

Diabetic ketoacidosis awareness among caregivers of type 1 diabetic children attending King Fahd Hospital, Khobar, Saudi Arabia

Abdullah Yousef^{1,2}, Mohammad Al-Qahtani^{1,2}, Lama Alfahhad², Zaineb Alhalal², Luluwh Albadeeb², Dina Alhatlani²

¹Department of Pediatrics, King Fahd Hospital of the University, Al-Khobar, Saudi Arabia; ²College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Abstract. *Background and aim:* Diabetic ketoacidosis (DKA) is a severe acute complication of diabetes mellitus, often precipitated by infections, insulin omission, and acute stress. Effective management of diabetes and awareness of risk factors can prevent this life-threatening condition. This study assesses the awareness of primary caregivers about the precipitating factors, symptoms, and preventive measures against DKA in children with type 1 diabetes. *Methods:* A cross-sectional, interview-based study was conducted at King Fahd Hospital of the University, Saudi Arabia. It involved 173 caregivers and 183 children over a three-month period. *Results:* Findings indicate that 78.6% of caregivers understood the definition of DKA, 90.8% recognized its dangerous nature, and 76.9% were aware of its precipitating factors, with insulin omission (40.5%) being the most acknowledged. Commonly recognized symptoms included nausea and vomiting (50.3%), abdominal pain (38.2%), and altered consciousness (37.6%). However, 56.6% of caregivers were unaware of DKA complications. In an emergency, 76.3% would immediately seek hospital care, and 71.7% identified insulin compliance as a key preventive strategy. *Conclusions:* The study underscores the necessity of diabetes education for caregivers. Enhanced understanding of the disease, its complications, and appropriate emergency responses is essential to prevent DKA. The data suggest a need for comprehensive education programs to improve caregivers' awareness and management skills. (www.actabiomedica.it)

Key words: diabetic ketoacidosis, type 1 diabetes, awareness, children, caregivers

Introduction

Type 1 Diabetes Mellitus (T1DM) is a prevalent endocrine disorder characterized by insulin deficiency, typically manifesting as a symptomatic triad of polyuria, polydipsia, and polyphagia (1). Annually, an estimated 79,000 children are diagnosed with T1DM (2), and its incidence in childhood is increasing globally. In Saudi Arabia, the incidence rate in children aged 0-14 years is approximately 31.4 per 100,000 annually, highlighting its significance as a regional health concern (3). Diabetic ketoacidosis (DKA), a serious

complication of T1DM marked by hyperglycemia, acidosis, and ketonuria, affects roughly one-third of T1DM patients (1,4). Various factors, such as acute stress, infection, or missed insulin doses, can precipitate DKA (1). Hence, identifying factors linked to DKA is essential for its prevention and effective management.

Parental awareness significantly impacts the risk of DKA in children with T1DM. Factors like low socioeconomic status, parental illiteracy, and a lack of clinical expertise are notable risk determinants for severe DKA episodes (4). Evidence suggests that children with tertiary-educated parents have a reduced

risk of DKA (5), emphasizing the importance of caregiver education and awareness in mitigating DKA incidence.

While local studies have explored parental DKA awareness, specific data from Khobar remains limited. This study seeks to evaluate the awareness level of primary caregivers concerning the risk factors, symptoms, early signs, and preventive measures for DKA among T1DM children at King Fahad Hospital of the University (KFHU) in Khobar, Saudi Arabia. In Riyadh, 70% of caregivers recognized DKA by its distinct breath smell, vomiting (66.2%), and body weakness (60.6%) (6). Conversely, a study in Abha revealed that over one-third of parents lacked essential knowledge about DKA. This knowledge gap was notably linked with being a father, aged over 40, low socioeconomic status, and non-healthcare-related occupations (7).

Patients and methods

Study design, setting and time

This cross-sectional, interview-based study was conducted at the diabetic pediatrics clinics of King Fahad Hospital of the University (KFHU) in the Eastern Province. The study spanned four months, from November 2022 to February 2023.

