



Diabetic Ketoacidosis in children : Prevalence and Precipitating Factors
Of diabetic ketoacidosis in children with Type 1 DM Patients at Saint
Paul's Hospital Millennium Medical College

By: Leul Mesfin (MD, Pediatric Resident)
April, 2023
Addis Ababa, Ethiopia



St. Paul Hospital Millennium Medical College

Graduate Study Program

Diabetic Ketoacidosis in children : Prevalence and Precipitating Factors
Of diabetic ketoacidosis in children with Type 1 DM Patients at Saint
Paul's Hospital Millennium Medical College

By: Leul Mesfin (MD, Pediatric Resident)

**Advisor: Bereket Fentahun (MD, Pediatrician, Endocrinologist, Associate
Professor of Endocrine)**

**A THESIS REPORT SUBMITTED TO THE DEPARTMENT OF PEDIATRICS AND
CHILD HEALTH, ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE FOR
THE PARTIAL FULFILLMENT FOR REQUIREMENT FOR CERTIFICATE IN
PEDIATRIC AND CHILD HEALTH**

**Addis Ababa, Ethiopia
Feb 2024**

Formatted: Tab stops: 2.37", Left + 6.5",
Right

DECLARATION

I hereby declare that; this thesis report is my original work and has not presented for a degree by another person in this or any other university and all source material used for this thesis have been acknowledged.

Name: _____

Signature_____

Date_____

Name of Advisor:_____

Signature_____

Date_____

List of table

Table 1: Work Plan	12
Table 2: Budget.....	13
Table 3: Age distribution for newly diagnosed.....	18
Table 4: Age distribution for know Dm.....`	18
Table 5: Duration of symptoms	20
Table 6: Distribution of symptoms	20
Table 7: Diagnosis made in the past 2 weeks.....	21
Table 8: Rbs at presentation for newly diagnosed	22
Table 9: Identified infection for newly diagnosed	23
Table 10: Identified infection for known Dm.....	25
Table 11: Rbs at presentation.....	26
Table 12: Urine ketone at presentation	27
Table 13: Uni variant and Muti variant analysis.....	28

List of Figures

Figure 1: Total DKA patients Seen in the past year	17
Figure 2: Presentation of DM Patients.....	19
Figure 2: Severity Of DKA for newly diagnosed dm patients	22
Figure 3: Severity of DKA For Known Type 1 Dm patients	25

Acronyms and Abbreviations

AA = Addis Abeba

Dm = Diabetes Mellitus

DKA= Diabetic Ketoacidosis

T1DM= Type 1 Diabetes Mellitus

T2DM= Type 2 Diabetes Mellitus

SPHMMC= Saint Paul hospital millennium medical collage

OP= Out patient department

EOP= Emergency Out patient Department

UTI= Urinary Tract Infections

SPSS= Statistical Package for the Social Sciences

EPI- Info= Epidemiological Information

CAP= Community acquired pneumonia

CRVHD = Chronic Rheumatic Valvular Heart Disease

RBS = Random Blood Sugar

ATP = Acute Tonsillitis and Pharyngitis

UTI = Urinary Tract Infection

URTI = Upper Respiratory Tract Infection

PICU = Pediatric Intensive Care Unit

GI= Gastrointestinal

Acknowledgement

I would like to acknowledge St. Paul's Hospital Millennium Medical College (SPHMMC), Department of Pediatrics and child health for providing me this opportunity to do this research. My deepest gratitude goes to my advisor Dr Bereket Fentahun for giving me constructive ideas, valuable comments and advice in preparing this proposal.

Table of Content

Abstract.....	1
Introduction	1
1.1 Background;	1
1.2. Statement of the Problem	2
1.3 Rationale of the study	3
2) Literature Review.....	4
3) Objective	7
3.1 General Objective	7
3.2 Specific Objective	7
4. Methods.....	8
4.1 Study Area	8
4.2 Study Period	8
4.3 Study Design.....	8
4.4 Study Population	8
4.5 Study Subjects	9
4.6 Sample size.....	9
4.7 Sampling Procedure:	9
4.8 Measurements	9
4.8.1 .Variables of a study.....	9
4.9 Sample size determination and Sampling Technique	9
4.10 . Inclusion Criteria	10
4.11 Exclusion criteria	10
4.11. Data Collection and Analysis.....	10
4.11.1 Data Collection.....	10
4.11. 2 Data Collection Techniques.....	10
4.11.3. Data processing & analysis.....	10

4.11.4. Data Quality Assurance	11
4.12. Operational Definitions	11
4.13. Ethical clearance	11
5 Work Plan	12
6. Budget	13
7 Questioner	14
8 Results	17
8.1 Sociodemographic Characteristics	17
8.1.1) Sociodemographic Characteristics of the newly diagnosed DM patients.....	17
8.1.2 Sociodemographic Characteristic of the known DM who came with DKA	18
8.2 Clinical parameters	19
8.2.1 Clinical characteristics of the newly diagnosed patients.....	19
8.2.3 Clinical Characteristics of the Known DM patients	24
Uni variate and Multivariate Analysis	27
Discussion.....	28
Conclusion.....	30
Strength of the study	31
Limitation of the study.....	31
9) References	32

Abstract

Introduction: Diabetic Ketoacidosis (DKA) is a life-threatening complication of Diabetes Mellitus (DM), particularly in pediatric patients. While DKA commonly occurs at the onset of DM diagnosis, it can also affect individuals with known Type 1 DM due to various precipitating factors. Understanding the prevalence of DKA in newly diagnosed pediatric patients with DM and identifying precipitating factors in known Type 1 DM are crucial for effective management and prevention of this serious condition.

Objective: This study aims to investigate the prevalence of DKA in newly diagnosed pediatric patients with DM and explore the precipitating factors contributing to DKA episodes in individuals with known Type 1 DM.

Methods:

A comprehensive retrospective analysis covered 184 pediatric patients admitted to Saint Paul Hospital with diabetes mellitus (DM) and diabetic ketoacidosis (DKA) between January 2017 and December 2022. Within this group, 84 were newly diagnosed with type 1 DM.

Data collected encompassed demographic information, clinical characteristics, laboratory findings, and precipitating factors associated with DKA development.

Results: Among the 84 newly diagnosed patients, a striking majority, 75 individuals (89%), presented with Ketoacidosis as their initial manifestation of Diabetes Mellitus. Conversely only minority comprising 9 patients (11 %) did not exhibit ketoacidosis as initial presentation. Additionally In children with known Type 1 DM who presented with DKA, a 50 of them (50%), had concurrent infections as a precipitating factor.

