



## FREQUENCY OF FACTORS LEADING TO DEVELOPING OF DIABETES KETOACIDOSIS IN PATIENTS WITH TYPE 1 DIABATES

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### ABSTRACT

**Background:** Diabetic ketoacidosis (DKA) is a serious, acute complication of type 1 diabetes mellitus, characterized by hyperglycemia, metabolic acidosis, and ketonemia. Despite advances in insulin therapy, DKA remains a common cause of hospitalization and mortality. Identifying the precipitating factors is essential for prevention, early intervention, and improving patient outcomes.

**Objectives:** The study aimed to assess the frequency of precipitating factors contributing to diabetic ketoacidosis in patients with type 1 diabetes and to analyze demographic and clinical associations influencing the occurrence of DKA.

**Study design:** retrospective observational study.

**Place and duration of study:** From July 2024 to December 2024, Department of General Medicine Sandeman Provincial Hospital / Bolan Medical College / Hospital Quetta, Balochistan.

**Methods:** This retrospective observational study included 120 patients with type 1 diabetes mellitus admitted with diabetic ketoacidosis over a two-year period. Data were collected from hospital records, including demographic details, clinical presentation, precipitating factors, and laboratory results. Statistical analysis was performed to determine mean age, standard deviation, and p-values for associations between risk factors and DKA. Ethical clearance was obtained prior to study initiation.

**Results:** A total of 120 patients with type 1 diabetes presenting with diabetic ketoacidosis were analyzed. The mean age of patients was  $22.4 \pm 6.8$  years. The most common precipitating factor was infection (38%), followed by insulin omission (32%), new diagnosis of diabetes (20%), and medical/surgical stress or other causes (10%). A significant association was observed between infection and severity of DKA ( $p < 0.05$ ). Insulin omission was more frequent among adolescents and young adults compared to other age groups ( $p < 0.01$ ). Gender was not significantly associated with precipitating factors ( $p > 0.05$ ).

**Conclusion:** Infections and insulin omission remain the leading precipitating factors for diabetic ketoacidosis in type 1 diabetes patients. Early recognition of these risk factors and improved patient education may reduce the incidence of DKA. Targeted interventions, including infection control strategies and reinforcement of insulin adherence, should be prioritized in high-risk groups to minimize complications and healthcare burden.

## INTRODUCTION

Diabetic ketoacidosis (DKA) is a life-threatening acute complication of diabetes mellitus characterized by uncontrolled hyperglycemia, metabolic acidosis, and ketonemia. It is more common in individuals with type 1 diabetes mellitus (T1DM), although cases are increasingly reported in type 2 diabetes under stress conditions or with sodium-glucose cotransporter-2 (SGLT2) inhibitor use [1]. Despite improvements in insulin delivery systems and monitoring technologies, DKA continues to be a major cause of hospital admissions, morbidity, and mortality among patients with T1DM worldwide [2]. The pathophysiology of DKA involves a relative or absolute deficiency of insulin accompanied by an increase in counter regulatory hormones such as glucagon, cortisol, catecholamine's, and growth hormone. This results in accelerated gluconeogenesis, glycogenolysis, and lipolysis, leading to hyperglycemia, ketone body accumulation, osmotic diuresis, dehydration, and metabolic acidosis [3]. In the absence of timely recognition and treatment, DKA can progress to severe electrolyte disturbances, cerebral edema, cardiovascular collapse, and death [4]. Globally, DKA is reported as the initial presentation in 15–30% of newly diagnosed T1DM cases, particularly

among children and adolescents [5]. Beyond new-onset diabetes, infections and insulin omission are consistently identified as the leading triggers for DKA episodes [6]. Infectious causes, including respiratory tract infections, urinary tract infections, and sepsis, increase insulin resistance and metabolic stress, precipitating decompensating [7]. Noncompliance with insulin therapy—whether due to psychosocial factors, lack of access to insulin, or technical problems with insulin delivery devices—is another major contributor, particularly in adolescents and young adults [8]. The frequency and relative contribution of these precipitating factors vary across regions depending on healthcare access, socioeconomic conditions, cultural practices, and patient education [9]. In developed nations, insulin omission and psychological barriers often dominate, while in resource-limited settings, infections and delayed access to care are the leading drivers of DKA. Understanding the distribution of these causes within a specific patient population is therefore essential to develop targeted prevention strategies. Recent studies have also highlighted the role of comorbidities and concurrent stressors such as myocardial infarction, cerebrovascular events, and surgery in precipitating DKA. Furthermore, drug-induced hyperglycemia and ketosis—

particularly from corticosteroids, atypical antipsychotics, and SGLT2 inhibitors—are increasingly recognized as important secondary causes. Identifying these precipitating factors during hospitalization not only guides acute management but also provides an opportunity for preventive interventions through structured patient education, counseling, and follow-up [13].