Sample size

A total of 221 questionnaires were initially completed by caregivers. After applying exclusion criteria, the final sample included 173 parents and 183 children.

Data collection

Data were gathered across three clinics using a structured questionnaire. The questionnaire collected information on demographics, knowledge about diabetic ketoacidosis (DKA), and the children's history of DKA.

Data analysis

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) software,

version 26. Qualitative data were presented as numbers and percentages, while quantitative variables were summarized as mean and standard deviation.

Variables

The study assessed various variables, including caregiver demographics, children's health status, and awareness of DKA.

Ethical approval

Ethical clearance was granted by the international review board (IRB-UGS-2022-01-406) on October 26, 2022, valid for 12 months. Verbal consent was obtained from all participants after explaining the study's nature and objectives. To ensure a high level of confidentiality and privacy, no names or personal identifiers were recorded.

Results

The mean age of caregivers was 41.57 ± 8.23 years, predominantly mothers (69.9%). Most caregivers were of Saudi nationality (98.3%), residing in the eastern region of Saudi Arabia (98.8%). A significant proportion were married (87.3%), with 45.1% reporting a monthly income exceeding 10,000 SR. Among the caregivers, 7.5% were healthcare professionals, and an equal percentage had a diagnosis of type 2 diabetes.

For the children, the mean age was 11.22 ± 3.62 years, with a slight female majority (56.3%). The average duration of diabetes was 4.14 ± 3.42 years. Notably, 65% of the children demonstrated excellent school performance, and 57.9% had no school absences due to diabetes. Comorbidities like celiac and thyroid diseases were present in a small fraction (3.3%). The children's mean HbA1c value stood at $8.68 \pm 2.88\%$.

In terms of DKA awareness, 78.6% of caregivers understood the definition of DKA, 90.8% acknowledged its severity, and 76.9% were aware of its precipitating factors, notably insulin omission (40.5%). The most recognized symptoms were nausea and vomiting (50.3%). However, 56.6% of caregivers lacked

knowledge about DKA complications. In a potential DKA scenario, 76.3% would immediately seek emergency care, and 71.7% emphasized the importance of insulin adherence for prevention.

Table 1. Sociodemographic of primary caregivers (No.:173).

Variable	No. (%)
Age of the caregiver	41.57 ± 8.23
Relationship to the patient - Father	46 (26.6%)
Relationship to the patient - Mother	121 (69.9%)
Relationship to the patient - Other	6 (3.5%)
Nationality - None-Saudi	3 (1.7%)
Nationality - Saudi	170 (98.3%)
Region of residence - Eastern Region	171 (98.8%)
Region of residence - Central	1 (0.6%)
Region of residence - Southern	1 (0.6%)
Marital Status - Divorced	11 (6.4%)
Marital Status - Married	151 (87.3%)
Marital Status - Single	3 (1.7%)
Marital Status - Widow(ed)	8 (4.6%)
Educational level - No education	1 (0.6%)
Educational level - Elementary	8 (4.6%)
Educational level - Middle school	16 (9.2%)
Educational level - High school	69 (39.9%)
Educational level - University	73 (42.2%)
Educational level - Postgraduate studies	6 (3.5%)
Monthly income < 5000	28 (16.2 %)
Monthly income 5000-10000	67 (38.7 %)
Monthly income > 10000	78 (45.1 %)
Both parents alive - No, father deceased	12 (6.9 %)
Both parents alive - No, mother deceased	4 (2.3 %)
Both parents alive - Yes	157 (90.8 %)
Healthcare worker - No	82 (47.4 %)
Healthcare worker - Yes	78 (45.1 %)
Diabetes mellitus - No	156 (90.2 %)
Diabetes mellitus - Yes, T1DM	4 (2.3 %)
Diabetes mellitus - Yes, T2DM	13 (7.5 %)
Number of children with T1DM - One	146 (84.4 %)
Number of children with T1DM - Two	24 (13.9 %)
Number of children with T1DM - Three	3 (1.7 %)
Mean number of children with T1DM	1.17 ± 0.42

Abbreviations: T1DM: Type 1 diabetes mellitus; T2DM: Type 2 diabetes mellitus.