Conclusion = The findings underscore the critical role of Ketoacidosis as the primary presentation of Diabetes Mellitus in a substantial majority of newly diagnosed patients and infection being the commonest precipitating factor for known DM patient to have Ketoacidosis.

Introduction

1.1 Background;

Among Childhood Diabetes Mellitus, Type 1 Diabetes Mellitus accounted for approximately 90%, type 2 diabetes and other special types accounted for approximately 10%. T1DM, also known as insulin-dependent diabetes, is a chronic autoimmune disease caused by T-cell-mediated islet beta cell destruction and absolute insulin deficiency. The pathogenesis of T1DM is still unclear, and it is believed to be the result of the combined action of genetic, environmental, immune, and other factors (1)

The incidence of T1D has been increasing by 2–5% worldwide and that the prevalence of T1D is approximately 1 in 300 in the US by 18 years of age(8)

Diabetic ketoacidosis is a consequence of absolute or relative lack of insulin with a concomitant rise in plasma levels of insulin counter-regulatory hormones such as catecholamines, glucagon, cortisol and growth hormone (3)

A diagnosis of diabetes is based on a fasting blood glucose concentration above 7.0 mmol/L (126 mg/dL), a random blood glucose concentration above 11.1 mmol/L (200 mg/dL) with symptoms, or an abnormal result from an oral glucose tolerance test(1)

Based on AAP pediatrics New-onset T1DM usually presents in one of three ways: with “classic” presenting symptoms, with diabetic ketoacidosis (DKA), or more rarely, as an incidental finding. (2)

In the absence of symptoms, abnormal glycaemia must be present on two different occasions. A diagnosis of diabetes can also be made on the basis of a glycated haemoglobin (HbA1c) concentration above 48 mmol/mol(6.5%). .(1)

Diabetic ketoacidosis (DKA) is the most serious metabolic disturbance of type 1 diabetes mellitus, previously known as insulin-dependent diabetes mellitus. (3).

It results from absolute or relative deficiency of circulating insulin and the combined effects of increased levels of the counter regulatory hormones: catecholamines, glucagon, cortisol and growth hormone. DKA is a medical emergency that requires treatment and monitoring for multiple metabolic abnormalities and vigilance for complications. DKA is the leading cause of death and permanent disability in children and adolescents with new onset diabetes (4)

DKA is characterized by severe depletion of water and electrolytes from both the intra cellular and extracellular fluid compartments At presentation, the specific deficits in an individual patient vary depending upon the duration and severity of illness, the extent to which the

patient was able to maintain intake of fluid and electrolytes, and the content of food and fluids consumed before coming to medical attention. (5)

Clinical manifestations of diabetic ketoacidosis Dehydration, Tachypnea; deep, sighing (Kussmaul) respiration Nausea, vomiting, and abdominal pain that may mimic an acute abdominal condition.(5)

Although not universally available, blood beta-hydroxybutyrate (BOHB) concentration should be measured whenever possible. BOHB ≥ 3 mmol/L is a sensitive indicator of DKA 11 but is not as specific as a value of ≥ 5.3 mmol/L, which has optimal accuracy (~91%) for predicting DKA in children with hyperglycemia presenting to an Emergency Department. (6)

DKA is the leading cause of death in children with T1DM because of hypokalemia, deep vein thrombosis, and cerebral edema (9)

1.2. Statement of the Problem

Diabetic ketoacidosis (DKA) is a serious and potentially life-threatening complication of type 1 diabetes mellitus (DM) in children. Despite advances in diabetes management, DKA remains a significant cause of morbidity and mortality among pediatric patients with type 1 DM.

Understanding the prevalence and precipitating factors of DKA in children with type 1 DM is essential for improving patient outcomes and developing targeted interventions.

The prevalence of ketoacidosis among newly diagnosed T1DM patients in Ethiopia remains largely unknown, presenting a significant gap in our understanding of the disease burden and healthcare needs of this population.

There are studies done on the prevalence of DKA among a child with newly diagnosed T1DM in developing nations, and they found that it was higher than in developed countries. However, the exact reasons behind this increase in prevalence are not known.

.In Ethiopia, there are only a few studies on this topic. This leaves a gap in the knowledge regarding the various risk factors that can be associated with DKA as first presentation of DM.. If preventable linked risk factors and extents are not known and addressed, the severity of DKA in children with T1DM will increase .

There is a trend change in Precipitating factors of Ketoacidosis among known Type 1 Dm patients.

1.3 Rationale of the study

The results of this study will aid in determining the current prevalence of Ketoacidosis as a primary presentation of diabetes, the severity of the Ketoacidosis and the outcome come of treatment . Understanding the prevalence of KA at the time of diagnosis of T1DM is crucial for healthcare providers to recognize and manage this acute complication promptly, thus reducing morbidity and mortality rates among newly diagnosed patients.

Additionally, it will analyze the clinical characteristics of a child who has DKA as their first sign of T1DM and look for any risk factors.

It can also can help healthcare providers develop screening protocols to detect early signs and symptoms of DKA. Early recognition and intervention can prevent the progression of KA to severe DKA, leading to improved patient outcomes and reduced healthcare costs.

This research can provide insights into modifiable risk factors that contribute to the development of this complication. By identifying factors such as missed insulin doses, infections, or psychological stressors, healthcare providers can implement targeted interventions to prevent recurrent episodes of DKA and improve long-term management of T1DM.

Also this study will identify the current common precipitating factor of Ketoacidosis among Type 1 Dm patients as there is a change in the trend of presentation. Thus, Understanding the precipitating factors of DKA can empower patients with T1DM to recognize potential triggers and take proactive measures to prevent DKA episodes. Educating patients about the importance of insulin therapy adherence, sick day management, and regular follow-up care can help reduce the incidence of DKA and improve overall diabetes self-management.

