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Original article

Diabetic Ketoacidosis in Libya: Clinical Characteristics, Triggers, and Hospital Outcomes from a Tertiary Care Center

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Abstract
Diabetic ketoacidosis (DKA) is a serious and potentially life-threatening complication of diabetes, most commonly associated with type 1 diabetes. Understanding the clinical profile, factors, and outcomes of DKA is essential for timely intervention and effective management. This study aims to assess the clinical profile and precipitating factors of DKA among patients admitted to Misurata Medical Center, to improve early recognition and management strategies. A retrospective descriptive study was conducted on 113 patients diagnosed with DKA. Data were collected from hospital records and included demographic details, type of diabetes, presenting symptoms, biochemical parameters, precipitating factors, treatment modalities, and hospital outcomes. The mean age of patients was 27.7 years, with nearly half aged 20 or younger. The majority were female (55.8%) and had type 1 diabetes (98.2%). Insulin omission (49.1%) and infections (26.8%) were the most common precipitating factors. Common symptoms included nausea and vomiting (42.7%) and abdominal pain (17.5%). Severe hyperglycemia (≥400 mg/dL) and metabolic acidosis (pH ≤ 7.2) were present in more than half of patients. The vast majority recovered with short hospital stays (≤3 days in 90.3%). Recurrent DKA was reported in 50 %(39/78) of cases, and complication rates were low (1.8%), with no in-hospital mortality. DKA remains a common and preventable acute complication of diabetes, particularly among young individuals with diabetes. Insulin omission and infection were the leading precipitating factors, suggesting gaps in adherence and patient education. The findings support the development of localized DKA management protocols and further research into long-term outcomes and risk factors.
Keywords: Diabetic ketoacidosis; Type 1 diabetes mellitus; Insulin omission; Infection; Clinical profile; Metabolic acidosis; Hospital outcomes.

Introduction

DKA is a metabolic emergency characterized by hyperglycemia, ketosis, and metabolic acidosis resulting from absolute or relative insulin deficiency, accompanied by increased counter-regulatory hormone activity including glucagon, catecholamines, cortisol, and growth hormone. This triggers lipolysis and the release of free fatty acids, which undergo hepatic ketogenesis, resulting in metabolic acidosis. Left untreated, it rapidly progresses to altered mental status and cardiovascular collapse and may result in death if not promptly treated. Recognition of other forms of DKA, such as Euglycemic diabetic ketoacidosis (euDKA), has increased in recent years, particularly following the introduction of sodium-glucose cotransporter-2 (SGLT2) inhibitors, creating additional diagnostic challenges that may potentially delay diagnosis and treatment. (1–3)

DKA continues to be a major cause of morbidity, mortality, hospitalization, and healthcare utilization worldwide. (4–6) According to the 2024 consensus report, the incidence of hyperglycemic emergencies in both T1DM and T2DM has significantly increased, with recent data reporting a global increase in DKA hospitalizations, especially in adults younger than 45 years, by approximately 55% in the past decade. (7–13) This may have contributed to a marked increase in DKA-related healthcare costs, with an estimated cost burden for DKA hospitalization in the United States alone of $5.1 billion in 2014. (14) The report highlights regional disparities in DKA-related mortality, with a mortality rate below 1% in developed healthcare settings. However, in other resource-constrained healthcare settings, mortality rates remain substantially higher, such as in sub-Saharan Africa (26% to 41.3%) and Pakistan (23.6%). (15,16)

Infection is widely recognized as a leading precipitating factor for DKA; however, reported rates vary considerably across populations (14–58%). Several studies from other resource-constrained healthcare settings have identified insulin omission as the most common precipitating factor. Considerable geographic variation exists, likely reflecting differences in healthcare access, socioeconomic conditions, and underlying disease patterns across populations. (17–19)

Understanding DKA in the MENA region is increasingly important because of the rapidly rising burden of diabetes. The region has the highest regional prevalence (17.6%) and is projected to experience the second-largest increase in diabetes burden by 2050 (92%). Despite accounting for 14.4% of the global diabetes population, the region contributes only 3.4% of worldwide diabetes-related healthcare expenditure. (20)

DKA incidence, precipitating factors, and outcomes vary considerably across regions, suggesting the influence of geographic, socioeconomic, and healthcare- and population- related factors. Therefore, regional studies are essential to determine the true local prevalence of DKA and identify precipitating factors that can inform targeted prevention strategies, resource allocation, and clinical management policies. (19,21,22)

Recent data indicate that the incidence of T1DM in Libya has been increasing. Khashebi et al. reported a 2.1% annual rise in childhood T1DM incidence between 2009 and 2018, with an age-standardized incidence rate of 31.7 per 100,000 children during 2014–2018, representing more than a threefold increase compared with earlier local studies. (23,24) Despite the growing burden of diabetes in Libya, data regarding the epidemiology and precipitating factors of DKA remain limited, and the prevalence and etiological factors of DKA among Libyan adults remain poorly characterized. This study aims to

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determine the clinical profiles of DKA and identify its precipitating factors in Libya, providing local evidence to support preventive strategies and inform local healthcare planning.

