2021-06

Incidence and Predictors of Hyperglycemic Emergency Among Adult Diabetic Patients Inbahir Dar City Public Hospitals, Northwest Ethiopia, 2021. A Retrospective Follow Up Study

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BAHIR DAR UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF HEALTH SCIENCES

DEPARTMENT OF ADULT HEALTH NURSING

INCIDENCE AND PREDICTORS OF HYPERGLYCEMIC EMERGENCY AMONG ADULT DIABETIC PATIENTS INBAHIR DAR CITY PUBLIC HOSPITALS, NORTHWEST ETHIOPIA, 2021. A RETROSPECTIVE FOLLOW UP STUDY

BY: MELSEW DAGNE (BSC, MSC STUDENT)

THE THESIS SUBMITTED TO THE DEPARTMENT OF ADULT HEALTH NURSING, SCHOOL OF HEALTH SCIENCES, COLLEGE OF MEDICINE AND HEALTH SCIENCES FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN ADULT HEALTH NURSING

JUNE, 2021

BAHIR DAR, ETHIOPIA

BAHIR DAR UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF HEALTH SCIENCES

DEPARTMENT OF ADULT HEALTH NURSING

The Thesis Submitted to the Department of Adult Health Nursing, School of Health Sciences, College of Medicine and Health Sciences for Partial Fulfillment of the Requirements for the Degree of Masters in Adult Health Nursing

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Title of the Research	Incidence and Predictors of Hyperglycemic emergency among Adult Diabetic Patients in Bahir Dar City Public Hospitals, Northwest Ethiopia, 2021
Thesis Area and Period	Bahir Dar City public hospitals from January 1, 2016 to December 31, 2020

DECLARATION SHEET

Letter of declaration

I, the undersigned, MSc student declare that this thesis is my original work in partial fulfillment of the requirement for the degree of master of Adult Health Nursing, which has not been presented in this or other universities. All sources of materials used for the thesis have been fully acknowledged.

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Date of Submission: _____

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Approval of Thesis Report

I hereby certify that I have supervised, read, and evaluated this thesis report titled "Incidence and Predictors of Hyperglycemic emergency among Adult Diabetic Patients in Bahir Dar City Public Hospitals, Northwest Ethiopia, 2021" by Melsew Dagne prepared under my guidance and it has been submitted for examination with my approval as university advisor.

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Approval of Thesis Report

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ACKNOWLEDGEMENT

Firstly, I would like to express my great thank and sincere appreciation to my advisors Mr. Ayele Semachew (BSc, MSc, Associate professor) and Mr. Solomon Emishaw (BSc, MSc, Assistant professor) for their unreserved guidance, constructive suggestions, supervision, and kind patience throughout the development of this thesis.

Secondly, I would like to acknowledge Bahir Dar University, College of Medicine and Health Sciences, School of Health Sciences, and Department of Adult Health Nursing for giving me the chance to do this thesis. My deepest gratitude goes to Woldia University, which sponsored me to continue my MSc education. Then I wish to extend my gratitude to Bahir Dar public hospitals for giving the necessary information for my work.

Last but not least, I would like to acknowledge my data collectors, supervisors, and Bahir-Dar public hospitals card room workers for their cooperation.

ABSTRACT

Background: Hyperglycemic emergency is the most serious acute complications of diabetes mellitus and its impact have been increased among adult diabetic patients. Despite the growing up of hyperglycemic emergency impact among adults with diabetes, its incidence and predictors have not been well studied particularly in Ethiopia.

Objective: To assess the incidence and predictors of hyperglycemic emergency among diabetic patients in Bahir Dar City public hospitals, Northwest Ethiopia, 2021.

Method: A retrospective follow up study design was conducted among adult diabetic patients who were registered from January 1, 2016 to December 31, 2020, in Bahir Dar City public hospitals, Northwest Ethiopia. A simple random sampling technique was used to select patients. The data were entered into EPI data version 4.6 and analyzed using STATA version 14.0. Cox proportional hazard regression model was fitted to identify the independent predictors of hyperglycemic emergency.

Result: Out of the 453 adult diabetic patients included in the study 147(32.45%) developed Hyperglycemic emergency in the entire follow-up period. Hence, the overall incidence was 1.22 per 100-person-month of observation and the overall median hyperglycemic free survival time was 53.85 months. Without Community health insurance (AHR = 1.63, 95%CI(1.14,2.35), type 1 diabetes mellitus (AHR = 2.75, 95%CI (1.68,4.51), history of medication noncompliance (AHR = 1.85, 95%CI(1.24,2.76), diabetes duration (AHR = 0.33, 95%CI(0.21,0.50), recent six month poor glycemic control (AHR = 3.47, 95%CI(2.17,5.56), follow up frequency of 2 to 3 months (AHR = 1.79,95%CI(1.06,3.01), acute recent illness (AHR = 2.99, 95%CI(2.03,4.43) and presence of comorbidities (AHR = 2.36, 95%CI(1.53,3.63) were significant predictors.

Conclusion: The incidence of hyperglycemic emergency was high especially during the early three years of diabetes mellitus diagnosis. Diabetic care should be focused on over controlling the identified predictors of hyperglycemic emergency to prevent its public health and economic impacts.

Keywords: hyperglycemic emergency, incidence, adult diabetic patients, Ethiopia

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ABBREVIATIONS

AAPH	Addis Alem Primary Hospital
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
DKA	Diabetic Ketoacidosis
DM	Diabetes Mellitus
FBGL	Fasting Blood Glucose Level
FHCSH	Felege-Hiwot Comprehensive Specialized Hospital
HGEs	Hyperglycemic Emergencies
HHS	Hyperglycemic Hyperosmolar Syndrome
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HR	Hazard Ratio
IQR	Interquartile Range
KM	Kaplan-Meier
MI	Myocardial Infarction
NCD	Non-communicable Disease
NPH	Neutral Protamine Hagedorn Insulin
OHGA	Oral Hypoglycemic Agent
OPD	Out Patient Department
RBGL	Random Blood Glucose Level
SD.Error	Standard Error
STATA	Statistical Analysis
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
TGSTH	Tibebe Ghion Specialized Teaching Hospital
USA	United States of America

1. INTRODUCTION

1.1. BACKGROUND

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia associated with defects in insulin secretion, insulin action, or both[1]. Diabetes mellitus frequently associated with life-threatening hyperglycemic emergencies[2]. Hyperglycemic emergencies are extreme metabolic derangements associated with uncontrolled diabetes mellitus which includes diabetic ketoacidosis and hyperglycemic hyperosmolar syndrome [3]. Diabetic ketoacidosis (DKA) by definition consists of hyperglycemia, ketonemia, and metabolic acidosis whereas the hyperglycemic hyperosmolar state (HHS) is similar to DKA but ketonemia is minimal or absent, and hyperglycemia and osmolality are much higher in HHS[1]. DKA and HSS commonly occur in type 1 Diabetes mellitus (T1DM) and type 2 Diabetes mellitus (T2DM) respectively; however, both can occur irrespective of DM type. HGEs have common clinical presentations of polyuria, polydipsia, polyphagia, weight loss, tachycardia, kussmaul breathing, hypotension, electrolyte disturbance, and confusion[4].

The management of hyperglycemic emergencies(HGEs) demands fluid replacement, correction of hyperglycemia(insulin), electrolyte replacement, treatment of precipitating factors, and also needs repeated clinical and laboratory assessment and close monitoring[5].

Delayed and unmanaged HGEs are commonly associated with complications of shock, cerebral edema, pulmonary edema, thromboembolism, and renal failure which are associated with significant mortality rates [4, 6]. HGEs can be prevented by improving access to medical care, identification of risk factors, and proper patient education [7].

1.2. STATEMENT OF THE PROBLEM

Diabetes mellitus is a major and growing clinical and public health problem of the world that is targeted by the World Health Organization prevention and control of the non-communicable disease[7, 8]. Globally, diabetes prevalence and its impact have increased dramatically, particularly in sub-Saharan Africa[6, 9]. Consequently, HGEs continue to be a significant health and socioeconomic problem among adults with DM [10, 11]

Hyperglycemic emergencies have been increased[10, 12]and it is the leading cause of diabetic-related morbidity, mortality and health care cost among adults with diabetes[13]. According to the Centers for Disease Control and Prevention(CDC) report in the United States (US), the rate of hospitalization from HGEs steadily increased with an annual hospitalization rate of 9.7 per 1,000 adults with diabetes[11]. A systematic review study[14] revealed that the worldwide prevalence of DKA ranges from 0- 128 per 1000 people with the lowest prevalence reported in Sweden and the highest in Canada. Evidence in Africa revealed that HGEs account for more than 12% of diabetic-related admissions[15, 16]. And it is the most common challenging condition in the emergency department of the health system[17]. Studies in Ethiopia showed that the prevalence of DKA ranges from 20-62% and HHS from 2%-4.6% among diabetic patients [18, 19]**.**

According to a World Health Organization report(2016), there were 1.6 million diabetic-related deaths, and high blood glucose is the major cause of premature death among adults with diabetes[19, 20]. Developing countries like Sub-Saharan countries including Ethiopia mostly focus on communicable disease; consequently, diabetes mellitus complications, particularly HGEs continues to be the leading cause of premature mortality among adults with diabetes[9, 21]. Different studies in the world showed that the mortality rate ranges 2-5% for DKA and 10- 20% for HHS [22, 23] with higher mortality in Sub-Saharan Africa including Ethiopia [9, 19, 24]. The burden of HGEs constitutes a health care cost crisis from patients to the national economy of the countries[13, 25].In Ethiopia, hyperglycemic emergencies take a great part in adult medical admission and the cost of inpatient diabetes management both in drug use and bed occupancy[26, 27].