2) Literature Review

Diabetes Mellitus (DM) is a major health problem worldwide. Current studies have revealed a definite global increase in the incidence and prevalence of diabetes, with the World Health Organization (WHO) projecting that there was almost 221 million cases in the year 2010 and up to 285million cases in the year 2025. (10)

In one study published in 2012, 65 studies of cohorts comprising over 29,000 children in 31 countries, result showed Worldwide, approximately 65,000 children aged under 15 years develop T1DM each year, and 12.8% to 80% of these children present with DKA at the time of diagnosis. The highest frequencies for DKA at presentation of T1DM are seen in Saudi Arabia (44.9%)⁵, Taiwan (65%), Romania (67%), and the United Arab Emirates (80%), and the lowest in Hungary (23%), Finland (22%), Canada (18.6%) and Sweden (14%) . Multi variable modelling showed the frequency of DKA was inversely associated with gross domestic product, latitude and background incidence of T1DM (11)

Another large study done by oxford University in 2011, 46 studies involving more than 24 000 children in 31 countries were included. Together they compared 23 different factors. Factors associated with increased risk were younger age <2 years , diagnostic error ethnic minority, lack of health insurance in the US, lower body mass index, preceding infection , and delayed treatment . (12)

Protective factors were having a first degree relative with T1DM at the time of diagnosis, higher parental education, and higher background incidence of T1DM. The mean duration of symptoms was similar between children presenting with or without diabetic Ketoacidosis (16.5 days and 17.1 days respectively), and up to 38.8% of children who presented with diabetic Ketoacidosis had been seen at least once by a doctor before diagnosis.(12)

In a separate study done in the USA on 2013, In youth with T1DM, the prevalence of DKA was high and stable over time (30.2% in 2002–2003, 29.1% in 2004–2005, and 31.1% in 2008–2010;). Higher prevalence was associated with younger age at diagnosis , minority race/ethnicity , income , and lack of private health insurance . (13)

In a subsequent study study Done in Albania on 2014 showed, the overall prevalence of Ketoacidosis was 67.8%. mean age was 7.75 ± 3.64 years, while that of children without DKA

was 9.29 ± 3.39 years . There were no statistically significant differences by age group and place of residence, but the percentage of females was higher in T1DM children with DKA (54.4%) than among

those without DKA (34.7%).

The most common presentation symptoms of children with DKA were polyuria (100%), polydipsia (100%), and weight loss (98.1%). The prevalence of general weakness, vomiting, enuresis nocturna, acetone odor, dyspnea, drowsiness and confusion was higher among children with DKA. (14)

In another 5 year period study at Oman in 2010, a total of 200 subjects were hospitalized with newly-onset T1DM. At diagnosis, approximately 48 (24%) of the children presented with DKA. And there was no significant correlation between age and the occurrence of DKA in this study.(15)

A study done in Henan province in China by 2022, showed incidence of DKA among children and adolescents is very high(62.9%) . Moreover, DKA can be easily delayed in diagnosis. Newly diagnosed infants with T1DM are more likely to present with DKA, suffer more severe metabolic disorders, endure longer hospital stays, and accrue higher medical costs. (16)

In 2016, similar study in Kuwait Showed over all incidence was 33.6% and mild/moderate DKA was present in 24.8% of the children, while severe DKA was present in 8.8%. Incidence of Ketoacidosis was significantly higher in young children less than 2 compared to children 2–14 years old, and a higher proportion presented with severe DKA . No association was seen with gender. (17)

A 2 years Retrospective study conducted in Nigeria in 2019 showed a case prevalence rate of 1.8/1000. The mean age at presentation was 11.1 (± 0.8) years, prevalent presenting features were polyuria (6, 100%), polydipsia (6, 100%), dehydration (6, 100%), weight loss (100%), fever (83.3%), and weakness (4, 66.7%).(18)

In another study done in Tanzania published in 2020 , showed Majority presented with classical symptoms of Diabetes i.e. polyuria (95%), polydipsia (93%) and weight loss (79%). Almost 4 out of 10 presented with DKA at the onset of T1DM. Age below 5 years and delayed diagnosis were the factors significantly associated with DKA at onset. Family history of DM and high

education level of caretakers were found to be protective factors against DKA at diagnosis of T1DM. Mean duration of symptoms before diagnosis was 3 weeks. However, children who were diagnosed at the age between 11 to 14 years were found to have a relatively longer duration of symptoms.(19)

A distinct study done in South africa on 2013 showed 69.8% of the newly diagnosed T1DM had DKA at the time of diagnosis. The median duration of symptoms preceding diagnosis in the DKA group was 2 weeks, versus 4 weeks in the non-DKA group. There was no significant difference between the groups when ethnicity, gender and age at presentation were compared. Of 42 patients who presented to healthcare facilities in the month preceding diagnosis, 27 (64.3%) were misdiagnosed. (20)

In 2008 a study conducted in Addis Abeba Ethiopia from September 1997 to September 2007 a total of 143 T1DM patients were seen at the pediatric OPD. Of these, 118 patients were newly diagnosed T1DM patients and 105 (80%) were admitted to TAH as a case of newly diagnosed T1DM patients in DKA. (21)

In a different study Study done in Northern part of Ethiopia, Tigri region published in 2019 showed 78.7% of the newly diagnosed T1DM, presented with diabetic Ketoacidosis at initial diagnosis. Median age of diabetic Ketoacidosis patients was 11 years. and The mortality rate of diabetic Ketoacidosis was 4.3%. Young age, presence of precipitating factors and symptoms of DKA/ diabetes were found to be highly associated with diabetic Ketoacidosis at initial diagnosis. (22)

According to American Diabetes association study most common precipitating factor in the development of DKA is infection, most commonly urinary tract infections and pneumonia (23)

In a study done in Saudi Arabi Poor compliance to continue the treatment and infection were the most common precipitating factors being responsible for 54.4% and 28% cases.(24)

A study done in Northwest Ethiopia Gojam, Showed non-adherence, inappropriate insulin placement at home, preceding gastroenteritis, and presence of upper respiratory tract infections were the common preprecipitating factors. (25)

Another study done in 2020 in Addis Abeba Ethiopia showed insulin omission was the commonest cause of DKA precipitating (26)

3) Objective

3.1 General Objective

- To assess the prevalence of diabetic Ketoacidosis among newly diagnosed T1DM Patients and Identify the precipitating factors of DKA among known Type 1 Dm patients from January 2018 to January 2023 .

3.2 Specific Objective

1. To determine the associated risk factors for Ketoacidosis among newly diagnosed and known T1DM patients.
2. To evaluate the clinical parameters of a child presented with DKA as first presentation of T1DM.
3. To assess the treatment outcome and length of hospital stay of newly diagnosed T1DM with DKA.
4. To assess the precipitating factors , Clinical parameters and Outcome of DKA in known diabetic patients.

4. Methods

4.1 Study Area

The study was conducted at Saintpaul hospital mellienum medical collage Addis Abeba . Addis Ababa is the capital city of Ethiopia with an estimated population of 5,461,000 in 2023. The city lies 9°1'48"N latitude and 38°44'24"E longitude and the area covers 540 Square .Kilometer.

St Paul's Hospital Millennium Medical College (SPHMMC) was established through the decree of the Council of Ministers in 2010 and the hospital was established in 1968 by Emperor Haile Selassie. SPHMMC has more than 2800 clinical, academic and administrative, and support staff that provide medical specialty services to patients who are referred from all over the country.

The data collection period was between March and November, 2023.

4.2 Study Period

The study period was over twelve month period, from September 2022-septemeber 2023.

4.3 Study Design

An institution based cross sectional study was conducted using routine hospital data.

