

Risk Factors for Diabetic Ketoacidosis among Diabetic Patients.

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Abstract:

Background: Diabetic ketoacidosis (DKA) is a life-threatening complication of diabetes, Assessment of risk factors play important roles in decreasing morbidity and mortality secondary to diabetic ketoacidosis. **Aim:** To assess risk factors for diabetic ketoacidosis among diabetic patients at Sohag University Hospital. **Research design:** Case-control retrospective research design had been utilized. **Setting:** The study was conducted in Emergency Medical unit, Internal Medicine department, and Outpatient Clinics of diabetes at Sohag University Hospital. **Sample:** 160 adult diabetic patients enrolled in this study. **Tool:** Patient assessment sheet for diabetic ketoacidosis was utilized for data collections during the period from January 2019 and ended October 2020. **Results:** The finding shows that age (p-value <0.01) as non-modifiable risk factors, dehydration (p-value <0.01), infection (p-value <0.01) poor compliance with treatment (p-value <0.01) and acute pancreatitis (p-value <0.01) were modifiable risk factors. There was highly statistical significant (p-value <0.01) association between DKA and risk factors. **Conclusions:** This study found strong associations between DKA and risk factors such as age, infection, poor compliance with treatment, dehydration, acute pancreatitis, emotional stress, surgery, myocardial infarction, and stroke. **Recommendations:** Modifiable risk factors have a significant role in the development of Diabetic Ketoacidosis, so a complete multidisciplinary diabetes education should be accessible to control these factors.

Keywords: *Diabetic Ketoacidosis & Risk Factors Diabetic patients.*

Introduction:

Diabetic ketoacidosis (DKA) is a serious complication of Diabetes Mellitus. It leads to significant risk of death and/or morbidity especially with delayed treatment. It starts when the body begins breaking down fat at a rate that is abundant too fast. The liver converts the fat into a fuel called ketones, which makes the blood to be acidic (**Butalia et al., 2019**).

Risk factors for DKA divided into non-modifiable risk factors, which include age, sex. Infection, poor compliance with treatment, dehydration and acute pancreatitis, newly diagnosis with diabetes, injury, serious illness, and stress of surgery are modifiable risk factors, which can lead to DKA in people with type I and type II diabetes (**Agarwal et al., 2020**).

The metabolic changes accompanied with Diabetic ketoacidosis DKA progress rapidly (usually within 24 hours), however the signs and symptoms of poor glycemic control (signs& symptoms of hyperglycemia) may be evident for several days before this. These are polyuria, polydipsia, weakness, fatigue and weight loss. Vomiting and abdominal pain are frequently the presenting symptoms in DKA. Blood sugar level is consistently higher than 300 milligrams per deciliter (mg/dL), or 16.7 millimoles

per liter (mmol/L), untreated diabetic ketoacidosis can lead to death (**Peters et al., 2020**).

The nurse's role in DKA, involves regular monitoring of hemodynamic state patient during acute stage. Teach patient how to control modifiable risk factors, stress on the importance of self-monitoring of blood glucose as well as check hemoglobin A1C at least two times a year. In addition to maintenance of healthy life style, (**Noble-Bell & Cox, 2020**).

Significance of the study:

Diabetic ketoacidosis is very dangerous and a serious condition that can cause diabetic coma and death. In 2019, about 280 cases were diagnosed with diabetes mellitus at Sohag University Hospital (**statistical hospital record, 2019**) the most of those patients presented by diabetic ketoacidosis. So this study assessed risk factors for diabetic ketoacidosis, among diabetic patients.

Aim of the study:

To assess risk factors for diabetic ketoacidosis among diabetic patients.

Subjects and Methods

Research design:

Case control retrospective study design was utilized.

Setting:

The study was conducted in Emergency Medical unit, Internal Medicine department, and outpatient clinics of diabetes at Sohag University Hospital.

Sample size:

A convenience sample, the estimated sample size is 160 patients divided equally into control and study group, at confidence level 95% and precision rate at 0.05 by using Steven equation, 2012. Since the total number was 256 patients.

$$n = \frac{N \times p(1-p)}{\left[N-1 \times (d^2 \div z^2) \right] + p(1-p)}$$

While:

P= 0.5

N= Total population Z= Z value "1.96"

D= Standard Error n= sample size

A total of 160 adult diabetic patients who divided into cases & control eighty (80) for each.