In Sub-Saharan countries, lack of funding for non-communicable disease, poor public health care, lack of proper health education poor self-glycemic control, and lacks of availability of studies and guidelines specific to the population has a great impact on the rising HGEs burden[9, 17]. Even studies in Ethiopia showed a higher rate of using traditional remedies and other behaviors that have a significant risk for HGEs[28]. Generally, potential risk factors of HGEs are Socio-demographic and behavioral related, treatment, and clinical related factors [7, 24, 29].

Despite the increasing worldwide burden of diabetes, data on the incidence of HGEs among known adult diabetic patients is limited, particularly in Africa. A systematic review including different worldwide countries revealed scarce data about the epidemiology of DKA and recommends further studies about the incidence of DKA[14] and the exact incidence of HHS is not identified[30]

In Ethiopia, Limited studies have been conducted and assessed the prevalence and associated factors of DKA and HHS [31-33]; however, these studies did not address the incidence of HGEs among known adult diabetic patients, and predictors of HGEs are not well addressed. And also, no study was conducted to show the time to develop HGEs among adult diabetic patients. There is a study about the incidence and predictors of DKA among children with diabetes[29]. However, as our searching technique, there is no published study in Ethiopia on the incidence and predictors of HGEs among adults diagnosed with DM. Therefore, this study aims to identify the incidence and predictors of HGEs among adult diabetic patients. And also, to determine the time duration to develop HGEs among adults diagnosed with diabetes.

1.3. SIGNIFICANCE OF THE STUDY

Studying the incidence and predictors of HGEs is vital for developing measures to prevent HGE incidence and its morbidity, mortality, and health care expenditure. Identifying the incidence of HGEs is important to show the burden of HGEs among adult diabetic patients and in the health care system which will contribute information for health service planning and delivery. Identifying the predictors of HGEs could help to develop preventive strategies and treatment protocols. Assessing the time to develop HGEs will help to identify the risky period to develop HGEs after DM diagnosis; consequently, will be used to develop a risk predictive model and giving attention to risk groups.

For health professionals, findings are expected to be important to identify adults with diabetes who are at high risk to develop HGEs and afterward, important to identify possible areas for intervention and for the development of interventions to reduce the occurrence of HGEs. This, in turn, may decrease bed occupancy in the hospital and reduce the amount of human and material resources needed to control it. For patients, it will give information about HGEs to prevent it and improve their quality of life and HGE-free survival time. For study area public hospitals it will give an alert about HGEs.

The finding of the study will also use as benchmark information for the individuals who are interested in carrying out further studies concerning HGEs. It also will provide information for policymakers and other governmental and non-governmental organizations as input to plan resources for possible interventions to combat HGEs and related consequences.

2. LITERATURE REVIEW

2.1. INCIDENCE

Some evidence revealed many diabetic patients had recurrent episodes of HGEs [34, 35]. A systemic review study conducted in different regions of the world revealed that the incidence of DKA ranges from 0- 263 per 1000 person per year with the highest in China (263 per 1000 person-year) and the lowest incidence rate in Israel and North America (0 event per 1000 person-year)[14]. Even though the exact incidence rate of HHS is not known it is estimated to account for < 1% of diabetic-related hospital admission among diabetic patients[11, 30]. A nationwide study in the United States of America(USA) revealed a significant increase in HGEs incidence[10], and currently, DKA accounts for 61.6 per 10,000 diabetic-related admissions per year[36]. The Annual incidence of DKA was about 41 persons per 1000 persons in England[12], 13 persons per 100,000persons in Denmark[37], and 1.8 per 100 persons in Finland [38], and 6.2% in Saudi Arabia [39]. An institutional-based retrospective study in Thailand showed that the incidence of hyperglycemic emergencies was 7.46%[40].In Korea, a nationwide study reported that the number of HGEs hospitalization incidence rates increased from 1.78 per 1000 diabetic cases in 2004 to 2.15 per 1000 diabetic cases in 2013 and the predicted hospitalization incidence rate of HGEs will increase by 2030[41]. A Study in Nigeria[42] revealed 40 % of HGEs hospitalization incidence while the study in Ethiopia showed 38.2% incidence of HGEs hospitalization from all DM-related admissions[31].

2.2. PREDICTORS OF HYPERGLYCEMIC EMERGENCIES

2.2.1. Socio-demographic and Behavioral factors

The incidence of hyperglycemic emergencies varies with geographical variation, age, sex, and other factors [36, 43]. And the incidence of HGEs is higher in females [25] and young age adults with diabetes[25].

A nationwide study in the USA revealed that HGEs are significantly associated with middle-aged adults(35-69 years) with the highest incidence rate age group(18-44 years)[43]. A study conducted in Atlanta [44], Israel[45], Iraq[46], Nigeria [47], and Ethiopia[33] showed that younger adults are significantly associated with a higher risk of developing HGEs. Whereas evidence in Nigeria[48] revealed that age is not significantly associated with HGEs. Studies in Ethiopia showed that age is a significant predictor of HGEs and higher among younger adult diabetic patients. And also, patients with HHS significantly older than patients with DKA [33, 49]. Studies in Iraq[46], Finland[38], Nigeria[48], and Ethiopia[33] reported that being male is significantly associated with more risk of developing HGEs while other studies conducted in the USA[43], Jamaica[50], and Ethiopia[51] reported that sex is not significantly associated with HGEs.

Finding in Iraq revealed that the address of the patient was a significant predictor of HGEs with higher risk among rural adult diabetic patients[46]. Evidence in Nigeria[52]showed that Urban residence has more likely to develop HGEs without a significant difference; While research done in Haramaya, Ethiopia[51] reported patients from the urban residence had more risk of developing HGEs but finding in Hawasa, Ethiopia showed no significant association between residence and HGEs[33]. Studies showed that not having community insurance is significantly related to HGEs occurrence among adult diabetic patients [13, 53, 54]

2.2.2. Clinical Characteristics

Studies revealed that comorbidities like cardiovascular disease and psychiatric disorders were predictors of HGEs among diabetic patients [33, 43, 48, 55]. However, other evidence [43] revealed that depression has no significant association and showed no significant association between HGEs and heart failure, stroke, and myocardial infarction(MI)[44]. Findings in China[56] and Ethiopia [24, 32, 46] showed recent acute illness, infection, comorbidities, and delayed treatment initiations were precipitating factors of HGEs. Studies in the USA[57], Australia[58], Finland[38], and Ethiopia revealed poor glycemic control was a predictor of the occurrence of HGEs among diabetic patients.

In finding from Iraq[46] DM duration was significantly associated with HGEs but finding from Nigeria[47] showed that DM duration is not significantly associated with HGEs. Evidence in Finland[38] Diabetic nephropathy and renal impairment were significantly associated with HGEs. Studies in Ethiopia [32, 59] reported that T1DM is significantly associated with HGEs.