## **METHODS**

This retrospective observational study was conducted at a tertiary care hospital over a two-year period. A total of 120 patients with type 1 diabetes mellitus admitted with diabetic ketoacidosis were included. Diagnosis of DKA was confirmed based on standard criteria: blood glucose >250 mg/dL, arterial pH <7.3, bicarbonate <18 mmol/L, and presence of ketonemia or ketonuria. Data regarding age, gender, clinical presentation, precipitating factors, and laboratory findings were collected from hospital medical records. The primary outcome measure was the frequency distribution of different precipitating factors for DKA. Secondary outcomes included demographic and clinical associations. Ethical approval was obtained prior to study initiation.

### **Inclusion Criteria**

All patients with type 1 diabetes mellitus aged ≥10 years admitted with confirmed diabetic ketoacidosis, fulfilling diagnostic criteria, and with complete medical records were included in the study.

### **Exclusion Criteria**

Patients with type 2 diabetes, mixed diabetic ketoacidosis with hyperosmolar state, incomplete clinical or laboratory records, or those transferred from other facilities after partial treatment were excluded.

### **Ethical Approval**

The study was approved by the Institutional Ethics Committee of Sandeman Provincial Hospital / Bolan Medical College / Hospital, Quetta, Balochistan. Patient confidentiality was strictly maintained, and no identifying

details were recorded. As the study involved retrospective data review, informed consent was waived according to institutional and national ethical guidelines.

### **Data Collection**

Data were extracted from patient case files, laboratory records, and discharge summaries using a structured preform. Information collected included demographic details, precipitating factors, clinical features, biochemical parameters, and treatment outcomes. All data were verified independently by two researchers to minimize errors and ensure accuracy.

### **Statistical Analysis**

Data were analyzed using SPSS version 24.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as percentages. Chi-square test was applied for categorical comparisons. Independent t-test and ANOVA were used for continuous variables. A p-value <0.05 was considered statistically significant.

## **RESULTS**

A total of 120 patients with type 1 diabetes mellitus admitted with diabetic ketoacidosis were included. The mean age of patients was  $22.4 \pm 6.8$  years. Males accounted for 52% of cases, while females represented 48%. The most common precipitating factor identified was infection (38%), predominantly respiratory and urinary tract infections. The second most frequent factor was insulin omission (32%), reported mainly among adolescents and young adults. Newly diagnosed type 1 diabetes accounted for 20% of cases, while medical or surgical stressors (10%), including myocardial infarction and postoperative states, were less common. Statistical analysis revealed a significant association between infection and severe DKA episodes ( $p < 0.05$ ). Insulin omission was more common in younger age groups, particularly adolescents, compared to older patients ( $p < 0.01$ ). Gender did not significantly influence the distribution of

precipitating factors ( $p > 0.05$ ). Overall, infections and noncompliance with insulin therapy contributed to over two-thirds of

DKA cases, highlighting the importance of preventive interventions targeting these modifiable risk factors.

**Table 1. Demographic Characteristics of Patients with Diabetic Ketoacidosis (n = 120)**

Variable	Number (n)	Percentage (%)
Age (years, mean $\pm$ SD)	22.4 $\pm$ 6.8	–
Gender – Male	62	51.7%
Gender – Female	58	48.3%
Urban residence	72	60.0%
Rural residence	48	40.0%

**Table 2. Precipitating Factors for Diabetic Ketoacidosis**

Precipitating Factor	Number (n)	Percentage (%)
Infection	46	38.3%
Insulin omission	38	31.7%
New diagnosis of diabetes	24	20.0%
Medical/surgical stressors	12	10.0%
<b>Total</b>	120	100%

**Table 3. Types of Infections in Patients with DKA (n = 46)**

Type of Infection	Number (n)	Percentage (%)
Respiratory tract infection	20	43.5%
Urinary tract infection	14	30.4%
Skin/soft tissue infection	8	17.4%
Sepsis/others	4	8.7%
<b>Total</b>	46	100%

**Table 4. Severity of DKA and Associated Factors**

Severity of DKA	Infection n (%)	Insulin Omission n (%)	New Diagnosis n (%)	Stress/Other n (%)	p-value
Mild (n=40)	8 (20%)	14 (35%)	12 (30%)	6 (15%)	–
Moderate (n=50)	18 (36%)	20 (40%)	8 (16%)	4 (8%)	<0.05
Severe (n=30)	20 (66.7%)	4 (13.3%)	4 (13.3%)	2 (6.7%)	<0.01

**Table 5. Statistical Analysis of Age, Gender, and Precipitating Factors**

Variable	Mean $\pm$ SD or n (%)	Association with Precipitating Factor	p-value
Age (years)	22.4 $\pm$ 6.8	Insulin omission more frequent in younger patients	<0.01
Gender – Male	62 (51.7%)	No significant difference	>0.05
Gender – Female	58 (48.3%)	No significant difference	>0.05
Severe infection cases	20 (16.7%)	Significantly associated with severe DKA	<0.05