4.4 Study Population

All Children's less than 18 years of age children with Type I DM who visited the emergency opds and regular opds between January 2017 till decemeber 2022.

4.5 Study Subjects

All Children's less than 18 years of age with Diabets Mellitus presented with DKA who visited the Emergency Department (ED) and regular out patient department (OPD) between January 2017 till Decemeber 2022 were included.

4.6 Sample size

All Children's less than 18 years of age children with Newly diagnosed type I DM and known Dm patients presented with DKA who visited the ED and OPD between January 2017 till Decemeber 2022. were included with consecutive sampling method.

4.7 Sampling Procedure:

Consecutive sampling technique was used.

4.8 Measurements

4.8.1 .Variables of a study

Dependent Variables

Diabetic Ketoacidosis among newly diagnosed DM patients and known Dm patients.

Independent variables

Age , Sex , Family history , Nutritional Status, , Health Insurance , Residency , Delayed diagnosis (doctors vist in the past 2 weeks) , Duration of symptoms and pattern of symptoms .

4.9 Sample size determination and Sampling Technique

All pediatric patients under 18 years old diagnosed with diabetes and presenting with ketoacidosis, who sought treatment at both the emergency outpatient department (OPD) and regular OPD from January 2017 to December 2022 (over a span of 5 years), were enrolled using consecutive sampling method.

4.10 . Inclusion Criteria

All children age less than 18 years and who were diagnosed to have DKA both newly diagnose and known diabetics were included

4.11 Exclusion criteria

All diabetes patients with out DKA were excluded.

4.11. Data Collection and Analysis

4.11.1 Data Collection

The data was collected from registration log book and patient chart, by compressive data extraction format for medical record review developed for this study. The data was collected by trained data collectors, residents and general practitioners. Compressive data extraction format was pretested and necessary modification was made before data collection. The data collectors were given one day training on compressive data extraction format. The data collectors were continuously supervised by the primary investigator during data collection process.

4.11. 2 Data Collection Techniques

Data over Five year of study period was collected by consecutive sampling technique.

4.11.3. Data processing & analysis

Data was checked for completeness and consistency and was cleaned, coded and entered into EPI- Info version 7 and then exported in to SPSS Version 26.0 for analysis. Descriptive and analytical statistics including bivariate and multivariate analysis was computed and Logistic regression model was used to identify the association between dependent and independent variables. Data was presented using frequency tables and Chi-square test and odds ratio was determined when appropriate. P-value less than 0.05 was considered statistically significant.

4.11.4. Data Quality Assurance

Each day the data was checked for accuracy and completeness. The participant's names will not be collected. The data will then be stored in a secured location and only the investigator will have access to this location.

4.12. Operational Definitions

Diabetes Mellitus= a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.

Diabetic Ketoacidosis - blood glucose level $\geq 250\text{mg/dl}$, Ketonuria and ketonemia.

.	
.	Newly Diagnosed Diabetes Mellitus Patients: Refers to individuals who have recently received a diagnosis of diabetes mellitus and have not yet initiated treatment, specifically insulin therapy.
.	
.	
.	Known Type 1 Diabetes Mellitus Patients: Denotes individuals with a confirmed diagnosis of type 1 diabetes mellitus who are already receiving insulin therapy for their condition.
.	
.	
.	
.	Precipitating Factors for DKA: Factors or conditions that contribute to the onset or exacerbation of diabetic ketoacidosis among known type 1 diabetes mellitus patients.
.	

4.13. Ethical clearance

The ethical clearance was obtained from SPHMMC ethical review committee, written consent was obtained from hospital administration, and confidentiality of the information was ensured using codes rather than names during registering data.

5 Work Plan

Table 1 : Work Plan

Activity	March -April, 2023	April, 2023	May, 2023	June, 2023	July, 2023	August- Nov,2023	Septmber 2023
Developing the research proposal							
Obtaining feedback from advisor on draft document							
Ethical clearance							
Recruiting and Training of data collectors and pre-test of questionnaire							
Data collection							
Data cleaning /checking and data entry							
Data analysis and writing up of the first draft of the thesis							
Final thesis submission and presentation							
Disseminating the final thesis							

6. Budget

Table 2: Budget

S. No	Budget category	Unit cost in ETB/ no	Multiplying factor	Total cost in ETB
1	Internet fee	20.00	50hr	1000
2	Printing proposal	5.00	150	750
3	Binding	50.00	10	500
4	Data collector	250.00	100	25,000
5	Pen	5.00	20	100
6	Pencil	5.00	10	50
7	Eraser	5.00	10	50
8	Sharpner	5.00	10	50
9	Stapler	200	1	200
10	Correction fluid	30	4	120
11	Printingfinal paper	5.00	200	1,000.00
Grand Total				27920

7 Questioner

1.Socio-Demographic
Variables (circle)

No	Questions	Coding Categories	Skip
101	What is the age of the child	_____ year	
102	The child sex?	1. Male 2. Female	
103	Residency	Urban 2.Rular	
104	Health insurance coverage	Yes 2.No	
105	Malnutrition	1.Yes 2 No	
106	Severity of Malnutrition	1.MAM 2.Sam	

2. ASSOCIATED RISK
FACTORS OF DKA

201	How long was the child symptomatic before the diagnosis of DKA was made	<1 Weeks 1-2Weeks 2-3Weeks >4 Weeks
202	What were the symptoms ?	Polydepsia polyuria 3. Weight loss

		4. weakness	
		4.1 & 2	
		5.1&3	
		6. 2&3	
		7.others	
203	Does the child have first degree relatives with Dm?	1. Yes 2. No	
204	Did the child Visited a health facility 2 weeks prior to the dx of DKA?	Yes No	
205	If yes, What was the diagnosis made at that time?	URTI UTI Others	
3. Clinical Parameters			
301	Was there additional Comobidites other than Dm?	Yes No	
302	If yes which co morbidites were identified		
303	What was the severity of DKA on Presentation	Mild Moderate Severe	
304	Was the Child in Shock?	Yes No	
305	What was the RBS at presentation?	1.250-350 2.350-450 450-550 >550	

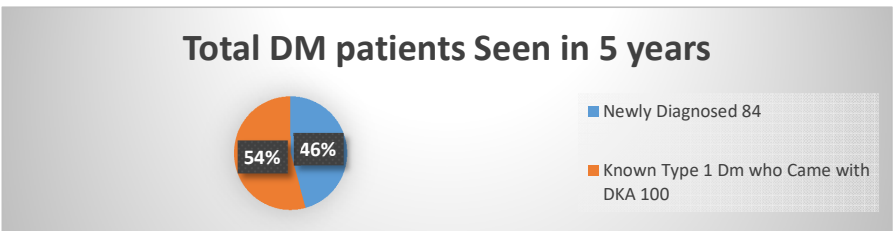
306	What was the urine ketone at the time of diagnosis	+2 +3 +4	
307	Which electrolyte abnormalities were seen ?		
308	Where was the management takes place?	EOPD Ward ICU	
309	How long did it took to reverse the Ketoacidosis?		
310	What was the Outcome of treatment ?	Recovered Died Left against medical advice Others	

8 Results

Out of 228 charts only 184 were able to be retrieved .