2.2.3. Treatment-related characteristics

Different studies in the world revealed that type of treatment and missed insulin dose was significantly associated with HGEs with a higher risk of developing HGEs among patients who are on insulin treatment and have missing insulin dose[46, 55]. Studies in Ethiopia showed that patients who are on insulin treatment have a significantly higher risk of developing HGEs[24] and type of anti-diabetic treatment (taking insulin only and glibenclamide and metformin) are significantly associated with HGEs.[49]. A systematic review study [60] revealed that Sodium-glucose co-transporter 2 inhibitors (SGLT2i's) had a significant risk of developing HGEs among type 2 DM patients; while another retrospective observational study, showed there wasn't a significant increase in the risk of developing HGEs [61]. Other studies in China[56], Nigeria[62], and Ethiopia[59] showed medication noncompliance was a significant predictor of developing HGEs. Diabetic patients who did not have regular diabetic follow up had a significant risk of developing HGEs[63]

3. CONCEPTUAL FRAMEWORK

The conceptual framework was adapted after reviewing different literatures [29, 32, 46, 50, 64] and it shows an association between dependent variables (incidence rate and time to develop HGEs) with the independent variables (socio-demographic characteristics, clinical characteristics, and treatment-related factors)

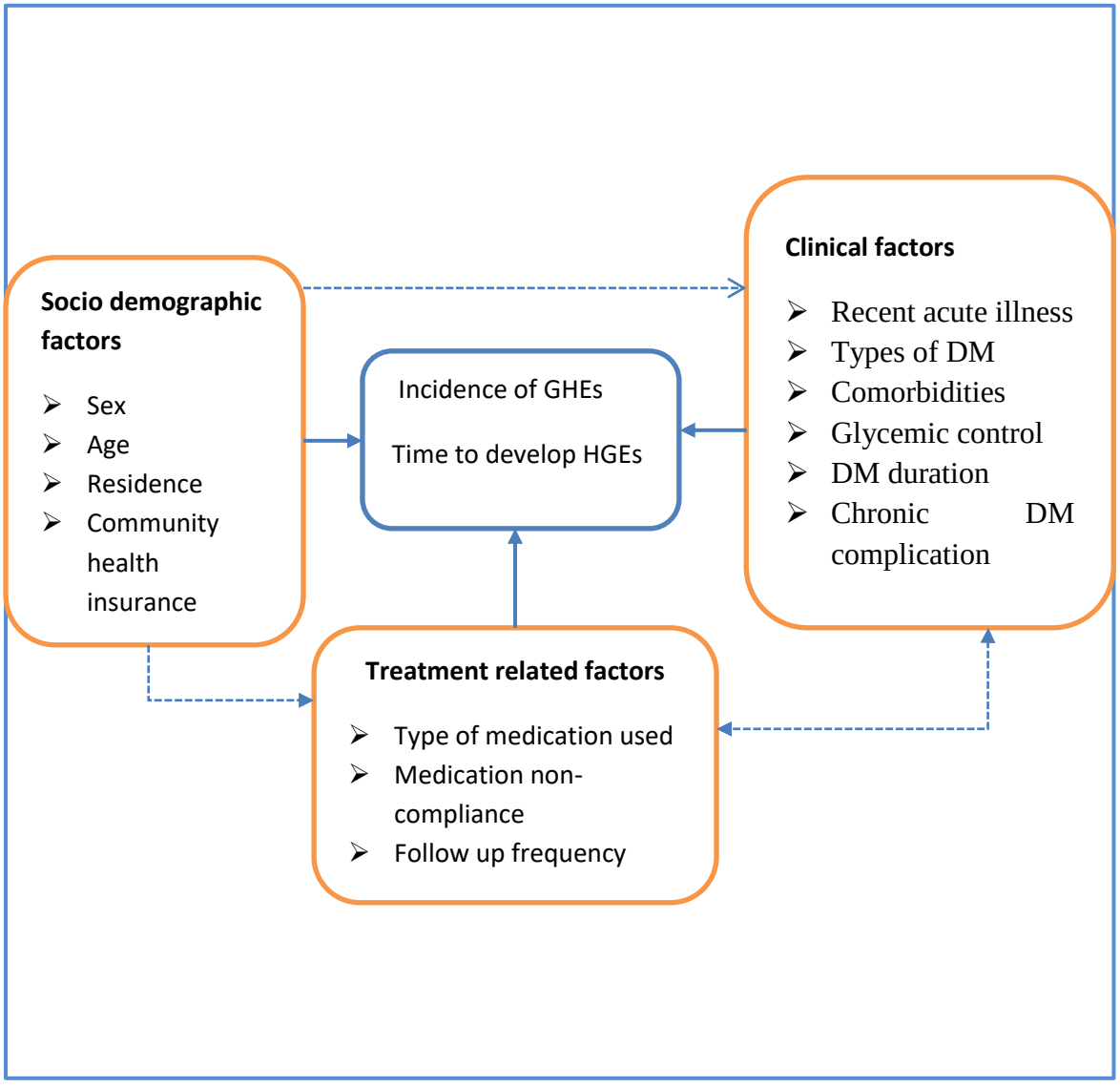


Figure 1: Conceptual framework of incidence and predictors of HGEs among DM diagnosed adults in Bahir Dar town public hospitals, Ethiopia, 2021.

4. OBJECTIVES

4.1. GENERAL OBJECTIVE

- To assess the incidence and its predictors of hyperglycemic emergency among adult diabetic patients who have followed up care in Bahir Dar City public hospitals, Amhara regional state, Northwest Ethiopia, 2021

4.2. SPECIFIC OBJECTIVE

- ✓ To determine the incidence of hyperglycemic emergency among adult diabetic patients who have follow-up care in Bahir Dar City public hospitals.
- ✓ To identify predictors of hyperglycemic emergency among adult diabetic patients who have followed up care in Bahir Dar City public hospitals.

5. METHODS AND MATERIALS

5.1. STUDY AREA AND PERIOD

The study was conducted in Bahir Dar public hospitals, North West Ethiopia from January 1, 2016, to December 31, 2020, and the data were collected from March 16, 2021, to April 14, 2021. Bahir Dar is the capital city of Amhara National Regional State, which is 565 km far from Addis Ababa (the capital city of Ethiopia) and altitude of 1,820 m above sea level. There are a total of 26 kebeles with a total population of 373,073 in the city. From this 268,733 are adult population[65]. Currently, in the city, there are three public hospitals; which are Felege Hiwot Comprehensive Specialized Hospital (FHCSH) and Tibebe Ghion Specialized Teaching Hospital (TGSTH), and Addis Alem Primary Hospital (AAPH) and four private hospitals (GAMBY, Afilas, Adinas, and Dream Care Hospital).

The Felege Hiwot Hospital is one of the compressive specialized governmental hospitals providing gynecology and obstetric, specialized clinics of internal medicine, mental health, surgery, orthopedics, pediatrics, ophthalmology, oncology, gynecology, otorhinolaryngology (ENT) and emergency services for better health services. It has 500 beds capacity and around 15 adult outpatient departments (OPD) serving about 5 million people coming from more than 500km distances. Tibebe Giwon Specialized Referral Hospital is a teaching hospital that has a 459-bed capacity and around 14 outpatient departments serving more than 5 million people. Addis Alem Hospital is a primary hospital with 47-bed occupancy and 8 outpatient departments serving 100,000 people. There were 3520, 925, and 900 adult diabetic patients who had DM follow-up in Felege hiwot, Tibebe Ghion, and Addis Alem hospitals respectively from January 1, 2016, to December 31, 2020. From these, 1542, 500, and 800 adult diabetic patients were diagnosed with DM from January 1, 2016, to December 31, 2020, in Felege Hiwot, Tibebe Ghion, and Addis Alem hospital respectively.

5.2. STUDY DESIGN

An institution-based retrospective follow up study was conducted.

5.3. POPULATION

5.3.1. Source Population

All adults (age ≥ 18 years old) diagnosed with T1DM and T2DM, and having chronic Diabetes Mellitus follow up in Bahir Dar public hospitals.

5.3.2. Study Population

All adults diagnosed with T1DM and T2DM and who have DM follow up from January 1, 2016, to December 31, 2020, in Bahir Dar public hospitals.

5.4. ELIGIBILITY CRITERIA

5.4.1. Inclusion criteria

All adults age ≥ 18 years old and who are diagnosed with T1DM and T2DM, having DM follow up from January 1, 2016, to December 31, 2020, in Bahir Dar public hospitals.

5.4.2. Exclusion criteria

All individuals who developed HGEs at the first diagnosis of DM and whose record is incomplete for important variables (date of diagnosis of DM and date of the event or last observation) and didn't have at least one follow-up after the first diagnosis were excluded from the study.

5.5. SAMPLE SIZE AND SAMPLING PROCEDURE

5.5.1. Sample Size Determination

Sample size determination, Stat Calc function of Epi Info software version 7 used by applying cohort sample size calculation technique and taking common predictor variables for HGEs with 95% confidence interval, 80% power, and 1:1 ratio of unexposed to exposed patients. Then the maximum sample size of the variables was taken.

Table 1: Summary of sample size calculation for predictors of HGEs among adults with diabetes in Bahirdar Public Hospitals, North West Ethiopia, 2021

SNo	Variables	Power	Confidence level	Assumptions	Fleiss total Sample Size	After adding10 %	References
1	Glycemic control(uncontrolled)	80%	95%	P1= 67.6 P2=35.8	76	84	[32]
2	Recent acute illness	80%	95%	P1=50.9 P2=27.4	134	168	[46]
3	Missed insulin dose	80%	95%	P1=48.8 P2=33.8	336	372	
4	Presence of comorbidity	80%	95%	P1=31.9 P2=17.2	268	295	[63]
5	Type of DM(T1DM)	80%	95%	P1=33.1 P2=21.1	430	473	

Key: P1= Percent of exposed with the outcome and P2 = Percent of non-exposed with the outcome

Finally, the maximum sample size of the study is 473.