Inclusion criteria:

Cases: Eighty patients who diagnosed with diabetic ketoacidosis, age ranged from 18 to 65 yrs., type I or type II diabetes mellitus, and admitted to the emergency medical unit or internal medical department at Sohag University Hospital.

Control: Eighty patients who attended to the Outpatient Clinics of diabetes at Sohag University Hospital, type I or type II diabetes mellitus, and didn't expose previously or currently to DKA but matched for age and sex with cases.

Exclusion criteria:

Patients who unable to give their informed consent and who didn't have an accompanying person with them who can consent to their participation in the study on their behalf excluded from the study.

Tool of data collection:**Patient assessment sheet for diabetic ketoacidosis:-**

It was established by researcher according to national and international literature review to assess risk factors for DKA. It was consisted of four parts;

Part I: Patients' socio-Demographic data;

It was included patients 'age, sex, marital status, residence, and level of education.

Part II: Clinical data:

This part included structured items about past & present health history such as (hypertension, vascular diseases, diabetes experience, onset of diabetes, duration, treatment, height, weight and body mass index).

Part III: Risk factors for DKA: Which included non-modifiable risk factors such as (age and sex) and modifiable risk factors such as infection, poor compliance with treatment, dehydration and acute pancreatitis, newly diagnosis of diabetes, injury, emotional stress, surgery and stroke.

Part IV: Diagnostic investigation for DKA among cases group.

Operational Design

It was included Preparatory phase, tool reliability, Pilot study, and fieldwork phase.

Preparatory Phase

It was included reviewing current and past, national and international related (books, journals and magazines) literature and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals, and magazines to develop tools for data collection.

Content validity and reliability:

It was established by panel of five (5) expertise (three (3) teaching staff of Medical Surgical Nursing, Faculty of Nursing, Assiut University, & two (2) teaching staff of Internal Medicine, Faculty of Medicine, Sohag University) who reviewed the tool for clarity, relevance, comprehensiveness, understanding, applicability and easiness, slight modification were required. Chronbach's alpha test measured the reliability of the tool; the calculated alpha was 0.77.

Pilot Study:

A pilot study was carried out on 10 percent (16) of patients in selected setting to evaluate the simplicity, possibility, and applicability of the tool. The data attained from the pilot study were investigated and modification was completed in the tool. Patients shared in the pilot study were involved in the study.

Ethical Consideration:

A formal permission was obtained from the head of Medical department at Sohag University Hospital. In addition to verbal approval was obtained from patients after the nature and purpose of the study were explained.

Fieldwork

- Data had been collected during the period from January 2019 and ended October 2020.
- Data were collected from three different places, all control group patients had been gathered from diabetes Outpatients Clinics, while cases group had been gathered from emergency medical units & internal medical department.
- The researcher greeted the patients, introduced herself and explained the aim of study prior to any data collection.
- According to control group, the researcher was attending two days per week each patient in this group was interviewed individually to assess part I, II, III using patient assessment sheet.
- According to cases group, the researcher was attending two hours per shift (morning, afternoon and evening shift) to assess part I, II, III & IV using patient assessment sheet. Some patients completed part IV in emergency medical units while others completed it in the internal medical department.

Statistical analysis:

Continuous data are expressed as Mean± SD, comparison between two groups were made by T-Test correlation was determined by Pearson's correlation coefficient- statistical significance was defined as P<0.01. Logistic regression analysis was used to assess risk factors for DKA, Odd Ratios &

95% confidence intervals (CI) were calculated. All analysis was performed with IBM SPSS ver.25.0 soft were.