Methods

This is a retrospective descriptive study conducted to analyze the clinical profile and precipitating factors of DKA among patients admitted to the Intensive Care Unit of Misurata Medical Center from June 2022 to June 2024. DKA was diagnosed in accordance with the American Diabetes Association by the presence of Hyperglycemia: Blood glucose levels (≥200 mg/dL) or a prior history of diabetes, though DKA can occasionally occur with normal glucose levels. Ketosis: Elevated ketone bodies in the blood (β-hydroxybutyrate ≥3.0 mmol/L) or urine (ketone strip 2+ or greater), and metabolic Acidosis: Venous pH <7.3 and/or serum bicarbonate <18 mmol/L**.** DKA severity classification was as follows: Mild DKA: Arterial pH 7.25–7.30, serum bicarbonate 15–18 mmol/L, anion gap >10; Moderate DKA: Arterial pH 7.00 to <7.24, serum bicarbonate 10 to <15 mmol/L, anion gap >12; Severe DKA: Arterial pH <7.00, serum bicarbonate <10 mmol/L, anion gap >12. These classifications follow the American Diabetes Association (ADA) Standards of Medical Care in Diabetes (2020) and the World Health Organization (WHO) diabetes classification (2019). (25,26) Recurrent DKA was defined as a documented previous episode of diabetic ketoacidosis before the index hospitalization, based on the available medical records. Recurrence data were available only for patients with documented information regarding previous DKA episodes.

Data were collected from the medical records of 113 patients. Patients aged ≥12 years with a confirmed diagnosis of DKA were included, whereas all patients with other mixed acid-base disorders were excluded. Permission was obtained from the ethical committee at Misurata Medical Center, maintaining patient confidentiality throughout the study. SPSS version 26.0 was used for data analysis. Continuous variables were summarized as mean ± standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages.

Results

A total of 113 DKA patients with a mean age of 27.7 years were included in this study **(Figure 1)**. Females represented 55.8% of the predominantly Libyan study population **(Figure 2).**

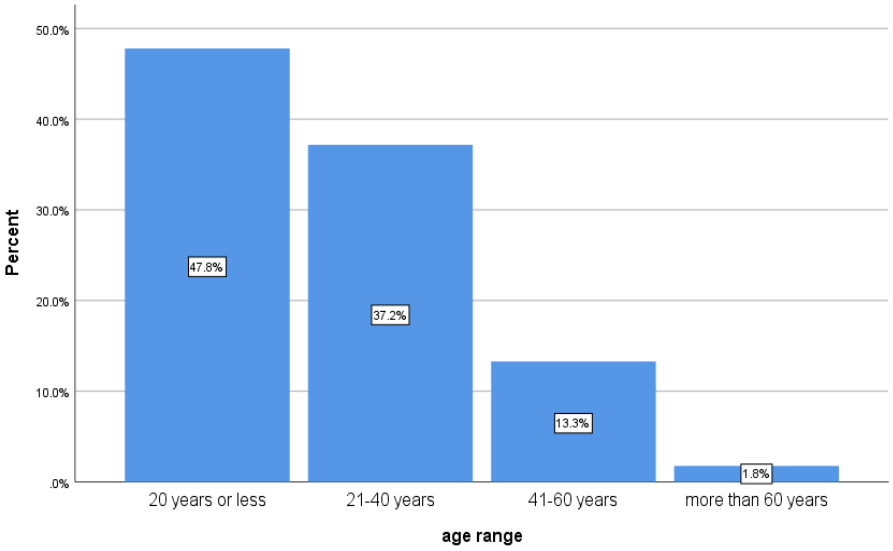

Figure 1. Patient distribution according to age groups

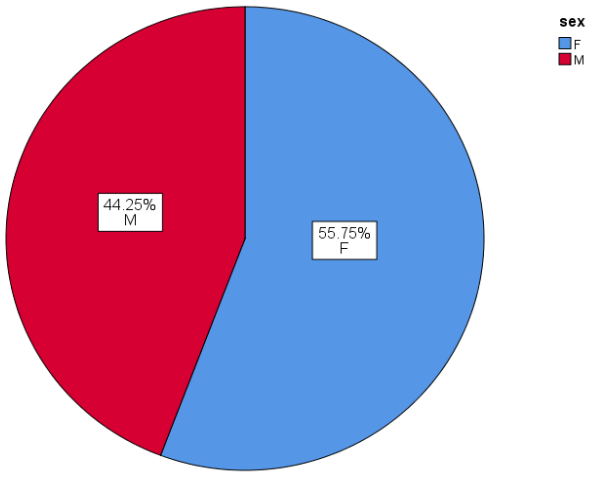

Figure 2. Patient distribution according to sex

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The vast majority of patients were Libyans **(Figure 3)** with T1DM (98.2%), and they were already receiving either insulin therapy alone (80.9%) or in combination with oral agents (5.5%). Most participants had no other documented comorbidities (84.8%). Regarding the clinical and biochemical profiles of our patients, the predominant clinical profile was non-specific symptoms, with nausea and vomiting being the most frequent symptoms (42.7%), followed by fatigue (23.3%) and abdominal pain (17.5%). Blood glucose levels at presentation showed substantial variability: 36.4% were between 250 and 400 mg/dL, and 32.7% were between 401 and 550 mg/dL. Regarding acid–base status, severe acidosis (pH below 7) and a severely elevated anion gap (>20) were reported in 23.4% and 45.5% of patients, respectively. **Table 1** summarizes patients' distribution according to their baseline characteristics.