5.5.2. Sampling technique and procedure

The three public hospitals (Addis Alem primary hospital, Tibebe Giwon, and Felege Hiwot Referral hospital) are selected. Then to select the study participants from each hospital, the proportional allocation formula was used based on caseloads. There were about 1542, 500, and 800 adults diagnosed with DM in Felege Hiwot, Tibebe Giwon, and Addis Alem respectively between January 1, 2016, to December 31, 2020. After that, medical records of adults diagnosed with DM were isolated from diabetic follow-up logbooks (OPD). From the isolated cards in each hospital, the computer generated simple random sampling technique was applied to select the study participants.

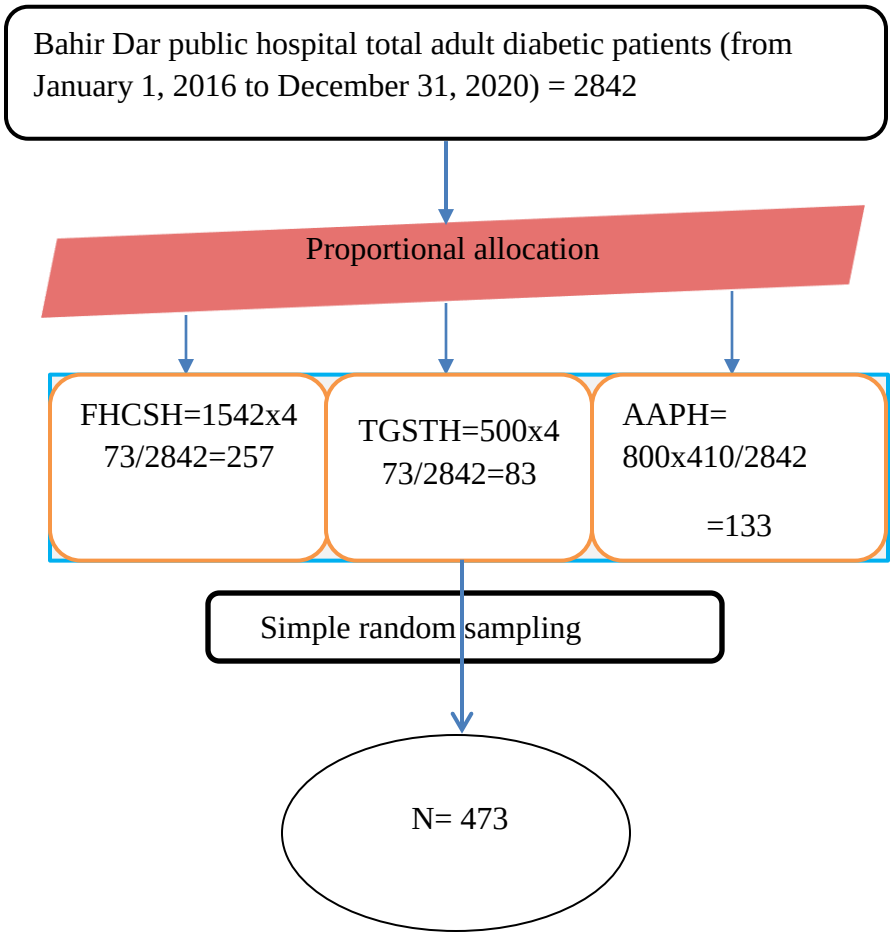


Figure 2: Schematic presentation of the sampling procedure of adult diabetic patients in Bahir Dar Public Hospitals, Northwest Ethiopia, 2021.

5.6. STUDY VARIABLES

5.6.1. Dependent Variable

The incidence rate of Hyperglycemic emergencies

Time to develop HGEs

5.6.2. Independent Variables

Socio-demographic Variables

- Age
- Sex
- Community health insurance
- Residence

Clinical variables

- Recent acute illness
- Types of DM
- Glycemic control
- DM duration
- Presence of Comorbidity
- Presence of chronic diabetic complication

Treatment factors

- Follow up frequency
- Type of drug used
- Medication non-compliance

5.7. OPERATIONAL DEFINITIONS OF VARIABLES

Survival: Time measured between the date of DM diagnosis and to the date of developing HGEs or date censored.

Censored: Adult diagnosed with DM and who did not develop HGEs during follow up study (transfer out, died, loss to follow up, still not develop HGEs because study ends)

Adult: Individual aged ≥ 18 years old

Hyperglycemic emergencies: Was considered based on a clinical diagnosis of DKA, HHS, or mixed diagnosis mentioned in the medical records or when there is RBGL > 250 mg/dl and urine ketone body ≥ +2 for DKA and RBGL> 600 with minimal or absent urine ketone body for HHS[66]

Classification of diabetes type: Was determined based on the clinical diagnosis made by a health care provider (T1DM and T2DM).

Co-morbidities: Adult with DM and having other chronic medical or psychiatric diseases

Psychiatric disorders: Diagnosed with depression, anxiety Schizophrenia, substance abuse behaviors, dementia, and epilepsy and eating disorders

Chronic cardiovascular disorders: Congestive heart failure, hypertension, and stroke

Chronic respiratory disorders: Chronic obstructive pulmonary disease, asthma, and pulmonary hypertension

Chronic liver diseases: Chronic hepatitis, liver cirrhosis, hepatocellular carcinoma, alcoholic liver disease, and non-alcoholic fatty liver disease

Event: occurrence of HGEs from diagnosis to end of the study.

Entry date: First date for each observation within the study period at the date of DM diagnosis

End date: Last date for each observation within the study period that the patient observed last.

Incomplete Records: Charts with incomplete information for variables of date of DM diagnosis and date of event occurred or last observation

Recent acute illness: Diagnosis of (acute febrile illness, respiratory infection, myocardial infarction, urinary tract infection, and gastrointestinal infection) before two weeks of developing HGEs or last follow-up observation which is recorded in the patients' medical card.

Glycemic control: Average three-month FBS level ranges from 70-130 mg/dl or HgA1c < 7% referred to controlled. And uncontrolled blood glucose defined as average FBS > 130 or < 70[67].

Recent six-month glycemic control: History of recorded glycemic control(poor or good glycemic control) in the near six-month follow-up periods before developing HGEs or being censored.

Medication noncompliance: history of medication noncompliance recorded in patients medical chart.

Age categories: Defined as young (18-44 years old), middle-aged (45-64years old), and older age (≥ 65 years old)[11].

5.8. DATA COLLECTION TOOL AND PROCEDURE

The data extraction checklist was developed by the principal investigator after reviewing different relevant literature [24, 29, 32]. Data were collected from patients' charts by using a pretested checklist. Charts were retrieved based on their medical registration number in each hospital. The data collecting team consisted of chart finders from the chart room, two BSC nurse data collectors, and one supervising BSC health officer. The extracted data were coded to avoid duplication.

5.9. DATA QUALITY ASSURANCE

Before data collection, the checklist was evaluated by experts and advisors. The pre-test was done in Felegehiwot Comprehensive Specialized Hospital on 24 (5%) of the sample size from adult diabetic patients' charts that were registered before one month of January 1, 2016. Cronbach alpha reliability test was done and the value was 0.72. After that, necessary modifications were done on the checklist. One day training was given to data collectors and supervisors by the principal investigator before actual data collection. The training was focused on introducing the purpose of the study, data collection tools, the initial and end of the data collection period, correct completion of the checklist, and ethical considerations to standardize the data collection. The completeness of the collected data was checked on the site daily basis during data collection with feedback by the supervisor and the principal investigator. Besides this, the principal investigator was carefully entered and double data entry was done. Data cleaning was done using Stata version 14.0 software before the commencement of the analysis.

5.10. DATA PROCESSING AND ANALYSIS

The data was coded, cleaned, and checked for its consistency and completeness, and then the data entered into EPI data version 4.6.0 and exported into STATA version 14.0 for statistical analysis. Descriptive and summary statistics were computed to determine the frequencies and summary statistics. Cox proportional hazard model assumption was checked using the Schoenfeld residuals test, Cox Snell residual, and parallel assumption test.

The Kaplan Meier survival curve was used to estimate the median survival time and the Log Rank test was used to statistically test survival between different categories of independent variables. The association between the independent variables and outcome variable was assessed by Cox-proportional hazard model. Variables having a p-value less than 0.25 in bivariable were a candidate for multivariable Cox proportional hazard analysis. By using a backward stepwise selection process 95% CI of hazard ratio (HR) was computed and variables having a p-value less than or equal to 0.05 in the multivariable model were considered as statistically significant with the dependent variables. Multi-collinearities between independent variables were checked by using correlation matrix coefficients of cox model (max |r| = 0.70).