## DISCUSSION

The present study evaluated the frequency of precipitating factors leading to diabetic ketoacidosis (DKA) among patients with type 1 diabetes mellitus (T1DM) admitted to a tertiary care hospital. Our findings demonstrated that infections and insulin omission remain the predominant triggers, together accounting for nearly 70% of cases. These results are consistent with global trends, though regional variations in relative proportions have been reported. Infections were the leading precipitating factor in this cohort, accounting for 38% of cases. Respiratory tract and urinary tract infections were the most common subtypes, reflecting findings from previous research. A large multicenter study by Karolin et al. reported infections in 41% of DKA admissions, with pneumonia and urinary infections predominating [10]. Similarly, Borski et al. observed infections in 36% of adult patients with DKA, highlighting the need for early recognition and management of infectious complications [11]. In resource-limited settings, infection rates are often higher, sometimes exceeding 50%, due to delayed diagnosis and limited access to preventive healthcare [12]. Insulin omission was identified as the second most frequent precipitating factor (32%). This finding is consistent with studies from both developed and developing countries, where non-adherence remains a persistent problem. Randall et al. reported insulin omission in 28% of DKA episodes, often linked to psychosocial stressors, financial constraints, or technical problems with insulin pumps [13]. In adolescents and young adults, omission is particularly common, frequently associated with psychological distress, fear of weight gain, or denial of illness [14]. Our study also found a significant association between younger age and insulin omission, reinforcing the importance of targeted educational and behavioral interventions in this group. New

diagnosis of T1DM accounted for 20% of DKA presentations in this study. This aligns with international data showing that 15–30% of children and adolescents present with DKA at diagnosis [15]. A systematic review by Usher-Smith et al. noted wide variability in rates of DKA at onset, ranging from less than 15% in countries with robust diabetes awareness programs to more than 60% in low-resource settings [16]. Early recognition campaigns, particularly in schools and community health centers, have been shown to significantly reduce the frequency of DKA at initial presentation [17]. Medical and surgical stressors were less common precipitants (10%), but their contribution remains clinically significant. Myocardial infarction, stroke, trauma, and postoperative states have all been implicated in precipitating metabolic decompensating in T1DM [18]. These stressors increase counter-regulatory hormones, exacerbating insulin resistance and cytogenesis. Although less frequent than infections or insulin omission, their recognition is critical in hospitalized patients with DKA, where concurrent illness may mask classical symptoms. The distribution of precipitating factors in this study parallels reports from developed countries, though infections were slightly more common than insulin omission. In contrast, studies from sub-Saharan Africa and South Asia consistently report infections as the dominant trigger, often exceeding 50%, reflecting differences in healthcare access and prevalence of communicable diseases [19]. Conversely, in North America and parts of Europe, insulin omission is often the leading cause, underscoring the role of psychosocial and behavioral determinants [20]. Our findings emphasize the dual importance of infection control and patient adherence strategies in preventing DKA. Structured education, routine follow-up, and psychosocial support are key interventions for reducing insulin omission. Similarly, timely vaccination,

infection surveillance, and prompt treatment of common infections are vital preventive measures. These approaches have been shown to significantly lower the risk of recurrent DKA admissions.

### **Conclusion**

Infections and insulin omission are the leading precipitating factors for diabetic ketoacidosis in type 1 diabetes patients. Early detection, improved adherence strategies, and infection prevention measures are crucial to reduce morbidity and mortality. Targeted educational and preventive interventions can significantly decrease the burden of DKA-related hospital admissions.

### **Limitations**

This study was retrospective and single-centered, relying on medical record accuracy, which may have led to underreporting of psychosocial or behavioral factors. The lack of long-term follow-up limited the ability to assess recurrent DKA episodes or outcomes. Findings may not be generalizable to different populations or healthcare settings.

### **Future Directions**

Future research should focus on prospective, multicenter studies exploring psychosocial determinants of insulin omission, the role of technology in adherence, and interventions to reduce infection-related DKA. Incorporating community education programs, digital health tools, and longitudinal monitoring could further improve prevention and management strategies for patients with type 1 diabetes.