Results**Table (1): Distribution of the studied patients according to their demographic characteristics.**

Demographic characteristics	Cases group (n=80)		Control group (n=80)		T. test	
	N	%	N	%	X2	p-value
Age (years)						
20-<30	10	12.5	8	10	2.301	.192 ^{ns}
30-<40	12	15	12	15		
40-<50	18	22.5	16	20		
≥ 50	40	50	44	55		
Mean± SD	52.37±2.09		53.71±7.71			
Sex						
Male	48	60	50	62.5	2.661	.184 ^{ns}
Female	32	40	30	37.5		
Marital status						
Single	12	15	6	7.5	3.108	.157 ^{ns}
Married	60	75	62	77.5		
Divorced	2	2.5	4	5		
Widow	6	7.5	8	10		
Educational level						
Illiterate	4	5	2	2.5	4.097	.101 ^{ns}
Primary education	6	7.5	4	5		
Preparatory education	11	13.7	10	12.5		
Secondary education	49	61.3	52	65		
University education	10	12.5	12	15		
Occupation						
Work	48	60	54	67.5	5.324	.097 ^{ns}
Not working	32	40	26	32.5		
Residence						
Urban	33	41.2	38	47.5	3.019	.141 ^{ns}
Rural	47	58.8	42	52.5		
Under weight	8	10	6	7.5		
Normal weight	48	60	44	55		
Above weight	12	15	16	20		
Obese	12	15	14	17.5		
Mean± SD	23.91±4.15		24.17±3.62			

Ns= Non significant difference $p>0.05$

Table (2): Comparison between the studied patients regarding to their clinical data.

Clinical data	Cases group (n=80)		Control group (n=80)		T.test	
	N	%	N	%	X2	p-value
Height (cm)						
150-<160	20	25	15	18.7	3.331	.117 ^{ns}
160-<170	48	60	52	65		
≥ 170	12	15	13	16.3		
Mean± SD	164.40±3.05		166.01±2.54			
Wight (kg)						
60-<80	55	68.8	50	62.5	4.514	.099 ^{ns}
80-<100	20	25	18	22.5		
≥ 100	5	6.2	12	15		
Mean± SD	77.18±6.16		79.75±7.71			
Body mass index						
Under weight	8	10	6	7.5	4.016	.103 ^{ns}
Normal weight	48	60	44	55		
Above weight	12	15	16	20		
Obese	12	15	14	17.5		
Mean± SD	23.91±4.15		24.17±3.62			
Frequency of blood glucose monitoring at home						
Not every day	50	62.5	46	57.5	2.014	.932 ^{ns}
Once daily	20	25	26	32.5		
Twice or more daily	10	12.5	8	10		
Use of sick day regimen						
Yes	18	22.5	15	18.7	1.054	2.360 ^{ns}
No	62	77.5	65	81.3		
Symptoms of current attack of DKA						
Vomiting	60	75	0	0.0	—	
Abdominal pain	22	27.5	0	0.0		
Rapid breathing	45	56.2	0	0.0		
Disturbed conscious level	20	25	0	0.0		
Classification of DKA						
Don't know	26	32.5	0	0.0	—	
Mild (pH7.25- 7.3)	24	30	0	0.0		
Moderate (pH7.0-7.25)	18	22.5	0	0.0		
Severe (pH less than7.0)	12	15	0	0.0		

Ns= Non significant difference $p>0.05$

Table (3): Present and past history of studied patients cases and control groups:

Health history	Cases group (n=80)		Control group (n=80)		T. test	
	N	%	N	%	X2	p-value
Diabetes experience						
Newly diagnosed	32	40	28	35	1.671	.974 ^{ns}
Old	48	60	52	65		
If newly diagnosed	(n=32)		(n=28)		1.964	.617 ^{ns}
Type I	24	75	18	64.3		
Type II	6	18.8	8	28.6		
Gestational DM	2	6.2	2	7.1		
If old	(n=48)		(n=52)		1.297	1.167 ^{ns}
Type I	32	66.7	36	69.2		
Type II	16	33.3	16	30.8		
Age at DM onset (year)						
< 20	8	10	10	12.5	1.108	1.364 ^{ns}
20 < 30	12	15	10	12.5		
30-<40	28	35	26	32.5		
≥ 40	32	40	34	42.5		
Mean± SD	37.8±1.99		37.9±8.75			