5.11. ETHICAL CONSIDERATION

Ethical clearance was obtained from the institutional review board (IRB) of Bahirdar University's ethical review committee on behalf of the College of Medicine and Health Science, School of Health Sciences, Department of Adult Health Nursing. Permission letter was obtained from each Bahirdar public hospital administrations and outpatient coordinators in the hospitals for data collection. Moreover, names and unique card numbers were not included in the data collection format and the data was not disclosed to any person other than the principal investigator and was used for only study purposes.

6. DISSEMINATION OF RESULTS

The thesis will be submitted to the Department of Adult Health Nursing, School of Health Science, College of Medicine and Health Sciences, Bahirdar University. It will also be disseminated to Addis Alem primary hospital, Felege Hiwot, Tibebe Ghion referral hospital, and other concerned bodies through conferences and reports. Finally, an effort will be made to publish the findings in peer-reviewed journals

7. RESULTS

7.1. Demographic characteristics and descriptive statistics

Among 473 adult diabetic patients reviewed charts from the 3 public hospitals, 453 of them were included in the study and analyzed. The rest of sample 20(4.2%) were accounted to incomplete chart and no history of follow up after their DM diagnosis. Out of 453 adults, almost half 233 (51.43%) were males and more than half 327 (72.19%) were from urban areas(see table 2). The median age of the patients at the time of diabetes diagnosis was 47 years with IQR (36-56).

The majority of patients 317 (69.98%) were T2DM patients and 279 (61.59) used oral hypoglycemic agent**.** Out of the total diabetic patients, 247(54.53%) had comorbidity and 52(21.1%) had more than one comorbidities. Cardiovascular disorders, HIV/AIDS, and chronic respiratory disorders were found to be the most common comorbid diseases. About 213 (47.02 %) of patients had poor recent six-month glycemic control(see table 3 and table 4).

Table 2: Baseline socio-demographic result of adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Variables	Category	Frequency	Percent
Age	Young age	195	43.05
	Middle age	201	44.37
	Older age	57	12.58
Sex	Male	233	51.43
	Female	220	48.57
Residence	Urban	327	72.19
	Rural	126	27.81
Community health insurance	Yes	209	46.14
	No	244	53.86

Table 3: Clinical-related result of adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Variables	Category	Frequency	Percent
DM type	T2DM	317	69.98
	T1DM	136	30.02
DM duration category	< 3 years	258	56.95
	≥ 3years	195	43.05
Recent six-month glycemic control	Controlled	240	52.98
	Uncontrolled	213	47.02
Acute recent illness	Acute febrile illness	32	7.06
	Respiratory infection	32	7.06
	Urinary tract infection	35	7.73
	Gastrointestinal infection	32	7.06
	Myocardial infarction	7	1.55
	Others*	21	4.64
Comorbidities	Chronic respiratory disorder	23	5.08
	Cardiovascular disorder	202	44.59
	HIV/AIDS	25	5.52
	psychiatric disorder	14	3.09
	Renal disease	24	5.30
	Others**	13	2.87
	More than one comorbidities	52	21.1
Chronic diabetic complications	Diabetic foot ulcer	22	4.86
	Diabetic neuropathy	26	5.74
	Diabetic nephropathy	18	3.97
	Diabetic retinopathy	9	1.99

*Others: includes meningitis, cellulitis, and thyrotoxicosis

**Others: includes, chronic liver disease, goiter, osteoporosis, dyslipidemia and benign prostate hyperplasia

Table 4: Treatment-related result of adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Variables	Categories	Frequency	Percent
Drug type	Oral hypoglycemic agent	279	61.59
	Insulin	151	33.34
	Oral and insulin	23	5.08
Medication noncompliance	No	373	82.34
	Yes	80	17.66
Follow up frequency	Weekly	28	6.18
	Monthly	192	42.38
	2-3 months	152	33.55
	>= 4 months	20	4.42
	Irregular	61	13.47

7.2. Incidence of HGE among adult diabetic patients

Totally, 453 adult diabetic patients were followed for different periods for five years with 12048 person-months observations. The overall mean follow-up length was 26.6 months (95%CI: 24.97-28.22). From the total adult diabetic patients included in the analysis about 147(32.45) developed HGEs and 306(67.55) censored in the entire follow-up period. Out of the total HGEs, 92(62.59) were males and 108(73.47%) had comorbidity. The overall HGE incidence in the cohort was 1.22 per 100-person month (14.4 person-year) observation (95%CI, 1.038-1.4342). The incidence of DKA was 12.5 per 100 person-year (36 per 100 (T1DM) and 6 per 100 (T2DM)). The incidence of HHS was 2.1 per 100 person-year (2.4 per 100 (T2DM) and 0.94 per 100 (T1DM)). The overall median HGEs-free survival time of the entire cohort was 53.85 months (95%CI, 46.88-59.67). A higher incidence of HGEs occurred between 0-12 months of follow-up interval (see table 5).

Table 5: Life table showing the survival to develop HGEs among adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Interval In months	Patients at risk	No of HGEs cases	Censored	Cumulative Survival	SD. Error	[95% CI]	
						L	U
[0 12]	453	57	57	0.8657	0.0165	0.8295	0.8948
(12 24]	339	30	64	0.7811	0.0209	0.7367	0.8190
(24 36]	245	29	60	0.6758	0.0257	0.6226	0.7232
(36 48]	156	22	76	0.5498	0.0320	0.4849	0.6099
(48 60]	58	9	47	0.4064	0.0474	0.3132	0.4973
(60 72]	2	0	2	0.4064	0.0474	0.3132	0.4973

7.3. Overall survival function

The overall Kaplan- Meier estimate showed that the probability of HGEs-free survival of adult diabetic patients was high during 1.02 months of observation (99.78%). The probability of HGEs-free survival relatively falls as follow-up month increases with sharp fall after 58.62 months and minimum survival probability was observed(30.72%) at 60 months of observations. (See figure-3 below)

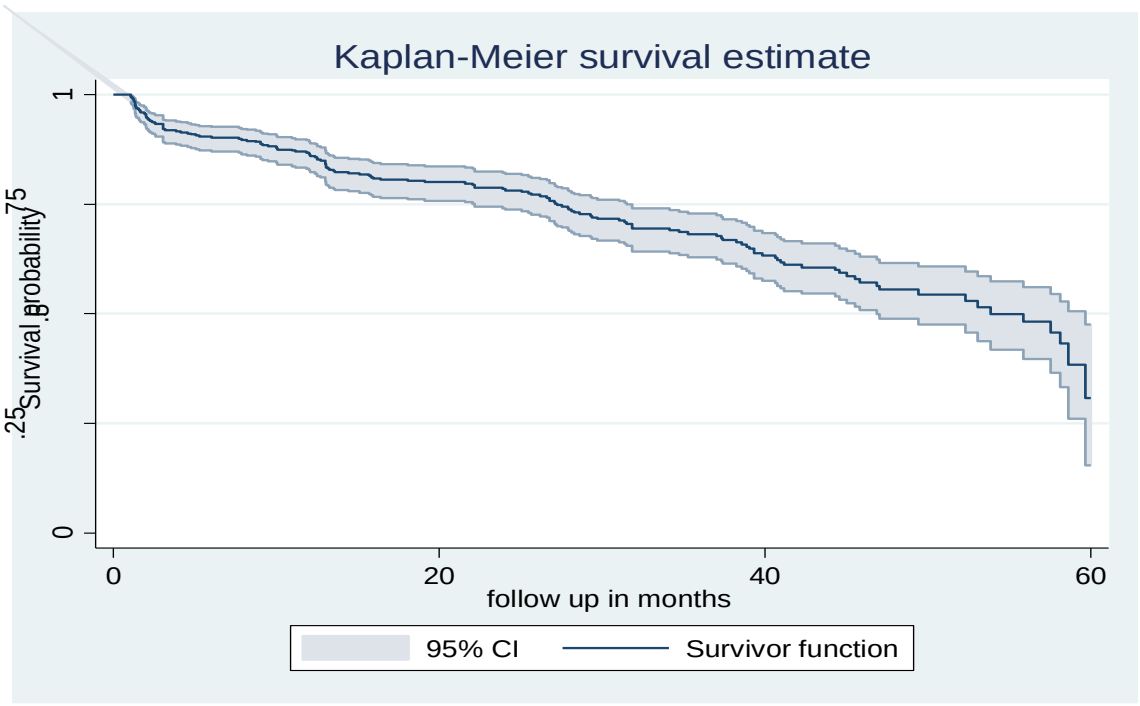


Figure 3: The overall Kaplan-Meier survival curve of HGEs-free survival estimate of adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

7.4. Survival function and Comparison of different categorical variables

The Kaplan-Meier estimator survival curve shows the estimate of HGEs-free survival among different groups of variables to make comparisons. The observed difference on the plot was statistically showed by the log-rank test. (See P- value on each KM graphs). The log-rank test was used to check statistically for the presence of any significant differences in survival among various categorical predictors.