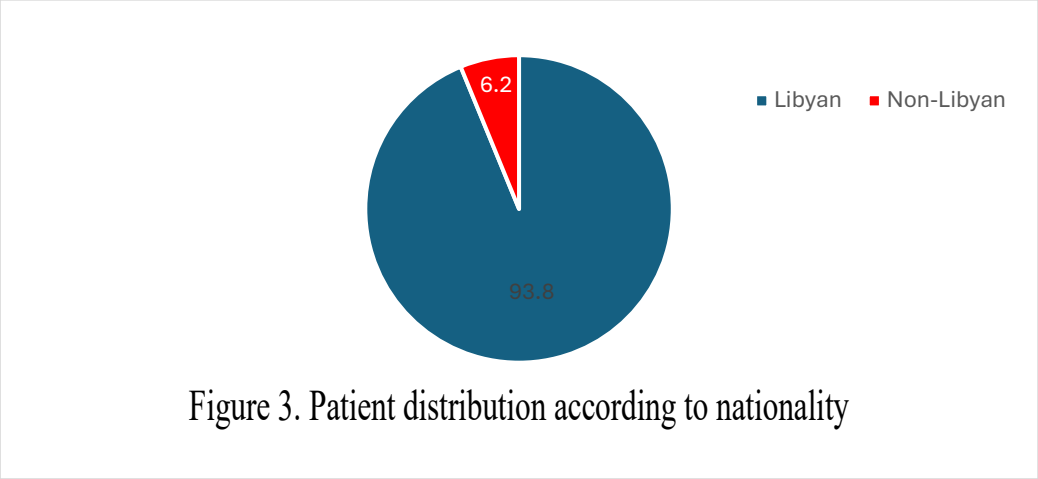

Figure 3. Patient distribution according to nationality

Table 1: Patient Distribution according to Baseline Clinical Characteristics

Variable	Findings	Frequency	Percentage
Type of Diabetes Mellitus	T1DM	111	98.2
	T2DM	2	1.8
Home treatment	OHA	5	4.5
	Insulin	89	80.9
	Newly diagnosed	10	9.1
	OHA + Insulin	6	5.5
Blood sugar at presentation (n=110)	less than 250	10	9.1
	250 to 400	40	36.4
	401 to 550	36	32.7
	more than 550	24	21.8
pH level (n=111)	less than 7	26	23.4
	7-7.2	31	27.9
	more than 7.2	54	48.6
Ketone levels (n=71)	+	5	7.0
	++	32	45.1
	+++	34	47.9
Sodium level (n=106)	Normal (135-145)	50	47.2
	Hyponatremia	52	49.1
	Hypernatremia	4	3.8
HCO3 level (n=111)	Mild metabolic acidosis (15-22)	19	17.1
	Moderate metabolic acidosis (10-15)	34	30.6
	Severe metabolic acidosis (<10)	58	52.3
Potassium level (n=88)	Normal (3.5-5)	69	78.4
	Hypokalemia	4	4.5
	Hyperkalemia	15	17
Anion Gap (n=55)	Normal (8-12)	7	12.7
	Mild elevation (13-16)	13	23.6
	Moderate elevation (17-20)	10	18.2
	Severe elevation (>20)	25	45.5

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Among the reported precipitating factors of DKA, insulin omission was the most common (49.1%), followed by upper respiratory tract infections (26.8%). Other identified factors included newly diagnosed diabetes mellitus (9.1%), acute gastroenteritis, depression, fasting, and stress. Recurrent DKA was documented in 39 of 78 patients (50.0%) with available recurrence data, indicating that recurrent DKA remains a substantial clinical concern. The most commonly used treatment regimen consisted of intravenous fluids, insulin, enoxaparin (62.2%), and antibiotics (35.1%), whereas sodium bicarbonate was administered to 20.5% of patients. Hospital outcomes were favorable, with most patients (90.3%) discharged within three days, with a mean hospital stay of 2.8 days. **Table 2** demonstrates patients' distribution according to their clinical management, precipitating factors, and outcomes.