Table 2. Sociodemographics of the child and other identifying factors of health (No.:183).

Variable	No. (%)
Age of the child (Year)	11.22 ± 3.62
Gender - Female	103 (56.3 %)
Gender - Male	80 (43.7 %)
How long have they had T1DM? (Year)	4.14 ± 3.42
School performance - Doesn't go to school yet	14 (7.7 %)
School performance - Excellent	119 (65 %)
School performance - Very good	41 (22.4 %)
School performance - Good	7 (3.8 %)
School performance - Pass	2 (1.1 %)
Absenteeism - Doesn't go to school yet	16 (8.7 %)
Absenteeism - Absent most days of the month	11 (6 %)
Absenteeism - Absent some days of the month	50 (27.3 %)
Absenteeism - Never absent	106 (57.9 %)
Child is on strict diabetic diet	58 (31.7 %)
Child is not on strict diabetic diet	117 (63.9 %)
Don't know if child is on strict diabetic diet or not	8 (4.4 %)
Chronic medical condition - Asthma	2 (1.1 %)
Chronic medical condition - Blood disease	2 (1.1 %)
Chronic medical condition - Celiac disease	4 (2.2 %)
Chronic medical condition - Down syndrome	2 (1.1 %)
Chronic medical condition - Eczema	1 (0.5 %)
Chronic medical condition - Eyes and joints disease	1 (0.5 %)
Chronic medical condition - Growth hormone deficiency	1 (0.5 %)
Chronic medical condition - Lactose intolerance	1 (0.5 %)
Chronic medical condition - Obesity	1 (0.5 %)
Chronic medical condition - Thrombocytopenia	1 (0.5 %)
Chronic medical condition - Thyroid disease	6 (3.3 %)
Chronic medical condition - Not diagnosed with any medical condition	161 (88 %)
Chronic medical condition - Child's last HbA1c	8.68 ± 2.88%

Abbreviations: T1DM: Type 1 diabetes mellitus; ASD: Autism spectrum disorder; OCD: Obsessive-compulsive disorder.

Table 3. Caregivers' knowledge regarding DKA (No.: 173).

Variable	No. (%)
The statement "DKA is a state of high blood sugar and acidity in the blood" is true	136 (78.6 %)
The statement "DKA is a state of high blood sugar and acidity in the blood" is partially true	10 (5.8 %)
The statement "DKA is a state of high blood sugar and acidity in the blood" is false	12 (6.9 %)
I don't know if the statement "DKA is a state of high blood sugar and acidity in the blood" is true or not	15 (8.7 %)
DKA is dangerous	157 (90.8 %)
DKA is not dangerous	7 (4 %)
I don't know if DKA is dangerous or not	9 (5.2 %)
There are preceipitating factors	133 (76.9 %)
There are no preceipitating factors	6 (3.5 %)
I don't know if there are preceipitating factors or not	34 (19.7 %)
Preceipitating factors - Omission of insulin	70 (40.5 %)
Preceipitating factors - Stress	25 (14.5 %)
Preceipitating factors - Infection	21 (12.1 %)
Preceipitating factors - Loss of fat at the sites of injection	2 (1.2 %)
Preceipitating factors - Not following diabetes diet	13 (7.5 %)
Preceipitating factors - Recurrent high blood glucose	16 (9.2 %)
Preceipitating factors - Dehydration	1 (0.6 %)
Preceipitating factors - High stomach acidity	1 (0.6 %)
Preceipitating factors - Failure to measure glucose levels regularly	2 (1.2 %)
Preceipitating factors - Low blood insulin levels	1 (0.6 %)
Preceipitating factors - High blood ketones	1 (0.6 %)
Preceipitating factors - Ketones in urine	1 (0.6 %)
Preceipitating factors - I don't know	1 (0.6 %)
Signs and symptoms of DKA - Abdominal pain	66 (38.2 %)
Signs and symptoms of DKA - Nausea and vomiting	87 (50.3 %)
Signs and symptoms of DKA - Change in consciousness level	65 (37.6 %)