Separate graphs of the estimates of the Kaplan-Meier survivor functions were constructed for categorical variables as described below (see figures-4, 5, 6 and 7). In general, the pattern that one survivorship function lying above another means the group defined by the upper curve has better HGEs-free survival than the group defined by the lower curve.

Patients who are with controlled six-month glycemic control, with community health insurance, without a history of medication noncompliance, duration ≥3 years and diagnosed with T2DM had better HGEs-free survival than the corresponding categories (See figures-4, 5 and 6).

The Kaplan-Meier survivor functions also showed that diabetic patients who had DM without comorbidities, and without a history of acute recent illness were better survived without developing HGEs as compared to their corresponding. (see figures-7)

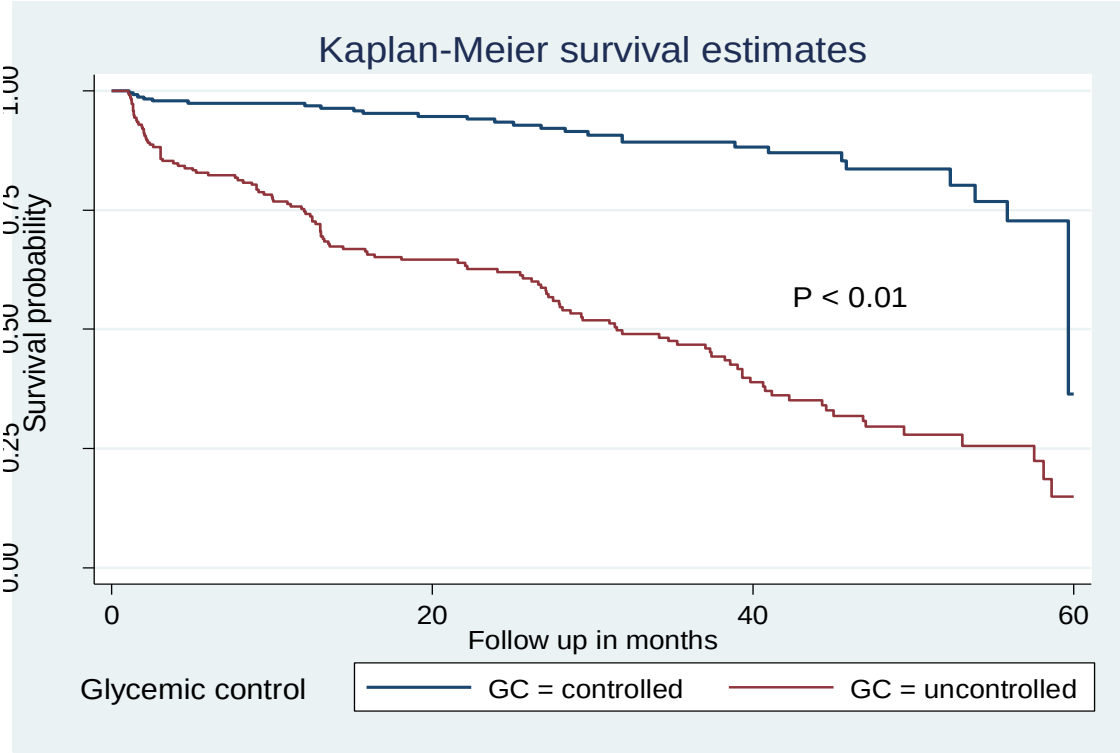
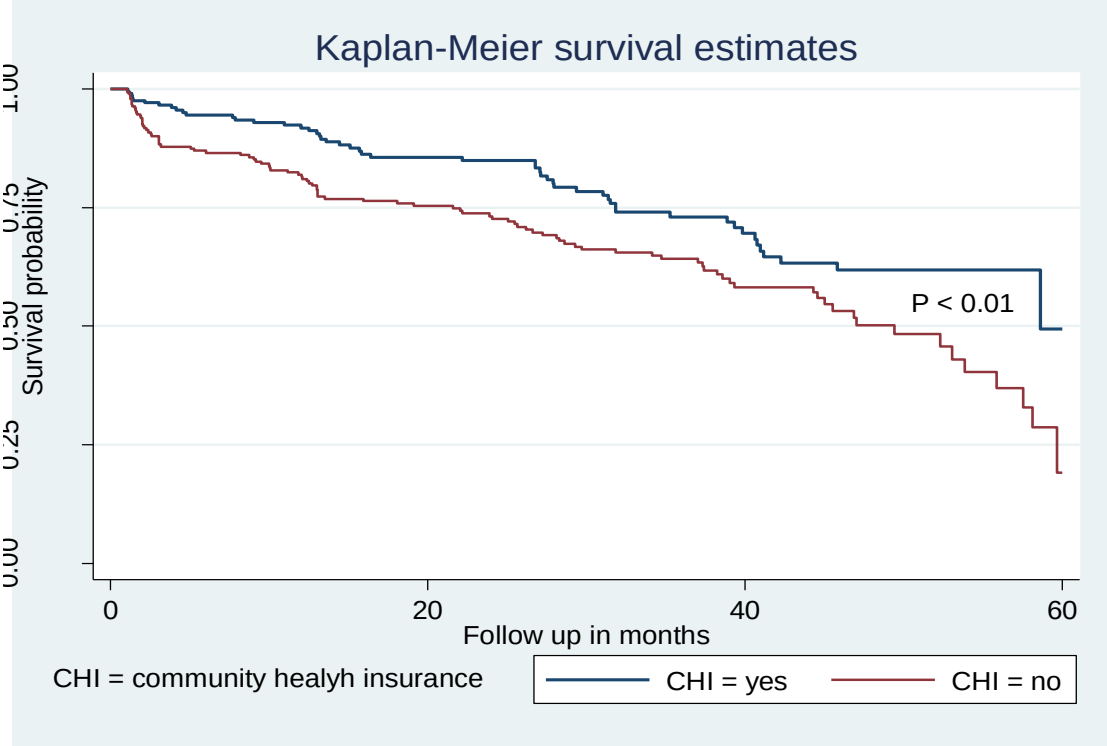


Figure 4: The Kaplan-Meier survival curves comparing survival time of adult diabetic patients based on history of recent six month glycemic control in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)