Table 2: Patient distribution according to Clinical Management, Precipitating Factors, and Outcomes

Variable	Category/ Findings	Frequency	Percentage
Hospital Stay Duration (n=113)	less than 3 days	102	90.3
	4-10 days	8	7.1
	11-30 days	2	1.7
	more than 30 days	1	0.9
Recurrent DKA (n=78)	Yes	39	50.0
	No	39	50.0
Precipitating Factors for DKA (n=112)	Insulin omission	55	49.1
	URTI	30	26.8
	Acute GE	7	6.3
	Stress	1	0.9
	Fasting	2	1.8
	Newly discovered DM	13	11.6
	Depression	3	2.7
	Hypertrophy of skin at injection site	1	0.9
$NaHCO_3$ Administration (n=112)	No	89	79.5
	Yes	23	20.5
Hospital Management (n=111)	IV fluid +insulin +Enoxaparin	69	62.2
	others	3	2.7
	IVF+ insulin+ Enoxaparin+ Antibiotics	39	35.1
Presenting Symptoms (n=103)	excessive thirst	5	4.9
	Polyuria	10	9.7
	Nausea & vomiting	44	42.7
	Abdominal pain	18	17.5
	Fatigue	24	23.3
	Others	2	1.9
Comorbidities (n=112)	Gallbladder Stone	1	.9
	HTN	14	12.4
	hyperthyroidism	2	1.8
	NO	95	84.8
Complications (n=113)	Hemodialysis	1	0.9
	Left arm DVT	1	0.9
	No complications	111	98.2

Discussion

This study provides a contemporary overview of the clinical characteristics, precipitating factors, management, and outcomes of DKA in a predominantly young adult Libyan population with type 1 diabetes mellitus. The observed frequency of recurrent DKA highlights the need for improved diabetes education, strategies to enhance treatment adherence, and structured post-discharge follow-up to reduce preventable hospital readmissions. Insulin omission and infections were identified as the principal precipitating factors. Despite the presence of severe metabolic abnormalities, treatment outcomes were favorable, with rapid clinical recovery, short hospitalization, and no mortality. These findings underscore the ongoing challenges of treatment adherence while demonstrating the effectiveness of current management practices in achieving positive short-term outcomes.

When evaluating the epidemiology and clinical profile of DKA patients in Libya, several reports indicate that DKA predominates among younger adults with T1DM, with similar findings reported in other Libyan cohorts. Similarly, another Tunisian study suggested that patients presenting with ketosis or ketoacidosis at diabetes onset were predominantly young

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adults with type 1 diabetes. The consistency of these findings reflects the regional demographic similarities (27–31) The proportion of DKA cases presenting as the first manifestation of diabetes was slightly lower in our study than in the study by Alfoghi et al. Similar observations have been reported in a pediatric Libyan cohort study and further supported by the recently published first meta-analysis assessing patterns and severity of DKA among Libyans. (31,32) Together, these findings suggest similar demographic patterns across Libya and that delayed recognition of diabetes is a significant contributor to the national DKA burden. Similar demographic patterns are reported from neighboring and international settings. (33–35)

The clinical and biochemical characteristics of our patients were broadly comparable to those reported in other Libyan cohorts. (29) Comparable symptom patterns have been reported in Tunisia. Mezghani et al. observed nausea and vomiting in 43.3% of patients and abdominal pain in 26.7%, confirming that gastrointestinal symptoms remain prominent manifestations of DKA across North African and European populations, suggesting that the clinical manifestations of DKA remain remarkably consistent across healthcare settings. (36)

The predominance of insulin omission as the leading precipitating factor for DKA in our cohort is consistent with findings from Libya and other regional countries. Insulin omission was the most common trigger, followed by infections, mirroring reports by Alfoghi et al., Elkituni et al., and the recent Libyan meta-analysis, suggesting that poor treatment adherence and preventable infections remain major contributors to DKA in Libya. (29–31) Similar patterns have been observed in Tunisia and Saudi Arabia, where treatment discontinuation or non-adherence and infections were identified as the principal precipitating factors (33,34,37). Collectively, these findings highlight inadequate insulin adherence as a major and potentially preventable cause of DKA across diverse regional healthcare settings.

Although the precipitating factors identified in our cohort are broadly consistent with international reports, regional differences exist. Studies from Europe and North America increasingly emphasize psychosocial factors, mental health disorders, and substance use, whereas studies from the Middle East and North Africa commonly identify insulin omission and infection as the dominant precipitating factors. These differences underscore the importance of developing context-specific prevention strategies and diabetes education programs. (38–40)

A notable finding in our study was the high rate of recurrent DKA, consistent with reports from both Elkituni et al. and Shebani et al., who identified recurrent ketoacidosis as an important clinical problem among Libyan patients. These findings suggest that poor diabetes education, psychosocial challenges, treatment non-adherence, and barriers to insulin access may contribute to repeated hospital admissions. (29,30,32) The need for these interventions is further supported by a pooled Libyan meta-analysis linking DKA recurrence to modifiable factors such as insulin omission and inadequate diabetes education, opening room for targeted interventions to reduce national DKA-related expenditure. (31) Regional similarities are reported from studies in Saudi Arabia, with medication non-adherence identified as an independent predictor of recurrence. (41) Published Tunisian literature has focused primarily on DKA at diabetes onset and precipitating factors rather than recurrence, limiting direct regional comparisons. Studies from North America have demonstrated that recurrent DKA is strongly associated with younger age, socioeconomic disadvantage, and psychological barriers, underscoring the importance of structured post-discharge follow-up, psychosocial assessment, and patient-centered diabetes education programs. (38,40)