Variable	No. (%)
Signs and symptoms of DKA - Polyuria, polydipsia, polyphagia	61 (35.3 %)
Signs and symptoms of DKA - Dryness in skin and mouth	31 (17.9 %)
Signs and symptoms of DKA - Fruity odor in the breath	35 (20.2 %)
Signs and symptoms of DKA - Increase in rate of breathing	14 (8.1 %)
Signs and symptoms of DKA - Blurry vision	9 (5.2 %)
If patient has DKA - I go to ER if something serious happens	13 (7.5 %)
If patient has DKA - I go to ER immediately	132 (76.3 %)
If patient has DKA - I give the child water	19 (11 %)
If patient has DKA - Increase insulin dose	41 (23.7 %)
If patient has DKA - I give the child juice or candy	8 (4.6 %)
If patient has DKA - I visit the doctor whenever they're available	1 (0.6 %)
If patient has DKA - I do nothing, it is not dangerous	0 (0 %)
If patient has DKA - I don't know	9 (5.2 %)
DKA Prevention - Give insulin doses on time and always	124 (71.7 %)
DKA Prevention - Dietary adjustments	18 (10.4%)
DKA Prevention - Keep changing the sites of injection	5 (2.9 %)
DKA Prevention - Treat infections and prevent times of acute stress	6 (3.5 %)
DKA Prevention - Decrease insulin doses	1 (0.6 %)
DKA Prevention - It happens suddenly, I can't stop it	2 (1.2 %)
DKA Prevention - I don't know	41 (23.7 %)
Complications of DKA - Coma	43 (24.9 %)
Complications of DKA - Kidney and other organ failure	26 (15 %)
Complications of DKA - Death	14 (8.1 %)
Complications of DKA - Pulmonary edema	1 (0.6 %)
Complications of DKA - I don't know	98 (56.6 %)

Abbreviation: DKA: Diabetic ketoacidosis.

Table 4. Caragivers' knowledge regarding DM control (No.: 173).

Variable	No. (%)
Normal fasting blood sugar - Less than 70 mg/dL	1 (0.6 %)
Normal fasting blood sugar - 70-99 mg/dL	94 (54.3 %)
Normal fasting blood sugar - 100-125 mg/dL	54 (31.2 %)
Normal fasting blood sugar - More than 125 mg/dL	12 (6.9 %)
Normal fasting blood sugar - I don't know	12 (6.9 %)
Normal blood sugar after 2 hours of food - 71-140 mg/dL	67 (38.7 %)
Normal blood sugar after 2 hours of food - 141-199 mg/dL	66 (38.2 %)
Normal blood sugar after 2 hours of food - More than 200 mg/dL	21 (12.1 %)
Normal blood sugar after 2 hours of food - I don't know	19 (11 %)
The ideal HbA1C to diabetic patients - Less than 5.5%	16 (9.2 %)
The ideal HbA1C to diabetic patients - 5.5 % -7.5 %	120 (69.4 %)
The ideal HbA1C to diabetic patients - More than 7.5 %	22 (12.7 %)
The ideal HbA1C to diabetic patients - I don't know	15 (8.7 %)

Abbreviation:DM: Diabetes mellitus.

Table 5. Children's history of DKA (No.:183).