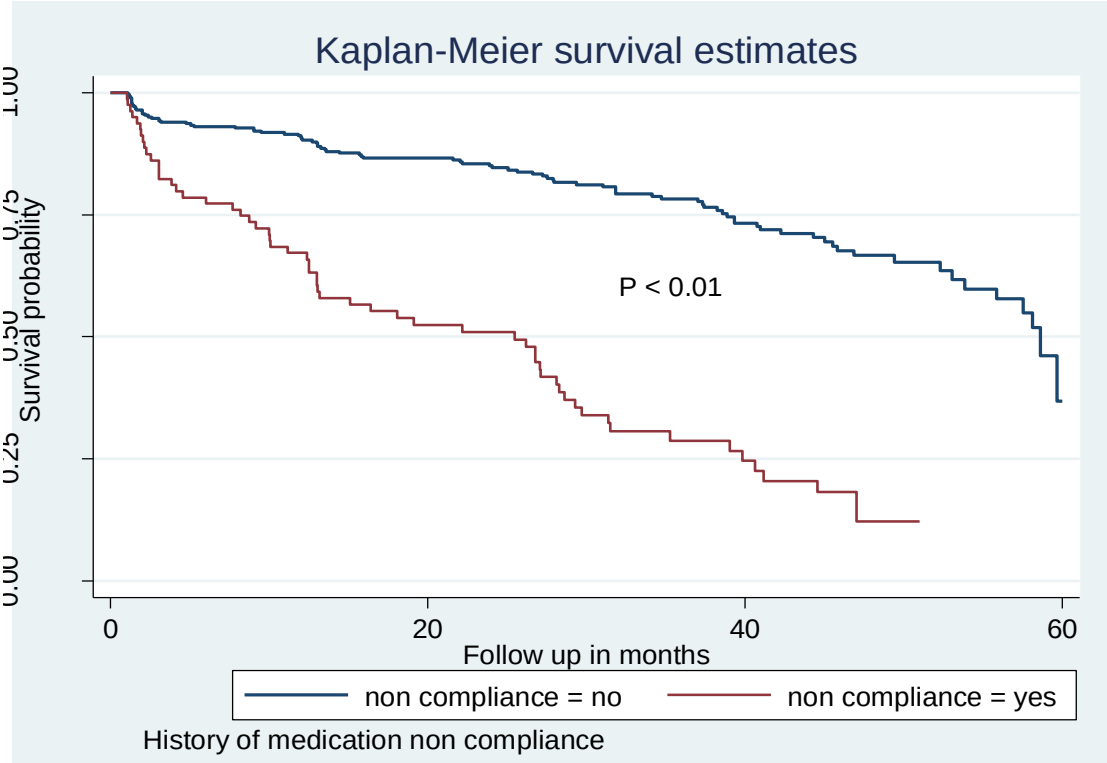
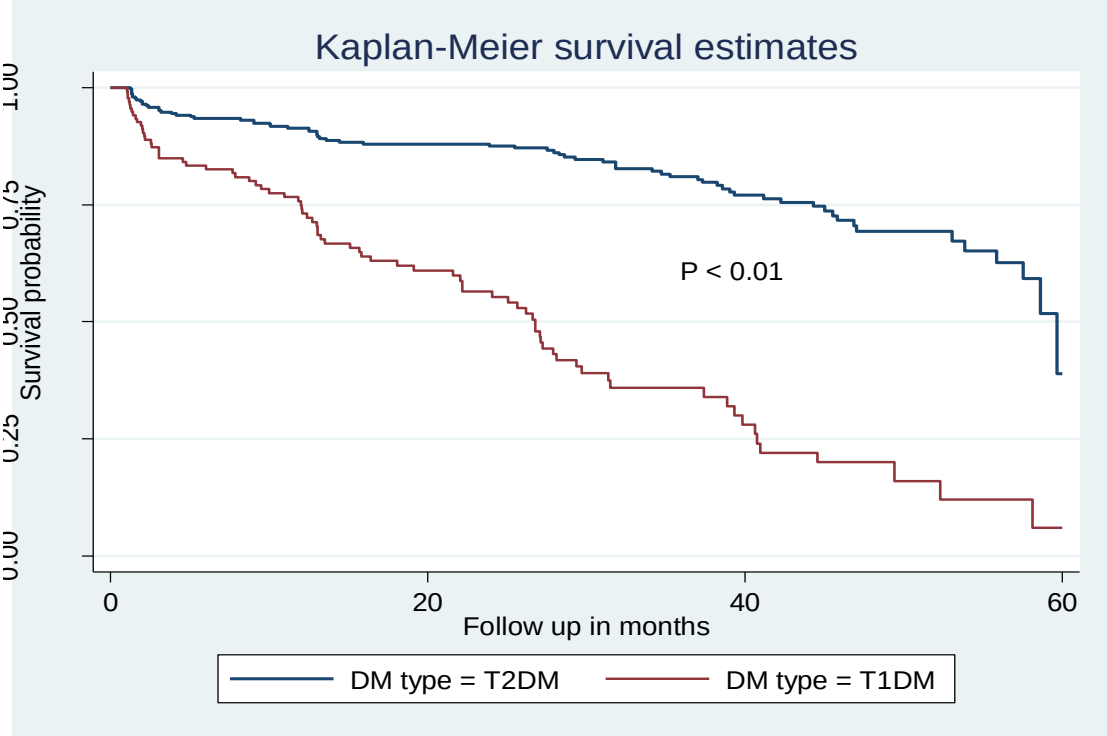


Figure 5: The Kaplan-Meier survival curves compare survival time of adult diabetic patients based having community health insurance and history of medication non compliance in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)



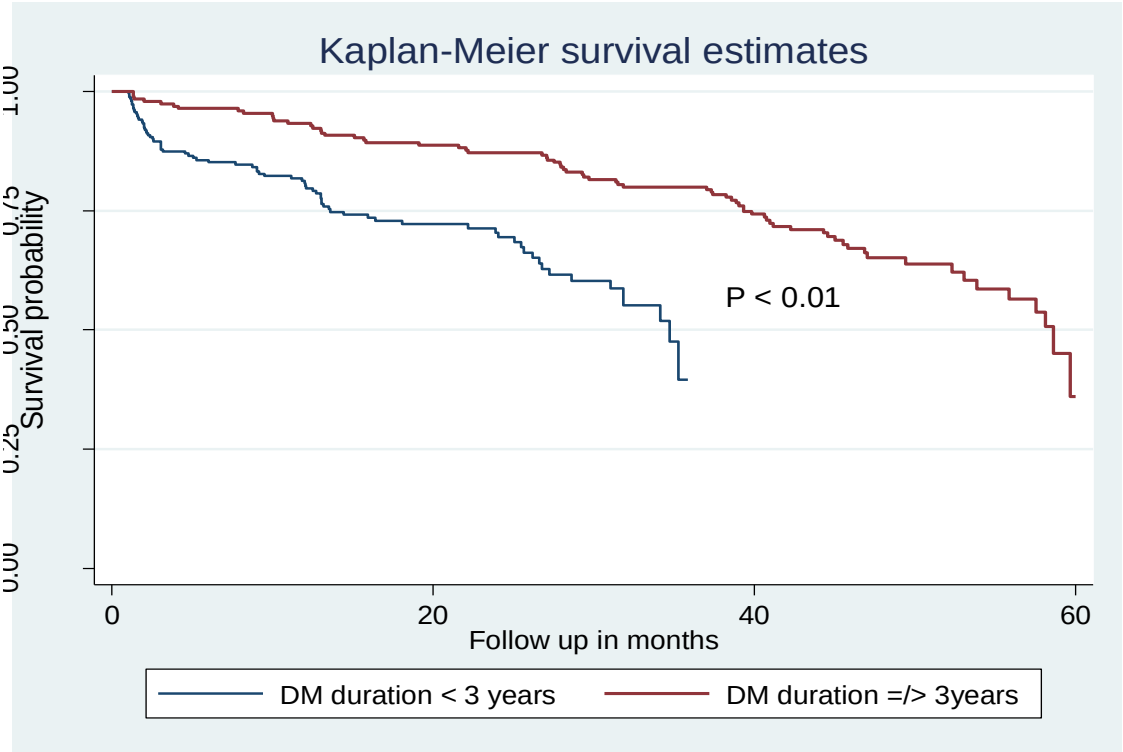
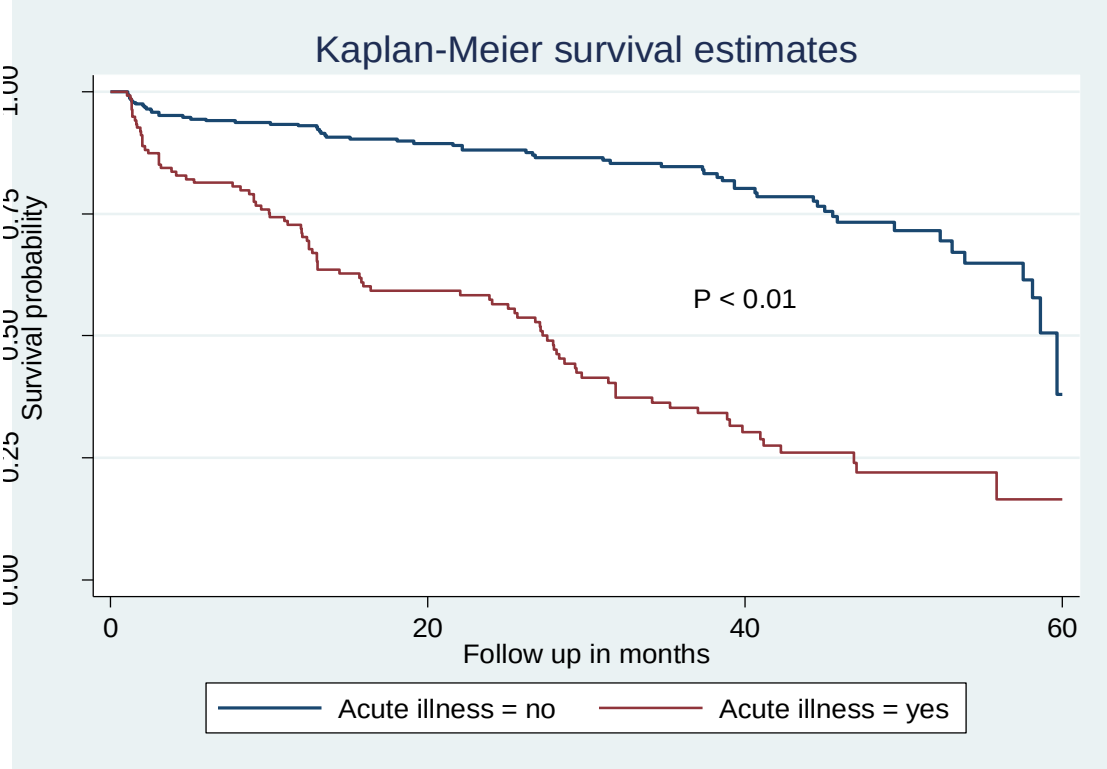