Characterizing local DKA patterns may facilitate earlier recognition and improved clinical outcomes. The clinical profile observed in this study, particularly the predominance of non-specific symptoms, reinforces the importance of incorporating these warning signs into triage and DKA screening protocols, which may improve early detection and reduce severity at presentation. In addition, the identification of insulin omission and infections as the most common local precipitating factors for DKA provides potential targets for preventive interventions. These findings suggest gaps in patient education and support the consideration of integrating vaccination into local diabetes care programs. (40,42,43)

Management of DKA involves treating the underlying cause, rehydration, insulin therapy, and managing electrolyte disturbances. Emerging evidence suggests that IV insulin is preferred for moderate to severe DKA; the American Diabetes Association supports subcutaneous rapid-acting insulin for selected patients with mild, uncomplicated DKA, and the British guidelines also recommend the co-administration of long-acting insulin glargine with IV insulin. These variables were not evaluated in our cohort, though they constitute major areas of debate in DKA management protocols. (30,31,44,45) Tunisian investigators have examined different intravenous insulin protocols and concluded they are comparable in terms of efficacy and safety, emphasizing that adherence to standardized treatment principles remains more important than minor protocol variations. (46)

The favorable short-term outcomes observed in this study, including a low complication rate, short hospital stay, and absence of mortality, are consistent with reports from developed healthcare systems where DKA-related mortality is typically below 1%. Similar outcomes have been reported from Saudi Arabia and the United Arab Emirates (37,47) In contrast, substantially higher mortality rates continue to be reported from some resource-limited settings in Africa and South Asia. (48,49) The excellent outcomes observed in our cohort may reflect the relatively young patient population, timely access to hospital care, and effective implementation of established DKA management principles.

Given the high proportion of patients with a new diagnosis of diabetes, guidance on early screening of at-risk individuals and ongoing post-discharge monitoring should also be included. Community-based studies could help identify at-risk populations and uncover the underlying causes of non-adherence. The development of locally relevant guidelines may improve consistency of care and enhance patient outcomes. (42,50)

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Several limitations should be acknowledged, including the single-center, retrospective design, which limits generalizability. In addition, important variables such as socioeconomic status, educational level, and psychosocial factors were not consistently documented in our medical records. The absence of long-term follow-up data also precluded assessment of important outcomes beyond hospitalization.

Conclusion

Diabetic ketoacidosis remains a common and preventable acute complication of diabetes among predominantly young Libyan patients with type 1 diabetes mellitus. Insulin omission and infections were the leading precipitating factors, while recurrent DKA was frequent among patients with available recurrence data, highlighting persistent challenges in treatment adherence and long-term diabetes management. Despite the severity of metabolic derangements at presentation, short-term clinical outcomes were favorable, with low complication rates, short hospital stays, and no in-hospital mortality, reflecting the effectiveness of current management practices at our institution.

These findings emphasize the importance of strengthening diabetes education, improving adherence to insulin therapy, ensuring timely identification and management of infections, and implementing structured follow-up strategies to reduce recurrent DKA and prevent avoidable hospital admissions. Further multicenter prospective studies are recommended to evaluate the long-term outcomes of DKA in Libya.