Health history	Cases group (n=80)		Control group (n=80)		T. test	
	N	%	N	%	X2	p-value
Type of diabetes						
Type I	56	70	54	67.5	1.040	1.517 ^{ns}
Type II	22	27.5	24	30		
Gestational DM	2	2.5	2	2.5		
Duration of diabetes						
< 5	32	40	34	42.5	1.093	1.497 ^{ns}
5-<10	28	35	30	37.5		
≥ 10	20	25	16	20		
Mean± SD	8.67±0.99		8.96±5.71			
Diabetes treatment						
Tablets "oral"	24	30	26	32.5	1.544	.988 ^{ns}
Insulin "injection"	56	70	54	67.5		
Number of previous hospital admission with DKA						
Not once	0	0.0	80	100	.110	10.33 ^{ns}
Once	67	83.8	0	0.0		
Twice	8	10	0	0.0		
Three	3	3.7	0	0.0		
More than three	2	2.5	0	0.0		

Ns= Non significant difference $p>0.05$

Table (4): Mean scores of laboratory investigations for studied patients (Cases group).

Laboratory investigations	Cases group (n=80)
	pt. finding
Blood glucose	405.9±10.9
Arterial PH	7.21±0.43
Anion gap	13.92±2.05
Serum bicarbonate	11.5±1.60
Urinalysis(ketones)	+++
Serum creatinine	1.97±0.73
Serum sodium	143.1±7.80
Serum potassium	5.24±3.11
Serum phosphate	4.49±2.82
White blood cell count	12.57±5.03

Table (5): Comparison between the studied patients regarding to their exposure of risk factors for diabetic ketoacidosis.

Risk factors	Cases group (n=80)		Control group (n=80)	
	Exposed N (%)	Not exposed N (%)	Exposed N (%)	Not exposed N (%)
Infection	50 (62.5)	30 (37.5)	14 (17.5)	66 (82.5)
Poor compliance with treatment	62 (77.5)	18 (22.5)	20 (25)	60 (75)
Newly diagnosed diabetes	65 (81.3)	15 (18.7)	42 (52.5)	38 (47.5)
Trauma	15 (18.7)	65 (81.3)	7 (8.7)	73 (91.3)
Dehydration	10 (12.5)	70 (87.5)	2 (2.5)	78 (97.5)

Risk factors	Cases group (n=80)		Control group (n=80)	
	Exposed N (%)	Not exposed N (%)	Exposed N (%)	Not exposed N (%)
Emotional stress	33 (41.2)	47 (58.8)	20 (25)	60 (75)
Surgery	22 (27.5)	58 (72.5)	7 (8.7)	73 (91.3)
Acute pancreatitis	10 (12.5)	70 (87.5)	2 (2.5)	78 (97.5)
Myocardial infarction	5 (6.2)	75 (93.8)	2 (2.5)	78 (97.5)
Stroke	5 (6.2)	75 (93.8)	2 (2.5)	78 (97.5)

Table (6): Logistic regression model of risk factors for diabetic ketoacidosis.

Risk factors	Odds Ratio	(95% Confidence Interval)		P- value
		lower	upper	
Non modifiable risk factors	1.21	125	320	0.007**
Age (per 5-year increase)				
Modifiable risk factors	7.85	420	3300	0.000**
Infection				
Poor compliance with treatment	10.33	360	3720	0.000**
Newly diagnosed diabetes	3.92	630	2470	0.003**
Trauma	2.40	455	1.095	0.005**
Dehydration	5.57	140	780	0.000**
Emotional stress	2.10	940	1.980	0.007**
surgery	3.95	406	1.606	0.003**
Acute pancreatitis	5.57	140	780	0.000**
Myocardial infarction	2.6	150	390	0.005**
Stroke	2.6	150	390	0.005**

**p-value <0.01 HS.

**= Highly significant(HS)

Table (1): Shows that, 50% of the cases group their age was ≥ 50 years, the mean age of them 52.37 ± 2.09 year. While 55% of the control group their age was ≥ 50 years, the mean age of them 53.71 ± 7.71 year. As regard to sex and marital status, 60% and 75% of the cases group were male and married, respectively. Also 62.5% and 77.5% of the control group were male and married, respectively. Also, 61.3% and 60% of the cases group had secondary education and working, respectively. While, 65% and 67.5% of the control group had secondary education and working, respectively. Regarding to residence, 58.8% of the cases group residing in rural areas. Also 52.5% of the control group residing in rural areas.