Variable	No. (%)
Had DKA before	107 (58.5 %)
Didn't have DKA before	76 (41.5 %)
For those who had DKA before (No.:107)	
Required ICU admission	91 (85.1 %)
Didn't require ICU admission	16 (14.9 %)
DKA events - 1-2 times per year	28 (26.1 %)
DKA events - 3-4 times per year	17 (15.8 %)
DKA events - 1-3 times a life	58 (54.4 %)
DKA events - 4-7 times a life	3 (2.8 %)
DKA events - Don't know	1 (0.9 %)
DKA was associated with precipitating factors	55 (51.5 %)
DKA wasn't associated with precipitating factors	52 (48.5 %)

Abbreviations: DKA: Diabetic ketoacidosis; ICU: Intensive care unit.

Regarding diabetes management, 54.3% of caregivers correctly identified the normal fasting blood sugar range (70-99 mg/dL), while 38.7% accurately knew the postprandial range (71-140 mg/dL). Approximately 69.4% believed the ideal HbA1c level for diabetic patients to be between 5.5% and 7.5%.

Data indicated that 58.5% of the children had a DKA history, with 54.4% experiencing it 1-3 times. The majority of DKA incidents (85.1%) necessitated ICU admission, and 51.5% of these episodes were associated with identifiable precipitating factors.

Discussion

This study assessed caregivers' awareness of diabetic ketoacidosis (DKA) in children with Type 1 Diabetes Mellitus (T1DM), focusing on symptoms, risk factors, complications, and emergency response. While a significant majority recognized the definition and danger of DKA, knowledge gaps in its precipitating factors and complications were evident, indicating a need for enhanced diabetes education among caregivers.

It is notable that 78.6% of caregivers understood the definition of DKA, a figure comparable to a study conducted in Riyadh where 70% of caregivers recognized DKA by distinct breath smell, vomiting, and body weakness (6). However, in this study, 40.5% identified skipping insulin doses as a precipitating factor, highlighting the necessity for broader education on other critical factors. Additionally, the lack of awareness of DKA complications (56.6%) echoes findings from a study in Abha, where over one-third of parents showed a knowledge gap, significantly associated with various demographics (7).

The understanding of common DKA symptoms, such as nausea and vomiting, was relatively high, yet recognizing other early signs needs improvement. This early detection is crucial for prompt intervention, potentially preventing severe DKA episodes. Encouragingly, the majority (71.7%) acknowledged the importance of insulin adherence, aligning with previous literature emphasizing insulin therapy as a cornerstone of diabetes management (8).

Furthermore, the high incidence of DKA among the children in this study, with 54.4% experiencing it 1-3 times and the majority requiring ICU admission, underscores the severity and frequency of DKA episodes, mirroring trends observed in other regional studies (7,9).

Conclusion

This study illuminates the level of DKA awareness among caregivers of children with T1DM. Although the understanding of DKA's definition and danger is relatively high, significant gaps in recognizing precipitating factors and complications persist. Comprehensive education on DKA risk factors, early signs, symptoms, and timely intervention is vital.

Enhancing caregivers' knowledge and awareness is pivotal in better managing T1DM, reducing severe DKA incidence, and ultimately improving children's health and well-being. Tailored diabetes education programs and interventions are recommended to promote early recognition and appropriate responses to DKA episodes.

Limitations and recommendations

Limitations of the study do not affect the results nor the significance of the study. They are just to illustrate possible roadblocks that have been faced that could be avoided in future studies. Limitations include small sample size, and one-center study. Furthermore, possible biases such as recall, interviewer, and social desirability. Recommendations for future studies is to include more caregivers and centers.

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Ethics Committee: The study was approved by Institutional Review Board at Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia. IRB number: IRB-UGS-2022-01-406. Approval date: 26/10/2022

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Correspondence:

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Zaineb Alhalal, MBBS
Imam Abdulrahman bin Faisal University
Dammam, 31441, Saudi Arabia
Phone: +966 541090991
E-mail: zaynabalhalal@gmail.com