References

1. Nasa P, Chaudhary S, Shrivastava PK, Singh A. Euglycemic diabetic ketoacidosis: A missed diagnosis. World J Diabetes. 2021 May 15;12(5):514–23. doi:10.4239/wjd.v12.i5.514 PubMed PMID: 33995841; PubMed Central PMCID: PMC8107974.
2. Goldenberg Rm, Berard Ld, Cheng Ayy, Gilbert Jd, Verma S, Woo Vc, et al. SGLT2 Inhibitor-associated Diabetic Ketoacidosis: Clinical Review and Recommendations for Prevention and Diagnosis. PubMed. doi:10.1016/j.clinthera.2016.11.002
3. Chow E, Clement S, Garg R. Euglycemic diabetic ketoacidosis in the era of SGLT-2 inhibitors. BMJ Open Diabetes Res Care. 2023 Oct 4. doi:10.1136/bmjdrc-2023-003666
4. Calimag APP, Chlebek S, Lerma EV, Chaiban JT. Diabetic ketoacidosis. Dis Mon. 2023 Mar 1;69(3):101418. doi:10.1016/j.disamonth.2022.101418
5. Diabetic Ketoacidosis | Diabetes | CDC [Internet]. [cited 2026 May 30]. Available from: https://www.cdc.gov/diabetes/about/diabetic-ketoacidosis.html?utm_source
6. Ghimire P, Dhamoon AS, Doerr C. Ketoacidosis (Nursing). In. StatPearls Publishing; 2023 [cited 2026 May 30]. Available from: https://www.ncbi.nlm.nih.gov/sites/books/NBK568717/
7. McCoy RG, Herrin J, Galindo RJ, Swarna KS, Umpierrez GE, Golden SH, et al. Rates of Hypoglycemic and Hyperglycemic Emergencies Among U.S. Adults With Diabetes, 2011–2020. Diabetes Care. 2023 Feb;46(2):e69–71. doi:10.2337/dc22-1673 PubMed PMID: 36520618; PubMed Central PMCID: PMC9887609.
8. O'Reilly JE, Jeyam A, Caparrotta TM, Mellor J, Hohn A, McKeigue PM, et al. Rising rates and widening socioeconomic disparities in diabetic ketoacidosis in type 1 diabetes in Scotland: A nationwide retrospective cohort observational study. Diabetes Care. 2021 Sep;44(9):2010–7. doi:10.2337/dc21-0689
9. 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. 11(4):e4353. doi:10.7759/cureus.4353 PubMed PMID: 31192058; PubMed Central PMCID: PMC6550510.
10. Shaka H, El-amir Z, Wani F, Albosta M, Dahiya DS, Alabi O, et al. Hospitalizations and inpatient mortality for hyperosmolar hyperglycemic state over a decade. Diabetes Res Clin Pract. 2022 Mar 1;185. doi:10.1016/j.diabres.2022.109230
11. Zhong VW, Juhaeri J, Mayer-Davis EJ. Trends in Hospital Admission for Diabetic Ketoacidosis in Adults With Type 1 and Type 2 Diabetes in England, 1998–2013: A Retrospective Cohort Study. Diabetes Care. 2018 Jan 31;41(9):1870–7. doi:10.2337/dc17-1583
12. Di Giovanni P, Meo F, Cedrone F, D'Addezio M, Di Martino G, Scampoli P, et al. Predictors and Trend of Ketoacidosis Hospitalization Rate in Type 2 Diabetes Mellitus Patients from 2006 to 2015 in Abruzzo Region, Italy. Clin Ter. 2020 Feb;170(1):e53–8. doi:10.7417/CT.2020.2189 PubMed PMID: 31850485.
13. Benoit SR, Zhang Y, Geiss LS, Gregg EW, Albright A. Trends in Diabetic Ketoacidosis Hospitalizations and In-Hospital Mortality - United States, 2000-2014. MMWR Morb Mortal Wkly Rep. 2018 Mar 30;67(12):362–5. doi:10.15585/mmwr.mm6712a3 PubMed PMID: 29596400; PubMed Central PMCID: PMC5877353.
14. Desai D, Mehta D, Mathias P, Menon G, Schubart UK. Health Care Utilization and Burden of Diabetic Ketoacidosis in the U.S. Over the Past Decade: A Nationwide Analysis. Diabetes Care. 2018 May 17;41(8):1631–8. doi:10.2337/dc17-1379
15. Ahuja W, Kumar N, Kumar S, Rizwan A. Precipitating Risk Factors, Clinical Presentation, and Outcome of Diabetic Ketoacidosis in Patients with Type 1 Diabetes. Cureus. 11(5):e4789. doi:10.7759/cureus.4789 PubMed PMID: 31372327; PubMed Central PMCID: PMC6669022.

Received*: 29-05-2026 -* ***Accepted****: 26-07-2026 -* ***Published****: 04-08-2026*