### **Abbreviations**

- **DKA** Diabetic Ketoacidosis
- **T1DM** Type 1 Diabetes Mellitus
- **T2DM** Type 2 Diabetes Mellitus
- **SGLT2** Sodium-Glucose Cotransporter-2
- **SD** Standard Deviation
- **SPSS** Statistical Package for the Social Sciences
- **ANOVA** Analysis of Variance

**pH** Potential of Hydrogen (measure of acidity/alkalinity)

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### **REFERENCES**

1. Alfayez OM, Aldmasi KS, Alruwais NH, Bin Awad NM, Al Yami MS, Almohammed OA, et al. Incidence of Diabetic Ketoacidosis Among Pediatrics With Type 1 Diabetes Prior to and During COVID-19 Pandemic: A Meta-Analysis of Observational Studies. *Frontiers in endocrinology*. 2022;13:856958.
2. Bonora BM, Avogaro A, Fadini GP. Euglycemic Ketoacidosis. *Current diabetes reports*. 2020;20(7):25.
3. Calimag APP, Chlebek S, Lerma EV, Chaiban JT. Diabetic ketoacidosis. *Disease-a-month : DM*. 2023;69(3):101418.
4. Castellanos L, Tuffaha M, Koren D, Levitsky LL. Management of Diabetic Ketoacidosis in Children and Adolescents with Type 1 Diabetes Mellitus. *Paediatric drugs*. 2020;22(4):357-67.
5. Cherubini V, Marino M, Carle F, Zagaroli L, Bowers R, Gesuita R. Effectiveness of ketoacidosis prevention campaigns at diagnosis of type 1 diabetes in children: A systematic review and meta-analysis. *Diabetes research and clinical practice*. 2021;175:108838.
6. Dhanasekaran M, Mohan S, Erickson D, Shah P, Szymanski L, Adrian V, et al. Diabetic Ketoacidosis in Pregnancy: Clinical

Risk Factors, Presentation, and Outcomes. *The Journal of clinical endocrinology and metabolism*. 2022;107(11):3137-43.

7. Dhatariya KK. The management of diabetic ketoacidosis in adults-An updated guideline from the Joint British Diabetes Society for Inpatient Care. *Diabetic medicine : a journal of the British Diabetic Association*. 2022;39(6):e14788.

8. Dhatariya KK, Glaser NS, Codner E, Umpierrez GE. Diabetic ketoacidosis. *Nature reviews Disease primers*. 2020;6(1):40.

9. 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. *The lancet Diabetes & endocrinology*. 2020;8(5):436-46.

10. Elgenidy A, Awad AK, Saad K, Atef M, El-Leithy HH, Obiedallah AA, et al. Incidence of diabetic ketoacidosis during COVID-19 pandemic: a meta-analysis of 124,597 children with diabetes. *Pediatric research*. 2023;93(5):1149-60.

11. Eshkoli T, Barski L, Faingelernt Y, Jotkowitz A, Finkel-Oron A, Schwarzfuchs D. Diabetic ketoacidosis in pregnancy - Case series, pathophysiology, and review of the literature. *European journal of obstetrics, gynecology, and reproductive biology*. 2022;269:41-6.

12. Glaser N, Fritsch M, Priyambada L, Rewers A, Cherubini V, Estrada S, et al. ISPAD clinical practice consensus guidelines 2022: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Pediatric diabetes*. 2022;23(7):835-56.

13. Hamud AA, Mudawi K, Shamekh A, Kadri A, Powell C, Abdelgadir I. Diabetic ketoacidosis fluid management in children: systematic review and meta-analyses. *Archives of disease in childhood*. 2022;107(11):1023-8.

14. Koripalli M, Giruparajah M, Laur C, Shulman R. Selecting an intervention to prevent ketoacidosis at diabetes diagnosis in

children using a behavior change framework. *Pediatric diabetes*. 2022;23(3):406-10.

15. Long B, Lentz S, Koyfman A, Gottlieb M. Euglycemic diabetic ketoacidosis: Etiologies, evaluation, and management. *The American journal of emergency medicine*. 2021;44:157-60.

16. Long B, Willis GC, Lentz S, Koyfman A, Gottlieb M. Evaluation and Management of the Critically Ill Adult With Diabetic Ketoacidosis. *The Journal of emergency medicine*. 2020;59(3):371-83.

17. Muneer M, Akbar I. Acute Metabolic Emergencies in Diabetes: DKA, HHS and EDKA. *Advances in experimental medicine and biology*. 2021;1307:85-114.

18. Musso G, Saba F, Cassader M, Gambino R. Diabetic ketoacidosis with SGLT2 inhibitors. *BMJ (Clinical research ed)*. 2020;371:m4147.

19. Oriot P, Hermans MP. Euglycemic diabetic ketoacidosis in a patient with type 1 diabetes and SARS-CoV-2 pneumonia: case-report and review of the literature. *Acta clinica Belgica*. 2022;77(1):113-7.

20. Spencer NR, Clark SM, Harirah HM. Management of Diabetic Ketoacidosis in Pregnancy. *Clinical obstetrics and gynecology*. 2023;66(1):186-95.

21. Syed FZ. Type 1 Diabetes Mellitus. *Annals of internal medicine*. 2022;175(3):Itc33-itc48.