Table (2): Shows that the clinical data was similar between two groups with no statistically significant difference between them ($P > 0.05$).

Table (3): Presents that, there was no statistically significant difference between two groups regarding to their past & present health history ($P > 0.05$).

Table (4): Indicates that, the mean \pm SD of blood glucose was 405.9 ± 10.9 . Also, the mean \pm SD of

arterial PH was 7.21 ± 0.43 . The mean \pm SD of anion gap and serum bicarbonate were 13.92 ± 2.05 and 11.5 ± 1.60 , respectively. The mean \pm SD of serum creatinine and serum sodium were 1.97 ± 0.73 and 143.1 ± 7.80 , respectively. The mean \pm SD of serum potassium and serum phosphate were 15.24 ± 3.11 and 4.49 ± 2.82 , respectively. The mean \pm SD of white blood cell count was 12.57 ± 5.03 .

Table (5): Shows that, 62.5% and 41.2% of the cases group were exposed to infection and emotional stress, respectively. While 17.5% and 25% of the control group were exposed to infection and emotional stress, respectively. Also, 81.3% and 77.5% of the cases group were newly diagnosed diabetes and had poor compliance with treatment, respectively. While 52.5% and 25% of the control group were newly diagnosed diabetes and had poor compliance with treatment, respectively.

Table (6): Logistic regression models illustrated that four independent variables as risk factors were powerfully related to diabetic ketoacidosis. Increase patients' age (per 5-year) increased the odds of rising DKA via one time. Exposing to **infection (7.85)**

increased the patients' odds of developing DKA by just over seven times. Exposing to **dehydration (5.57)** also increased the odds of developing DKA by six times, and having **acute pancreatitis (5.57)** increased the odds of developing DKA by eleven times compared to controls. Also individuals with DKA are **(10.33)** times more likely to be exposed to **Poor compliance with treatment** than those without DKA.

Discussion:

Diabetic ketoacidosis (DKA) is one of the most serious complications after diabetes poor control, which seriously threatens human life, health, and safety. DKA can rapidly develop within hours or days leading to death. Early evaluation of the prognosis of DKA patients and timely and effective intervention are very important to improve the prognosis of patients. Eventually by estimation of the risk factors for DKA among diabetic patients and targeting those patients will reduce the risk of morbidity among this group of patients. **According to socio demographic characteristics & clinical data of studied patients** diagnosed with diabetic ketoacidosis (Cases group), the current study demonstrated that half of the cases group their age was ≥ 50 years, the mean age of them 52.37 ± 2.09 year related to poor complains with treatment. Extra than half and three quarters of the cases group were male and married respectively related to increase stress. Extra than half of the cases group residing in rural areas. About, Body Mass Index "BMI" Less than two thirds of the cases group had normal weight with mean 23.91 ± 4.15 and mean of body weight was 77.18 ± 6.16 kg and mean of height was 164.40 ± 3.05 cm.

These findings inconsistent with a study conducted by (Wu & Fang, 2020) titled in "clinical profiles, outcomes and risk factors among type 2 diabetic inpatients with diabetic ketoacidosis and hyperglycemic hyperosmolar state" a hospital-based analysis over a 6-year period, at 158 diabetic patients who were admitted to Shanghai Tongji Hospital and reported that average age was 64.8 ± 17.7 years. Less than half (71/158) were male and more than half (87/158) were female.

While, supported with the study performed by (Radhi et al., 2020) titled in "characteristics of diabetic ketoacidosis in adult patients in Bahrain" with sample size 224 patients and stated that more than half of them were male and married. Also, cohort with the study performed by (Bedaso et al., 2019) about "diabetic ketoacidosis among adult patients with diabetes mellitus admitted to emergency unit of Hawassa University comprehensive specialized hospital" with sample

size 195 patients and presented that more than half of studied patient residence at rural area and less than two thirds were male.

