)**
Increase oral fluids and contact/visit healthcare facility	93 (57.4)	69 (42.6)
Belief: “Stop insulin when appetite decreases” (incorrect)	46 (28.4)	116 (71.6)
Mentioned ketone testing as part of action plan	33 (20.4)	129 (79.6)
Seek urgent care if vomiting persists	74 (45.7)	88 (54.3)
Seek urgent care if breathing becomes deep/rapid	58 (35.8)	104 (64.2)
Seek urgent care if confusion/drowsiness occurs	61 (37.7)	101 (62.3)

Predictors of good awareness

In multivariable logistic regression, above-secondary education (AOR 2.7; 95% CI 1.4–5.3), prior structured diabetes education (AOR 2.4; 95% CI 1.2–4.7), and prior DKA exposure (AOR 3.1; 95% CI 1.1–8.7) were independent predictors of good awareness.

Table 5. Multivariable logistic regression for predictors of good DKA awareness

Predictor	**Adjusted Odds Ratio (AOR)**	**95% CI**	**p-value**
Education above secondary (vs	2.7	1.4–5.3	0.003

≤secondary)			
Structured diabetes education (yes vs no)	2.4	1.2–4.7	0.011
Prior DKA exposure (yes vs no)	3.1	1.1–8.7	0.036
Caregiver (vs patient)	1.2	0.6–2.4	0.58

Discussion

In this study, the awareness level of diabetic ketoacidosis (DKA) in diabetic patients and their caregivers was evaluated in Peshawar using 162 samples. Overall awareness was not good because only a minority of the participants scoring good in the awareness score. The most notable gaps were in the more practical fields of their application- the lack of knowledge in ketone testing and awareness of serious warning signs (i.e. the deep/rapid breathing and fruity breath). These results are an indication that though many respondents might be aware of DKA as a severe condition, a large percentage of respondents are still unaware of the specific knowledge they need to identify it early and respond promptly when they are sick [11].

One of the findings was a lack of awareness in relation to ketone testing. Patient education sources and international guidelines have recommended that ketones should be monitored during intercurrent illness and/or persistent hyperglycaemia and emergency treatment should be given when ketones occur in combination with other signs such as vomiting, dehydration, or changes in breathing [12]. In the absence of proper knowledge of when and how to monitor ketones, patients and caregivers could delay till DKA progresses to advanced stages, which predisposes them to extreme dehydration, acidosis, and hospitalization. In setting whiere ketone strips are not regularly provided or are seen as unnecessary, the knowledge gap can be additionally complicated by access barriers. The small percentage of those who report having ketone-strips at home indicates an education-and-access problem instead of the knowledge problem [13].

Limited understanding on severe clinical signs was also identified. Although expected hyperglycaemia-related symptoms, including excessive thirst and urine, were often detected, less people were aware of such characteristic severe cases as Kussmaul breathing or fruity breath [14]. This is a potentially clinically significant pattern: serious symptoms are not usually random, but they usually represent more serious metabolic disturbances and need immediate evaluation. In practice, the initial symptoms can be treated with home remedies or delayed outpatient care by patients and families, whereas the acute signs provoke emergency treatment. Outpatient clinic educational messages should thus clearly point out on red flag symptoms and the urgency that they depict [15].

The other alarming observation is the persistence of the misconceptions related to management of insulin during illness. The large percentage of respondents thought that the insulin should be discontinued when the level of appetite reduces. This misconception is dangerous as the stress hormones associated with illness tend to aggravate hyperglycaemia, and discontinuation of insulin may increase the rate of ketogenesis and induce DKA. ick-day guidance usually include the advice to continue insulin basal therapy and a systematic approach to glucose monitoring, fluid intake, and dose adjustment under the supervision of a professional [16]. This is one of the misconceptions that should be taken care of during diabetes counseling sessions, especially among the insulin treated patients.

The analysis has shown that better awareness was correlated with higher education and previously organized diabetes educational training. It aligns with the evidence on health literacy in general: education helps understand counseling messages, printed information, and structured diabetes education would give repeated exposure to key principles of self-management (glucose monitoring, sick-day rules, ketone monitoring,

and emergency thresholds). Awareness was also better when there was prior exposure to DKA (self or family history) and this probably represents learning following a serious event. However, using the experience of the hospital to enhance awareness is not acceptable; prevention must be suggested by an active education prior to the emergence of an emergency [17].

In the country with high diabetes burden such as in Pakistan, there is a high need to optimize outpatient education. According to the IDF estimates, the number of adults with diabetes in Pakistan is very high, and prevention programs that could minimize the number of acute crisis and emergency admissions are of high priority. Caregivers tend to have an impact on treatment choices in acute illness in Peshawar in particular and therefore caregiver-inclusive education is important [16,17].