Among these, 84 individuals (45.7%) were newly diagnosed with type 1 diabetes mellitus, while 100 individuals (54.3%) were previously known diabetics on insulin who presented with diabetic ketoacidosis.

Fig 1 Total DKA cases Seen in 5 year period



8.1 Sociodemographic Characteristics

8.1.1) Sociodemographic Characteristics of the newly diagnosed DM patients

Among the 84 newly diagnosed children with type 1 diabetes mellitus, their ages ranged from 6 months to 17 years, with a mean age of 7.25 years. The majority of these children fell within the age range of 1-5 years, accounting for 33.3% (28 children), followed closely by those aged 10-14 years, representing 32.1% (27 children) of the total.

Table 3: Age distribution for Newly diagnosed DM Patients

Variables		Frequency	Percentage
Age	<6mon -1 year	8	9.5
	1-5 Years	28	33.3
	5-10years	17	20.2
	10-14years	27	32.1
	>14 years	4	4.8

Among the newly diagnosed diabetes mellitus patients, there were slightly more females (51.2%) than males (48.8%). The majority of these children hailed from Addis Abeba (61.9%), with a smaller portion residing outside of Addis Ababa (38.1%). A significant number of children (69%) did not have health insurance, while 31% did. Additionally, almost half of the children (47.6%) were found to have malnutrition, with 37.6% experiencing moderate acute malnutrition and 10.7% suffering from severe acute malnutrition.

8.1.2 Sociodemographic Characteristic of the known DM who came with DKA

For the known Diabetics who were already on insulin therapy who presented with DKA majority 44(44%) ranged in the age between 10-14 years followed by 5-10 years 26(26%).

Table 4= Age distribution for Known DM Patients Who had DKA

Variables		Frequency	Percentage
Age	<1 year	2	2
	1-5 Years	24	24
	5-10years	26	26
	10-14years	44	44
	>15 years	5	5

Out of which 63(63%) were females and 37(37%) were males.

majority 77(77%) were from Addis Abeba and 23(23%) were out of addis abeba.

Majority of the children 52 (52%) had health insurance and the remaning 48(48%) didn't had health insurance.

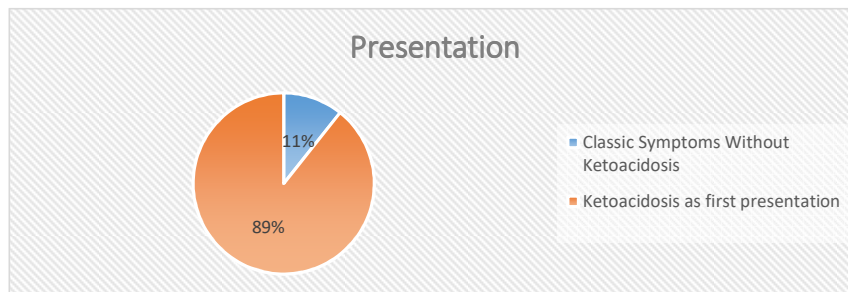
From the 100 known diabetics who were already on insulin 32 had malnutrition out of which 28(28%) had Moderate Acute Malnutrition and 4 (4%) Had Severe Acute Malnutrition.

8.2 Clinical parameters

8.2.1 Clinical characteristics of the newly diagnosed patients

From the 84 newly diagnosed patients, 75 (89%) presented with ketoacidosis as their first presentation, while only 9 (11%) did not have ketoacidosis as their initial presentation.

Fig.2 Presentation of DM patient



Among those with ketoacidosis, 40 (47.6%) were symptomatic for less than a week, 32 (38.1%) were symptomatic for 1 to 2 weeks, and 7 (8.3%) were symptomatic for 2 to 3 weeks before diagnosis.

Table 5 Duration of symptoms prior to presentation

Variables		Frequency	Percentage
Duration of symptoms	<1 week	40	47.6%
	1-2weeks	32	38.1%
	2-3 weeks	7	8.3%
	>3 weeks	5	6%

Polyurea and polydepsia were the commonest presenting symptoms observed 59(70.2%) followed by vomiting seen in 10 (11.9%) of the children.

Table 6 Distribution of Symptoms

Variables		Frequency	Percentage
Symptoms	Polyurea and Polydepsia	69	82.1%
	Polyphagia	5	5.9%
	Vomiting	10	11.9%
	Abdominal pain	8	9.5%
	Weight loss	9	10.7%
	Fast breathing and cough	8	9.5%
	Weakness	5	5.9%

Out of the 84 newly diagnosed patients, 15 of them (17.8%) had a positive first-degree family history of diabetes mellitus. On the other hand, the majority, comprising 69 patients (82.1%), did not have a family history of DM.

Regarding their healthcare visits, it was found that 23 patients (27.4%) had visited a health facility two weeks before being diagnosed with DM. In contrast, the majority, consisting of 61 patients (72.6%), did not have any recent visits to a health institute within the past two weeks.

Among the 23 patients who visited a health facility within the past 2 weeks, the diagnosis made for 16 of them Known . Out of these 16 patients, 4 were diagnosed with CAP (Community-Acquired Pneumonia), while 3 patients were diagnosed with Acute Tonsillitis and another 3 patients were diagnosed with Urinary Tract Infection.

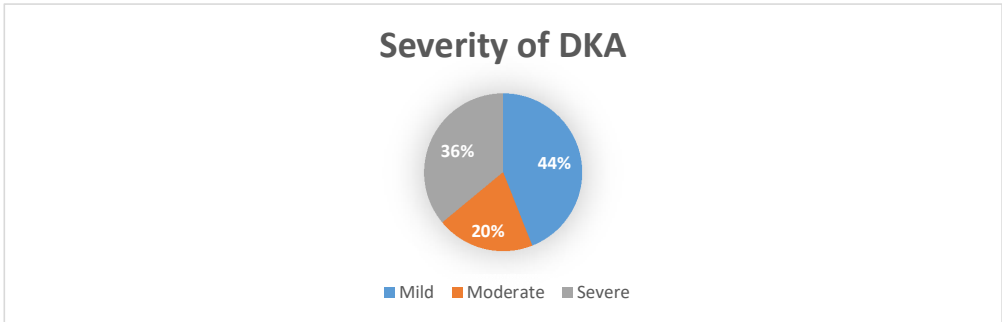
Table 7 Diagnosis made in the last 2 weeks

Variables		Frequency	Percentage
Diagnosis made in the last 2 weeks	CAP	4	25%
	Acute Tonsillitis	3	18.7%
	Urinary tract infection	3	18.7%
	Typhoid Fever	2	12.5%
	Dyspepsia	2	12.5%
	Gastroenteritis	1	6.25%
	Vaginal Candidiasis	1	6.25%

Out of the 84 newly diagnosed patients, it was found that 3 of them had pre-existing chronic medical illnesses before being diagnosed with DM. Specifically, 1 patient had Chronic Rheumatic Valvular Heart Disease (CRVHD), 1 had hypothyroidism with intellectual disability and while another patient had epilepsy.