The current study demonstrated that more than half of the control group their age was ≥ 50 years, the mean age of them 53.71 ± 7.71 year. Also less than two thirds and more than three quarters of the control group were male and married, respectively. Also extra than half of the control group residing in rural areas. About two thirds and more than two thirds of the control group had secondary education and working. Related BMI, more than half of the control group had normal weight with mean 24.17 ± 3.62 . As is evident, the researcher was keen to ensure that the two samples are identical with regard to the demographic specialist.

These findings inconsistent with a study performed by (Metwally et al., 2019) titled in "effect of counteracting lifestyle barriers through health education in Egyptian type 2 diabetic patients, at Egypt" with sample size 197 patients and stated that extra than half of them were female, extra than one third were illiterate and more than half of them don't work. While, similar with the study conducted by (Abd El Dayem et al., 2019) titled in "sclerodactyly and diabetic complications among Egyptian adolescent type 1 diabetic patient, at Egypt" with sample size 63 patients and reported that mean BMI of them was 21.86 ± 6.47 kg. **Also, the** current study presented that more than half of case and control group did not monitored these blood glucose every day at home. Regarding classification and symptoms of DKA, the current study showed that more than half suffered from mild and moderate DKA and three quarters of them suffered from vomiting, more than half suffered from rapid breathing. These findings congruent with a study conducted by (Hoshina et al., 2018) titled in "treatment modality-dependent risk of diabetic ketoacidosis in patients with type 1 diabetes" danish adult diabetes database study, with sample size 20.902 patients and reported that more than half of them who exposed to DKA was mild episode and more than two thirds of them suffered from vomiting, rapid breathing due to DKA.

Also, regular with the study done by (Garrett et al., 2019) titled in "recurrent diabetic ketoacidosis and a brief history of brittle diabetes research" contemporary and past evidence in diabetic ketoacidosis research including mortality, mental health and prevention, who stated that main symptoms of DKA was nausea & vomiting, stomach pain, disturbed of breathing and fluctuation conscious level.

Regarding past and present history of studied patients, the current results mentioned that extra than one third of case group and control group were newly

diagnosed with DM and more than two thirds of them diagnosed with type I diabetes. Also, revealed that more than two thirds treated with insulin injection and about number of previous hospital admission with DKA, the control group no one of them, while at case group majority of them was the first time admitted to hospital with DKA. Finally, there was no statistically significant difference between (cases group and control group) regarding to their past and present health history at ($P = > 0.01$). According this study DKA occur more than in newly diagnosed with DM in case group and control group, while DKA most common in patients treatment with insulin injection.

These findings cohort with a study performed by (Schwarzfuchs et al., 2020) titled in Clinical and Epidemiological Characteristics of Diabetic Ketoacidosis in Older Adults, who reported that more than two thirds patient from 307 studied patients dependent on insulin injection and less than half newly onset of DM. Also, similar with the study performed by (Clark et al., 2019) about Evaluation of a diabetic ketoacidosis order set in adults with type 1 and type 2 diabetes at a tertiary academic medical centre: A retrospective chart audit, who stated that less than three quarter with type 1 and one quarter with type 2 diabetes. The historical cohort consisted of 59 admissions, more than two thirds with type 1 and less than one third with type 2 diabetes.

Also, with same line with the study conducted by (Zhong et al., 2018) titled in Trends in hospital admission for diabetic ketoacidosis in adults with type 1 and type 2 diabetes in England, who detected that hospitalization for DKA increased in adults with T1DM and in those with T2DM.

Regarding laboratory investigations; According to classification of DKA the current study detected moderate DKA that the mean \pm SD of blood glucose was 405.9 ± 10.9 . Also, the mean \pm SD of Arterial PH was 7.21 ± 0.43 . The mean \pm SD of anion gap and serum bicarbonate were 13.92 ± 2.05 and 11.5 ± 1.60 , respectively. The Serum creatinine and Serum sodium were normally, respectively. The Serum potassium was 15.24 ± 3.11 (normal) and Serum phosphate was normally. Most case group was between mild and moderate DKA characterized by acidosis, positive ketone in both urine and blood. These findings regular with the study conducted by (Lee, 2019) titled in "characterization of variable presentations of diabetic ketoacidosis based on blood ketone levels and major society diagnostic criteria" a new view point on the assessment of diabetic ketoacidosis, who stated that PH was 7.41(normal) and Anion gap 15.7(increase), K was 4.3(normal) and serum Na 131.6(normal)

Also, (Holkar et al., 2017) titled in "Study of Serum Electrolytes Levels in Patients with Diabetic Ketoacidosis" who stated that mean score of Na was 126.2 ± 2.7 (normal), K was 5.73 ± 0.07 (normal) and urine ketone was +++(positive).