Conclusion

This article examined the level of DKA awareness between diabetic patients and their caregivers in Peshawar (n=162). There was poor awareness on key actionable areas, especially ketone testing, recognition of severe warning signs, and proper sick-day insulin practices. Increased awareness was accredited to higher education, formatted diabetes education, and previous exposure to DKA, which implies that more meaningful raise in knowledge were conveyed by enhanced counseling and systematic education procedures. It is suggested to reinforce the role of routine clinic-based education, internalize the participation of caregivers, and enhance access to ketone testing supplies to promote earlier recognition and timely care-seeking, thus preventing preventable DKA-related morbidity.

References:

Wondie, Y., Minwuyelet, A., Bogale, A. D., Hailu, G., & Mengstie, E. A. (2025). Risk factors of diabetic ketoacidosis among patients with diabetes attending at public hospitals of East Gojjam Zone, Northwest Ethiopia: an unmatched case - control study. BMC endocrine disorders, 25(1), 222. https://doi.org/10.1186/s12902-025-02023-x

Eltom, E. H., Alali, A. O. A., Alanazi, R. K. M., Alanazi, A. A. M., Albalawi, M. A. A., Alanazi, S. A. N., Alanazi, M. S. G., Badawy, A. A., Mokhtar, N., & Fawzy, M. S. (2024). Exploring Awareness Levels of Diabetic Ketoacidosis Risk Among Patients with Diabetes: A Cross-Sectional Study. Clinics and Practice, 14(6), 2681-2692. https://doi.org/10.3390/clinpract14060211.

Barski L, Nevzorov R, Rabaev E, et al. Diabetic ketoacidosis: clinical characteristics, precipitating factors and outcomes of care. Isr Med Assoc J. 2012;14:299–303.

Kakusa M, Kamanga B, Ngalamika O, Nyirenda S. Comatose and noncomatose adult diabetic ketoacidosis patients at the University Teaching Hospital, Zambia: clinical profiles, risk factors, and mortality outcomes. Indian J Endocrinol Metab. 2016;20:199–205. doi:10.4103/2230-8210.176358.

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

Kitabchi AE, Umpierrez GE, Murphy MB, Kreisberg RA. Hyperglycemic crises in adult patients with diabetes: a consensus statement from the American Diabetes Association. Diabetes Care. 2006;29:2739–2748. doi:10.2337/dc06-9916.

Shaltout AA, Channanath AM, Thanaraj TA, et al. Ketoacidosis at first presentation of type 1 diabetes mellitus among children: a study from Kuwait. Sci Rep. 2016;6:27519. doi:10.1038/srep27519.

Mahesh MG, Shivaswamy RP, Chandra BJS, Syed S. The study of different clinical pattern of diabetic ketoacidosis and common precipitating events and independent mortality factors. J Clin Diagn Res. 2017;11:42–46. doi:10.7860/JCDR/2017/25347.9760.

Lone SW, Siddiqui EU, Muhammad F, Atta I, Ibrahim MN, Raza J. Frequency, clinical characteristics and outcome of diabetic ketoacidosis in children with type-1 diabetes at a tertiary care hospital. J Pak Med Assoc. 2010;60:725–729.

Muneer M, Akbar I. Acute metabolic emergencies in diabetes: DKA, HHS and EDKA. Adv Exp Med Biol.2021;1307:85–114. doi:10.1007/5584_2020_545.

Farran BA, Bin Elaiwah RI, Aldarsouny AT, et al. Level of awareness of diabetic ketoacidosis among diabetes mellitus patients in Riyadh. J Family Med Prim Care. 2020;9:2676–2679. doi:10.4103/jfmpc.jfmpc_385_20.

Thakare PS, Ankar R. To assess the knowledge regarding signs and symptoms of diabetic ketoacidosis and its prevention among diabetes patients in Wardha district, Maharashtra, India. J Evolution Med Dent Sci. 2021;10:1413–1416.

Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011;94:311–321. doi:10.1016/j.diabres.2011.10.029.

Schneider S. Hyperglycemic crisis in patients with diabetes mellitus [Article in German]. Med Klin Intensivmed Notfmed. 2012;107:435–439. doi:10.1007/s00063-012-0114-1.

Alanazi AM, Alotaibi AJ, Albakheit HA, Aldewish SN, Alenzi MKA, Salim AA. Awareness of risk factors of DKA among diabetic adults in KSA. Egypt J Hosp Med. 2018;71:2304–2309.

Elhassan AB, Saad MM, Salman MS, Ibrahim A, Ali A, Alla AA, Saad FM. Diabetic ketoacidosis: knowledge and practice among patients with diabetes attending three specialized diabetes clinics in Khartoum, Sudan. Pan Afr Med J.2022;41:299. doi:10.11604/pamj.2022.41.299.31129.

Satti SA, Saadeldin IY, Dammas AS. Diabetic ketoacidosis in children admitted to Pediatric Intensive Care Unit of King Fahad Hospital, Al-Baha, Saudi Arabia: precipitating factors, epidemiological parameters and clinical presentation. Sudan J Paediatr. 2013;13:24–30.