Based on the clinical severity scoring, it was determined that out of the 84 newly diagnosed patients, 39 of them (46.4%) had Mild Diabetic Ketoacidosis (DKA), 15 patients (17.9%) had moderate DKA, and 30 patients (35.7%) had severe DKA.

Fig 3. Severity of DKA for newly diagnosed patient



Majority 21(28.5%) had Random blood sugar ranging between 350-450 and 18 (21.4%) had RBS >600mg /dl.

Table 8 RBS at presentation

Variables		Frequency	Percentage
RBS presentation	250-350	18	21.4%
	350-450	24	28.57%
	450-550	17	20.2%
	550-600	7	8.3
	>600	18	21.4%

Urine Ketone was +3 for53(63.1%) +2 in 11 patients (13..%) and +4 in 10 (11.9.%) of the patients.

21 (24%)patients had concomitant infection ATP Being the commonest.

Table 9 Identified Infections

Variables		Frequency
Identified Infections	ATP	4
	Sever Pneumonia	3
	UTI	3
	URTI	1
	ExtensiveTenia Capitis	2
	Vaginal Candidiasis	1
	Acute Gastroenteritis	1
	Diaper Dermatitis	1
	Tenia Corporis	1
	Acute Hepatitis	1
	Pyogenic Meningitis	1
	Sepsis	1
	Septic Shock of GI focus	1

Electrolyte abnormality was seen in 43(51.9%) of the patients. Hyponatremia was the commonest seen in 32 (38%) of the patients and hypokalemia was present in 9 (10.7) % of the patients.

Of whom 20 (23.8%) had mild hyponatremia and 5 (5.9%) had severe hyperkalemia.

Majority 34(45.9%) .6%) of the newly diagnosed DM patients were initially managed at the ER and latter admitted to the wards, 23(31.7%) were managed at the ED and discharged and 18(24.4%) were admitted at PICU first and latter transferred to the wards.

Out of the 73 managed for DKA 18(24.6%) developed management related complication .

14 (19.1%) developed hypoglycemia , 2 (5.4%) developed cerebral edema and 2(5.4%) developed hyponatremia .

Out of the 84 newly diagnosed DM patients 80 were discharged improved 3 patient left against medical advice and 1 patient died making MR of 1.19 %.

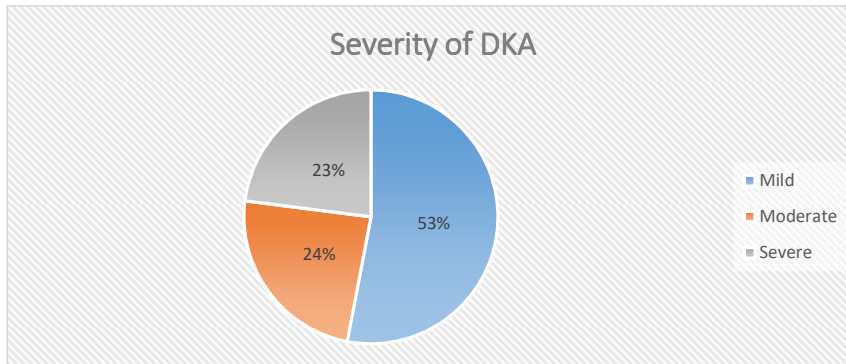
The Cause of Death was documented to be Cerebral edema with septic Shock .

37(49.3%) of the newly diagnosed with were out of DKA in <24 hrs , 21(28%) 24-36 hrs and 17(22.6%) took >36 hrs to reverse acidosis.

8.2.3 Clinical Characteristics of the Known DM patients

Based on the clinical severity scoring 53(53%) had mild DKA 19(19%), moderate DKA and 23(23%) had severe DKA.

Fig 4 Severity of DKA for Known Diabetic patients



Out of this 79(79%) were managed at ER and discharged 7(7%) were admitted to PICU and 14(14%) were admitted to the wards.

For the Known Diabetics 100 who were on insulin 54 had mild DKA , 26 had moderate and 20 had Severe DKA.

Among the 68 patients with identified precipitating factors, various factors were found to contribute to the development of Diabetic Ketoacidosis (DKA). Specifically:

Infection was the most prevalent precipitating factor, identified in 50 patients, highlighting the significant role of infectious processes in triggering DKA episodes.

Thirteen patients experienced DKA due to discontinuation of their medication regimen. Reasons for discontinuation included unavailability of the medication (7 patients), seeking alternative herbal treatments (2 patients), medication breakage (1 patient), and absence of a caretaker (3 patients).

Additional precipitating factors included uvelectomy (2 patients), psychological stress (1 patient), and suboptimal medication dosage coupled with poor dietary habits (3 patients).

Table 10 Identified infections for Known Dm patients with DKA

Variables		Frequency
Type of infection identified	ATP	16
	UTI	3
	Pneumonia	4
	Uvelectomy	2

	Superinfected Tenia Capitis	3
	Gastritis	4
	AGE	4
	Vaginal Canidiasis	4
	Gluteal Abscess	1
	Periodontitis	2
	Septic Shock	2
	Cellulites	1
	Acute Appendicites	1
	Mesenteric Lymphadenitis	1
	Chin Abscess	1
	Mumps	1
	Total	50

Among those treated for diabetic ketoacidosis (DKA), eight had pre-existing chronic medical conditions apart from diabetes mellitus. Specifically, three had cerebral palsy, two had epilepsy, one had bronchial asthma, one had chronic liver disease, and one had autoimmune polyglandular syndrome, comprising celiac disease, autoimmune hepatitis, and type 1 diabetes mellitus.