According to risk factors, the present study detected that less than two thirds and more than one third of the cases group were exposed to infection and emotional stress, respectively. While less than one fifth and one quarter of the control group were exposed to infection and emotional stress, respectively. Also, majority and more than three quarters of the cases group were newly diagnosed diabetes and had poor compliance with treatment, respectively. While about half and one quarter of the control group were newly diagnosed diabetes and had poor compliance with treatment, respectively. This study appeared that infection and emotional stress were more serious effected on DKA occur may be related to catabolic distress and metabolic acidosis.

These results supported with the study performed by (Ndebele & Naidoo, 2018) titled in "the management of diabetic ketoacidosis at a rural regional hospital in KwaZulu-Natal" with sample size 115 patients and reported that extra than half of DKA patients was newly diagnosed as type 1 diabetes. Also, similar with the study conducted by (Ehrmann et al., 2020) titled in "risk factors and prevention strategies for diabetic ketoacidosis in people with established type 1 diabetes" who detected that low socioeconomic, lack of treatment and psychological stress, were risk factors for DKA. According logistic regression models, the present study indicated that four independent variables were powerfully related to diabetic ketoacidosis. Exposing to **infection** increased the patients' odds of developing DKA by just over seven times. Exposing to **dehydration** also increased the odds of developing DKA by six times, and having **acute pancreatitis** also increased the odds of developing DKA by over five times compared to controls. Moreover, **Poor compliance** with treatment also increased the odds of developing DKA by ten times compared to controls. Illness or infection can make uncontrolled blood sugar levels so leads to hyperglycemia and electrolyte disturbances. These is may be related to increase in counter-regulatory hormones (glucagon, catecholamine, cortisol, growth hormones and epinephrine).

These finding supported with the study performed by (Sato et al., 2020) about Factors affecting in-hospital mortality of diabetic ketoacidosis patients: A retrospective cohort study, who stated 25,627 DKA patients and 839 (3.3%) in-hospital deaths. Factors associated with increased in-hospital mortality

included higher Charlson comorbidity index (≥ 4) (odds ratio, 3.38; 95% confidence interval, 2.30–4.96; $p < 0.001$), sepsis (odds ratio, 3.09; 95% confidence interval, 2.38–4.00; $p < 0.001$). Also, agreement with the study by (Michaelis et al., 2020) Features and long-term outcomes of patients hospitalized for diabetic ketoacidosis, who reported that risk for readmission for DKA is higher for young patients with long duration of diabetes, poor compliance of insulin treatment and poorly controlled diabetes.

But, incohort with the study by (Bradford et al., 2017) about Predictors of recurrent hospital admission for patients presenting with diabetic ketoacidosis and hyperglycemic hyperosmolar state, who showed that Readmission odds were significantly increased for patients with age < 35 , history of depression or substance/alcohol abuse, and self-pay/publicly funded insurance. HbA1C $> 10.6\%$ on admission and ethnic minority status did not significantly increase readmission odds, with inadequate study power for these variables.

Conclusion

The current study concluded that strong associations between DKA and risk factors such as age as non-modifiable risk factor while infection, poor compliance with treatment, dehydration, acute pancreatitis, emotional stress, surgery, and medical conditions (myocardial infarction and stroke) are modifiable risk factors for DKA.

Recommendations:

Modifiable risk factors have a significant role in the development of DKA, so a complete multidisciplinary diabetes education should be accessible for patients to control these factors by educate the patient about survival skills, including treatment modalities (diet, insulin administration, monitoring of blood glucose and for type I & type 2 diabetes, monitoring of urine ketones).

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