16. Ibrahim A, Bayramoglu B, Hokenek NM, Tekyol D. Lactate clearance during the first 2 hours after hospital admission: A useful biomarker for predicting 30-day mortality in patients with diabetic ketoacidosis. Int J Clin Pract. 2021;75(7):e14204. doi:10.1111/ijcp.14204
17. Weinert LS, Scheffel RS, Severo MD, Cioffi AP, Teló GH, Boschi A, et al. Precipitating factors of diabetic ketoacidosis at a public hospital in a middle-income country. Diabetes Res Clin Pract. 2012 Apr 1;96(1):29–34. doi:10.1016/j.diabres.2011.11.006
18. Magadla S, Ekpebegh C, Ndlovu N, Dubula T, Joseph S. Precipitating factors and clinical outcomes of diabetic ketoacidosis in Eastern Cape, South Africa. J Coll Med South Afr. 2025 Jan 6;3(1):5 pages. Located at: Age. doi:10.4102/jcmsa.v3i1.99
19. Umpierrez GE, Davis GM, ElSayed NA, Fadini GP, Galindo RJ, Hirsch IB, et al. Hyperglycemic Crises in Adults With Diabetes: A Consensus Report. Diabetes Care. 2024 Jun 22;47(8):1257–75. doi:10.2337/dci24-0032
20. Diabetes in the Middle East & North Africa | IDF Diabetes Atlas [Internet]. [cited 2026 Jun 1]. Available from: https://diabetesatlas.org/data-by-location/region/middle-east-and-north-africa/
21. Global Burden of Diabetic Ketoacidosis - Viswanathan Mohan, Kenneth Lee, 2025 [Internet]. [cited 2026 May 30]. Available from: https://journals.sagepub.com/doi/full/10.1177/15209156251390828?utm_source
22. Farsani SF, Brodovicz K, Soleymanlou N, Marquard J, Wissinger E, Maiese BA. Incidence and prevalence of diabetic ketoacidosis (DKA) among adults with type 1 diabetes mellitus (T1D): a systematic literature review [Internet]. 2017 Jul 1. doi:10.1136/bmjopen-2017-016587
23. Kadiki OA, Roaeid Rb. Incidence of type 1 diabetes in children (0-14 years) in Benghazi Libya (1991-2000). PubMed. PubMed PMID: 12522326.
24. Khashebi RM, Patterson CC, Shebani MS. The Incidence Trend of Type 1 Diabetes among Children and Adolescents 0-14 Years of Age in the West, South, and Tripoli Regions of Libya (2009-2018). J Clin Res Pediatr Endocrinol. 2023 Dec;15(4):356–64. doi:10.4274/jcrpe.galenos.2023.2023-1-17 PubMed PMID: 37218134; PubMed Central PMCID: PMC10683548.
25. American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2020. Diabetes Care. 2019 Dec 16;43(Supplement_1):S14–31. doi:10.2337/dc20-S002
26. Classification of diabetes mellitus [Internet]. [cited 2026 Jun 6]. Available from: https://www.who.int/publications/i/item/classification-of-diabetes-mellitus
27. Chihaoui M. Characteristics of Ketosis-onset Diabetes in Tunisian Population. J Diabetes Metab. 2012;03(01). doi:10.4172/2155-6156.1000175
28. Taieb A, Cheikh Ab, Hasni Y, Maaroufi A, Kacem M, Chaieb M, et al. [Study of acute inaugural ketosis-prone diabetes in a Hospital in Central-Eastern Tunisian]. PubMed [Internet]. 2018 [cited 2026 Jun 6]. Available from: https://pubmed.ncbi.nlm.nih.gov/31037194/?utm_source=chatgpt.com
29. https://medjpps.com/mjpps. Clinical profile of Libyan patients admitted with diabetic ketoacidosis [Internet]. [cited 2026 Jun 5]. Available from: https://medjpps.com/mjpps/clinical-profile-of-libyan-patients-admitted-with-diabetic-ketoacidosis?utm_source=chatgpt.com
30. Elkituni A, Elshwekh H, Bendala NM, Atwear WS, Aldaba FA, Fellah AM. Profile of diabetic ketoacidosis at the National Diabetes and Endocrine Center in Tripoli, Libya, 2015. Diabetes Metab Syndr Clin Res Rev. 2021 May 1;15(3):771–5. doi:10.1016/j.dsx.2021.03.014
31. Elmiladi S, Elgdhafi E, Dyab E. Pattern, Severity, Precipitating Factors, and Outcome of Diabetic Ketoacidosis in People Admitted to Libyan Hospitals: A Systematic Review and Meta-Analysis. Ibnosina J Med Biomed Sci. 2026 Apr 17;18. doi:10.1055/s-0046-1819601
32. Shebani MS, Khashebi RM. Exploring ketoacidosis frequency and risk factors in childhood-onset type 1 diabetes: an 8-year retrospective study (2011–2018) at a tertiary paediatric hospital in Tripoli, Libya. Vol. 37. 2024;Journal of Pediatric Endocrinology and Metabolism37(6):497–504. doi:10.1515/jpem-2024-0011
33. Hare MJL, Deitch JM, Kang MJY, Bach LA. Clinical, psychological and demographic factors in a contemporary adult cohort with diabetic ketoacidosis and type 1 diabetes. Intern Med J. 2021 Aug 1;51(8):1292–7. doi:10.1111/imj.14877
34. Abd-El-Fatah, Walaa M;, State, Basma Z, Omnia I;, Elmorsy,. Audit of management of Diabetic ketoacidosis in Mansoura Specialized Medical Hospital [Internet]. 2024 [cited 2026 Jun 5]. Available from: https://mmj.mans.edu.eg/home/vol53/iss2/10/?utm_source=chatgpt.com doi:https://doi.org/10.58775/2735-3990.1414
35. Saadeh NA, Hammouri HM, Zahran DJ. Diabetic Ketoacidosis in Northern Jordan: Seasonal Morbidity and Characteristics of Patients. Diabetes Metab Syndr Obes Targets Ther. 2023;16:3057–64. doi:10.2147/DMSO.S413405 PubMed PMID: 37810572; PubMed Central PMCID: PMC10559898.
36. Mezghani I, Marrakchi R, Ksentini M, Boudaya M, Jammoussi K, Turki M, et al. Prevalence of symptoms and precipitating factors of Diabetic Ketoacidosis in diabetic patients. In. BioScientifica; 2023 [cited 2026 Jun 6]. Available from: https://www.endocrine-abstracts.org/ea/0090/ea0090ep297?utm_source
37. Alotaibi A, Aldoukhi A, Albdah B, Alonazi JA, Alseraya AS, Alrasheed N. Diabetic Ketoacidosis Treatment Outcome and Associated Factors Among Adult Patients Admitted to the Emergency Department and Medical Wards at King Abdulaziz

Received*: 29-05-2026 -* ***Accepted****: 26-07-2026 -* ***Published****: 04-08-2026*

Medical City, Riyadh, Saudi Arabia. Cureus. 12(8):e10067. doi:10.7759/cureus.10067 PubMed PMID: 32999787; PubMed Central PMCID: PMC7522050.