Table 11 = RBS at presentation for known Dm patients with DKA

		Frequency	Percent
Rbs	250-350	22	22.0
	350-450	22	22.0
	450-550	32	32.0
	550-600	10	10.0
	>600	14	14.0

Total	100	100.0
-------	-----	-------

Table 12= Urine ketone for known Dm patients with DKA

		Frequency	Percent
Urine ketone	+2	24	24.0
	+3	55	55.0
	+4	21	21.0
	Total	100	100.0

Seventeen patients encountered management complications, with nine experiencing hypoglycemia, four developing cerebral edema, and four developing hyponatremia.

Uni variate and Multivariate Analysis

In the initial univariate analysis, factors such as residency status, health insurance coverage, malnutrition, and recent health visits within the last two weeks were found to be associated with ketoacidosis as the first presentation of DKA. However, after adjusting for multiple variables, only health insurance remained highly statistically significant, indicating a strong protective effect against presenting with DKA as the initial manifestation of diabetes [AOR 0.025, 95% CI 0.002-0.332, P=0.0005].

Variable		n(%)	Univariate analysis			Multivariate analysis		
			COR	95% CI	p-value	AOR	95% CI	p-value
Residency	Rural	32(38.1)	1					
	Urban	52(61.9)	3.769	0.8-16	0.076	8.133	0.842-78.596	0.070
Health Insurance	No	26(31.0)	1					
	Yes	58(69.0)	4.15	0.005-0.337	0.005	0.025	0.002-0.332	0.005
Malnutrition	No	44(52.4%)	1					
	Yes	40(47.6%)	3.5	0.7-18	0.125	4.068	0.339-48.815	.268
Health care Visit In the last 2 weeks	No	61(72.6)	1					
	Yes	23(27.4)	0.057	0.06-1.04	0.057	0.121	0.011-1.282	0.08

Table 13 Uni variate and Multivariate Analysis

Discussion

Our study showed the majority of patients newly diagnosed with type 1 diabetes mellitus present with ketoacidosis, with a prevalence of 89%. This finding is consistent with similar research conducted in Ethiopia (80%)(2), the UAE (80%), Romania (67%), Taiwan (65%), and South Africa (69.8%). However, the prevalence of ketoacidosis at diagnosis is significantly lower in Sweden (14%), Canada (18.6%), Finland (22%), and Hungary (23%). These results highlight the widely recognized geographic variation in the frequency of diabetic ketoacidosis at the onset of pediatric diabetes mellitus.

The variations in the prevalence of diabetic ketoacidosis at the time of type 1 diabetes diagnosis across different countries can be attributed to a multitude of factors. These include differences in study populations, the underlying prevalence of diabetes within specific regions, family history of type 1 diabetes, socioeconomic status, potential delays in diagnosis and treatment, as well as variations in how diabetic ketoacidosis is defined and identified in each study. These diverse factors collectively contribute to the observed differences in the magnitude of ketoacidosis presentation at the onset of pediatric diabetes mellitus.

When comparing this study to research conducted in Addis Ababa in 2008, the prevalence of diabetic ketoacidosis at Black Lion Hospital was reported as 80%. (12) However, a subsequent study in 2015 at Black Lion, Yekatit 12, and Zewditu Hospitals showed a lower prevalence of 35.8%. (1) One possible reason for this discrepancy could be the difference in sample size, as the latter study had a larger sample size of 143 participants. Additionally, the exclusion of referral cases from outside the city in the 2015 study may have contributed to the lower prevalence, as cases seen at Saint Paul Hospital are predominantly referral cases

The age distribution in our study aligns closely with findings from previous research, indicating consistency in the demographic profile of children diagnosed with diabetic ketoacidosis (DKA) (2, 3, 6). Similarly, the distribution of sex among our cases mirrors that of earlier studies, with no significant association observed between sex and DKA (1, 5) risk, consistent with existing literature.

A notable finding in our study is the high percentage (28%) of children who had sought healthcare within the two weeks preceding their diabetic ketoacidosis (DKA) diagnosis. This suggests a potential knowledge gap in recognizing the symptoms of diabetes mellitus in children. Furthermore, we observed that a history of infection or febrile illness was significantly associated with an elevated risk of DKA, affecting 24% of our cases.

Our study revealed a significant association between health insurance coverage and the occurrence of diabetic ketoacidosis (DKA) among children [Adjusted Odds Ratio (AOR) 0.025, 95% Confidence Interval (CI) 0.002-0.332, $P=0.0005$].

Based on these results, there appears to be a significant association between health insurance status and the likelihood of developing DKA. Specifically, individuals with health insurance are significantly less likely to develop DKA compared to those without health insurance, after adjusting for other factors. However, it's important to note that this association does not imply causation, and there may be other factors influencing the relationship between health insurance status and DKA development. This is similar with some previous research conducted in other countries, which suggested that the lack of health insurance is linked to higher rates and greater severity of DKA at diagnosis (30). Those who do not have health insurance have limited access to health services, delayed in diagnosis and management, financial constraints and limited access to diabetic education and support.

Our findings revealed that half of patients with known diabetes mellitus who experienced diabetic ketoacidosis (DKA) cited infection as a precipitating factor. This contrasts with previous research conducted in Jimma and Bahirdar (27, 28) where inappropriate storage of insulin and poor adherence were identified as major causes. This discrepancy could be attributed to the possibility that having a good understanding of the disease may lead to improved adherence to

medication, thereby reducing the likelihood of DKA precipitated by factors such as insulin storage or non-adherence.

Conclusion

This research reveals a concerning trend where a majority of newly diagnosed Type 1 Diabetes Mellitus (T1DM) patients continue to present with Diabetic Ketoacidosis (DKA) as their initial manifestation. Notably, the sole associated factor identified was the absence of health insurance, suggesting a lack of access to timely healthcare services may contribute to the development of DKA.

Furthermore, the study highlights a critical gap in the healthcare system, as many patients who visited healthcare facilities were not accurately diagnosed with DM, subsequently leading to DKA onset. Had healthcare professionals recognized the atypical symptoms or maintained a high index of suspicion for DM, the incidence of DKA as the first manifestation of DM could potentially have been mitigated.

For known Type 1 DM patients under insulin therapy, infection emerged as the predominant precipitating factor for DKA episodes. This underscores the importance of proactive infection management and heightened clinical surveillance in this patient population to prevent DKA exacerbations.

In conclusion, this research underscores the urgent need for enhanced healthcare provider education and improved diagnostic practices to promptly identify and manage DM in pediatric patients, thereby reducing the incidence of DKA as the initial presentation. Additionally,

proactive measures targeting infection prevention and timely intervention are crucial in mitigating DKA episodes among known Type 1 DM patients receiving insulin therapy.

Strength of the study

Clear objectives

The study collected a wide range of data, including demographic information, clinical characteristics, laboratory findings, and precipitating factors associated with DKA development, providing a comprehensive understanding of the topic.

Limitation of the study

Single center study The study's reliance on data from a single hospital may limit the generalization of the findings to other healthcare settings or populations with different characteristics.

Retrospective design are susceptible to bias and limitations inherent in data collection and documentation practices, potentially impacting the accuracy and completeness of the findings.

9) References

1. Meglio AD, Molina BE, Oram RA. Type 1 diabetes. *Lancet*. The Lancet. 2018;391(10138):2449-62.
2. Gregory, J.M., Moore, D.J. and Simmons, J.H., 2013. Type 1 diabetes mellitus. *Pediatrics in review*, 34(5), pp.203-215.
3. White NH. Diabetic ketoacidosis in children. *Endocrinology and metabolism clinics of North America*. 2000 Dec 1;29(4):657-82.
4. Atkilt HS, Turago MG, Tegegne BS. Clinical characteristics of diabetic ketoacidosis in children with newly diagnosed Type 1 diabetes in Addis Ababa, Ethiopia: a cross-sectional Study. *PloS one*. 2017 Jan 30;12(1):e0169666.
5. Palmer BF CD. Electrolyte and Acid-Base Disturbances in Patients with Diabetes Mellitus. *N Engl J Med*. 2015;373(6):548-59
6. Tremblay ES MK, Monuteaux MC, Bachur RG, Wolfsdorf JI. Plasma beta-Hydroxybutyrate for the Diagnosis of Diabetic Ketoacidosis in the Emergency Department. *Pediatr Emerg Care*. 2020;
7. Laffel L. Ketone bodies: a reivew of physiology, pathophysiology and application of monitoring to diabetes. *Diabetes Metab Res Rev*. 1999;15:412-26.
8. Maahs DM, West NA, Lawrence JM, Mayer-Davis EJ. Epidemiology of type 1 diabetes. *Endocrinology and Metabolism Clinics*. 2010 Sep 1;39(3):481-97.
9. Neu A, Willasch A, Ehehalt S, Hub R, Ranke MB, DIARY group Baden-Wuerttemberg. Ketoacidosis at onset of type 1 diabetes mellitus in children—frequency and clinical presentation. *Pediatric diabetes*. 2003 Jun;4(2):77-81.
10. Al Rashed AM. Pattern of presentation in type 1 diabetic patients at the diabetes center of a university hospital. *Annals of Saudi Medicine*. 2011 May;31(3):243-9.
11. Usher-Smith JA, Thompson M, Ercole A, Walter FM. Variation between countries in the frequency of diabetic ketoacidosis at first presentation of type 1 diabetes in children: a systematic review. *Diabetologia*. 2012 Nov;55:2878-94.

12. (Usher-Smith JA, Thompson MJ, Sharp SJ, Walter FM. Factors associated with the presence of diabetic ketoacidosis at diagnosis of diabetes in children and young adults: a systematic review. *Bmj*. 2011 Jul 7;343.
13. (Dabelea D, Rewers A, Stafford JM, Standiford DA, Lawrence JM, Saydah S, Imperatore G, D'Agostino Jr RB, Mayer-Davis EJ, Pihoker C. Trends in the prevalence of ketoacidosis at diabetes diagnosis: the SEARCH for diabetes in youth study. *Pediatrics*. 2014 Apr;133(4):e938-45.
14. Laurant Kollçaku*, Agim Gjokopulli, Virtut Velmishi, Sonila Tomorri, Paskal Cullufi and Ermira Dervishi
- Ketoacidosis as the First Presentation of Type 1 Diabetes Mellitus in Children and Adolescents during the Period of 2010-2014 in Albania**
15. (Razavi Z. Frequency of ketoacidosis in newly diagnosed type 1 diabetic children. *Oman medical journal*. 2010 Apr;25(2):114.
16. (Huang A, Chen Q, Yang W, Cui Y, Wang Q, Wei H. Clinical characteristics of 683 children and adolescents, aged 0–18 years, newly diagnosed with type 1 diabetes mellitus in Henan Province: a single-center study. *BMC pediatrics*. 2023 Dec;23(1):1-9.
17. Shaltout AA, Channanath AM, Thanaraj TA, Omar D, Abdulrasoul M, Zanaty N, Almahdi M, Alkandari H, AlAbdulrazzaq D, d'Mello L, Mandani F. Ketoacidosis at first presentation of type 1 diabetes mellitus among children: a study from Kuwait. *Scientific reports*. 2016 Jun 22;6(1):27519.
18. (18)Umar UI, Muhammed IL, Aliyu I. Retrospective review of presentation of newly diagnosed children with diabetes mellitus in a Nigerian rural setting. *Medical Journal of Dr. DY Patil University*. 2019 Nov 1;12(6):490-4.
19. Kipasika H, Majaliwa E, Kamala B, Mungai L. Clinical presentation and factors associated with diabetic ketoacidosis at the onset of type-1 diabetes mellitus in children and adolescent at Muhimbili National Hospital, Tanzania: a cross section study. *Int J Diabetes Clin Res*. 2020;7(3):126.
20. Reddy Y, Ganie Y, Pillay K. Characteristics of children presenting with newly diagnosed type 1 diabetes. *South African Journal of Child Health*. 2013 May;7(2):46-8.
21. Fantahun B, Gedlu E. Prevalence of diabetic ketoacidosis in newly diagnosed diabetes mellitus pediatric patients in tikur Anbessa Specialized Hospital. *Ethiopian Journal of Pediatrics and Child Health*. 2008 Jan 26;4(1):1-8
22. Hadgu FB, Sibhat GG, Gebretsadik LG. Diabetic ketoacidosis in children and adolescents with newly diagnosed type 1 diabetes in Tigray, Ethiopia: retrospective observational study. *Pediatric health, medicine and therapeutics*. 2019 May 23:49-55.
23. Kitabchi AE, Umpierrez GE, Murphy MB, Barrett EJ. Hyperglycemic crises in diabetes. *Diabetes care*. 2004;27:S94.
24. Qari FA. Precipitating factors for diabetic ketoacidosis. *Saudi medical journal*. 2002 Feb 1;23(2):173-6.

25. Assefa B, Zeleke H, Murugan R, Wondwossen K. Incidence and predictors of diabetic ketoacidosis among children with diabetes in west and east Gojjam zone referral hospitals, northern Ethiopia, 2019. *Italian Journal of Pediatrics*. 2020 Dec;46(1):1-9.

26. Gebeyehu K, Tefera M, Melaku B, Yeshwas S. Assessment of clinical profiles, and treatment outcomes for children with diabetic ketoacidosis, in two hospitals selected from Addis Ababa, Ethiopia, 2020. *Ethiopian Journal of Health Development*. 2022 Sep 16;36(2).