38. Randall L, Begovic J, Hudson M, Smiley D, Peng L, Pitre N, et al. Recurrent Diabetic Ketoacidosis in Inner-City Minority Patients: Behavioral, socioeconomic, and psychosocial factors. Diabetes Care. 2011 Aug 19;34(9):1891–6. doi:10.2337/dc11-0701
39. Garrett CJ, Moulton CD, Choudhary P, Amiel SA, Fonagy P, Ismail K. The psychopathology of recurrent diabetic ketoacidosis: A case–control study. Diabet Med. 2021;38(7):e14505. doi:10.1111/dme.14505
40. Allcock B, Stewart R, Jackson M. Psychosocial factors associated with repeat diabetic ketoacidosis in people living with type 1 diabetes: A systematic review. Diabet Med. 2022 Jan 1;39(1):e14663. doi:10.1111/dme.14663
41. Alotaibi R, Alsulami M, Hijji S, Alghamdi S, Alnahdi Y, Alnahdi H, et al. Diabetic ketoacidosis in Saudi Arabia: factors precipitating initial admission and readmission. Ann Saudi Med. 2022 Mar;42(2):119–26. doi:10.5144/0256-4947.2022.119 PubMed PMID: 35380064; PubMed Central PMCID: PMC8982000.
42. Watson A, McConnell D, Coates V. Reducing unscheduled hospital care for adults with diabetes following a hypoglycaemic event: which community-based interventions are most effective? A systematic review. J Diabetes Metab Disord. 2021 Jun 10;20(1):1033–50. doi:10.1007/s40200-021-00817-z PubMed PMID: 34131570; PubMed Central PMCID: PMC8192108.
43. Looijmans-Van den Akker I, Verheij TJM, Buskens E, Nichol KL, Rutten GEHM, Hak E. Clinical Effectiveness of First and Repeat Influenza Vaccination in Adult and Elderly Diabetic Patients. Diabetes Care. 2006 Aug 1;29(8):1771–6. doi:10.2337/dc05-2517
44. Dunn BK, Coore H, Bongu N, Brewer KL, Kumar D, Malur A, et al. Treatment Challenges and Controversies in the Management of Critically Ill Diabetic Ketoacidosis (DKA) Patients in Intensive Care Units. Cureus. 2024 Sep;16(9):e68785. doi:10.7759/cureus.68785 PubMed PMID: 39360087; PubMed Central PMCID: PMC11446492.
45. Alnuaimi A, Mach T, Reynier P, Filion KB, Lipes J, Yu OHY. A systematic review and meta-analysis comparing outcomes between using subcutaneous insulin and continuous insulin infusion in managing adult patients with diabetic ketoacidosis. BMC Endocr Disord. 2024 Aug 1;24(1):133. doi:10.1186/s12902-024-01666-6 PubMed PMID: 39090718; PubMed Central PMCID: PMC11293178.
46. Jouini S, Othmani S, Aloui A, Bouzid K, Manai H, Hedhli H. Efficacy and safety of two protocols of intravenous insulin therapy in the management of diabetic ketoacidosis. Tunis Médicale. 2022 Dec;100(12):830–6. PubMed PMID: 37551533; PubMed Central PMCID: PMC10481825.
47. Almazrouei R, Siddiqua AR, Alnuaimi M, Al-Shamsi S, Govender R. Clinical and biochemical characteristics of diabetic ketoacidosis in adults with type 1 or type 2 diabetes at a tertiary hospital in the United Arab Emirates. Front Clin Diabetes Healthc. 2022 Aug 8;3:918253. doi:10.3389/fcdhc.2022.918253 PubMed PMID: 36992724; PubMed Central PMCID: PMC10012054.
48. Abebe GK, Aynalem ZB, Meseret F, Abate MD, Muhamed AN. Mortality and its predictors in Adult Diabetic ketoacidosis patients in East Africa: A 2025 Systematic review and meta-analysis [Internet]. F1000Research 2025 14:864; 2025 [cited 2026 Jun 17]. Available from: https://f1000research.com/articles/14-864/v1 doi:10.12688/f1000research.169430.1
49. Fatima S, Rehman N, Hashmi M, Khan A, Shahzaib M, Akram MT, et al. Threshold-based compliance with diabetic ketoacidosis management protocols and its association with inpatient mortality: a retrospective single-centre study in a tertiary hospital in Karachi, Pakistan. BMJ Open. 2025 Jul 30;15(7):e102173. doi:10.1136/bmjopen-2025-102173 PubMed PMID: 40738643; PubMed Central PMCID: PMC12315034.
50. Ehrmann D, Kulzer B, Roos T, Haak T, Al-Khatib M, Hermanns N. Risk factors and prevention strategies for diabetic ketoacidosis in people with established type 1 diabetes. Lancet Diabetes Endocrinol. 2020 May 1;8(5):436–46. doi:10.1016/S2213-8587(20)30042-5

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