Figure 6: The Kaplan-Meier survival curves comparing survival time of adult diabetic patients based on DM type and DM duration in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)



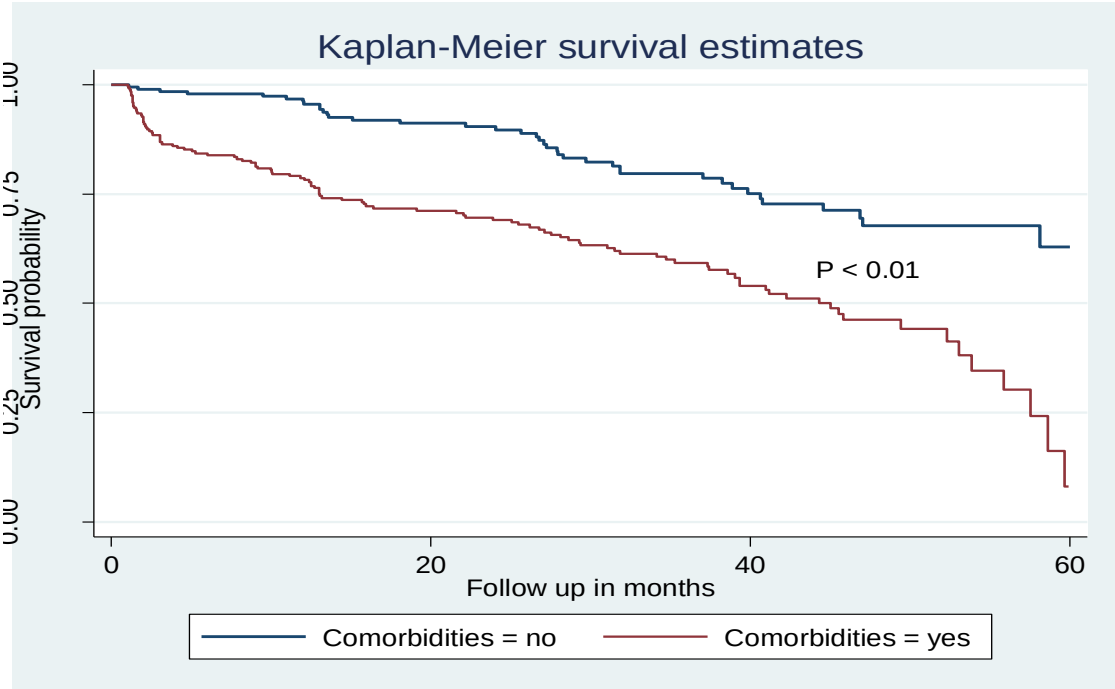


Figure 7: The Kaplan-Meier survival curves comparing survival time of adult diabetic patients based on presence of acute recent illness and comorbiditiy categories in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453).

7.5. Bivariable and multivariable Cox regression analysis

In bivariable Cox Regression model, variables (P < 0.25) were candidates for multivariable Cox Regression analysis. Fourteen variables fitted to the multivariable cox regression model and eight variables of them were significant.

In the multivariable Cox Regression model community health insurance, type of DM, DM duration, recent six-month glycemic control, history of acute recent illness, presence of comorbidities, follow up frequency of 2 to 3 months and history of medication noncompliance were significantly associated with the incidence and time to develop HGEs (P < 0.05). Baseline age, sex, treatment started duration, residence, type of drug used, chronic diabetic complications were not statistically significant predictors associated with the incidence and time to develop HGEs (see table-6)

Table 6: Bivariate and Multivariate Cox regression analysis of adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Variables	Category	Censored	Developed HGEs	CHR [95% CI]	AHR[95%CI]	P-value
Age	Young age	105(53.5)	90(46.15)	1		
	Middle age	165(82.9)	36(17.91)	0.33(0.22,0.48)	0.70(0.44, 1.13)	0.145
	Older age	36(63.16)	21(36.84)	0.65(0.41,1.05)	1.04(0.58,1.86)	0.895
Sex	Male	141(60.2)	92(39.48)	1.		
	Female	165(75.0)	55(25.00)	.52(.37,.73)	0.74(0.51,1.06)	0.101
residence	Urban	253(77.7)	74(22.63)	1.		
	Rural	53(42.06)	73(57.94)	4.39(3.14,6.1)	0.94(0.61,1.46)	0.784
community health insurance	Yes	158(75.0)	51(24.40)	1		
	No	148(60.6)	96(39.34)	1.69(1.20,2.37)	1.63(1.14,2.35)	0.008
DM type	T2DM	248(78.3)	69(21.77)	1.		
	T1DM	58(42.65)	78(57.35)	4.52(3.24,6.3)	2.75(1.68,4.51)	< 0.001
type of drug used	OHGA	228(81.2)	51(18.28)	1		
	Insulin	65(43.05)	86(56.95)	4.56(3.22,6.48)	1.44(0.89,2.33)	0.136
	Insulin + OHGA	13(56.52)	10(43.48)	2.83(1.44,5.58)	1.54(0.75,3.19)	0.243

Variables	Category	Censored	Developed HGEs	CHR [95% CI]	AHR[95%CI]	P-value
Treatment started duration	Immediate	297(68.5)	136(31.4)	1		
	Not immediate	9(45.00)	11(55.00)	1.98(1.07,3.67)	0.93(0.44,1.97)	0.858
Follow up frequency	Monthly	163(84.9)	29(15.10)	1		
	Weekly	19(67.86)	9(32.14)	1.92(.89,4.14)	1.71(0.72, 4.05)	0.221
	2 to 3 months	73(48.03)	79(51.97)	4.42(2.89,6.78)	1.79(1.06,3.01)	0.029
	>/=4mons	3(15.00)	17(85.00)	10.23(5.58,18.1)	2.02(0.99,4.12)	0.053
	Irregular	48(78.69)	13(21.31)	1.19(.62,2.30)	1.15(0.55,2.40)	0.707
History of medication noncompliance	No	284(76.1)	89(23.86)	1		
	Yes	22(27.50)	58(72.50)	4.50(3.20,6.32)	1.85(1.24,2.76)	0.003
DM duration	<3years	181(70.1)	77(29.84)	1		
	>=3 years	125(64.1)	70(35.90)	.33(.22,.49)	0.33(0.21, 0.50)	< 0.001
Recent 6-month glycemic control	Controlled	213(90.6)	22(9.36)	1		
	Uncontrolled	93(42.66)	125(57.3)	6.39(4.20,9.71)	3.47(2.17, 5.56)	< 0.001
Acute recent illness	No	255(80.9)	60(19.05)	1		
	Yes	51(36.96)	87(63.04)	4.68(3.36,6.53)	3.0(2.03,4.43)	< 0.001
Comorbidities	No	167(81.7)	39(18.93)	1		
	Yes	139(56.8)	108(43.2)	2.73(1.89,3.95)	2.36(1.53,3.63)	< 0.001
Presence of chronic diabetic complications	No	283(73.2)	103(26.8)	1		
	Yes	23(34.33	44(65.67)	3.181(2.23,4.53)	1.23(0.81,1.88)	0.329

CHR= crude hazard rate AHR= adjusted hazard rate, HR=1 is a reference category

7.6. Model checking

7.6.1. Test of the assumption of proportional hazards

The Schoenfeld residuals proportional hazard assumption test for the individual covariates and global tests was used. Finally, each covariate was (P-Value > 0.05), and the entire covariates combined or global test (P=0.89) all showed fitted cox proportional hazard model(see table 7).

Table 7: Test of proportional-hazards assumption of adult diabetic patients data in Bahir Dar Public Hospitals, North West Ethiopia, 2021(n=453)

Covariates	Rho	Chi-square	DF	P-value
Age	0.045	0.390	1	0.532
Sex	-0.092	1.270	1	0.259
Residence	-0.014	0.040	1	0.843
Community health insurance	0.013	0.020	1	0.875
DM type	0.125	2.880	1	0.090
Drug type	-0.037	0.210	1	0.646
Treatment started duration	-0.063	0.800	1	0.372
Follow up frequency	0.031	0.140	1	0.712
DM duration	-0.064	0.640	1	0.425
History of medication non compliance	0.071	0.920	1	0.336
Glycemic control	-0.028	0.140	1	0.710
Presence of acute illness	0.096	1.580	1	0.209
Presence of comorbidities	-0.038	0.220	1	0.639
Presence of chronic diabetic complication	0.052	0.490	1	0.485
Global test		10.780	14	0.703

7.6.2. Graphically test proportional hazard assumption

The covariates included in the model were assessed with a plot of log minus log and we observed that variables included in the final model yielded parallel curves which show proportional hazard across the group(see figures 8 and 9).

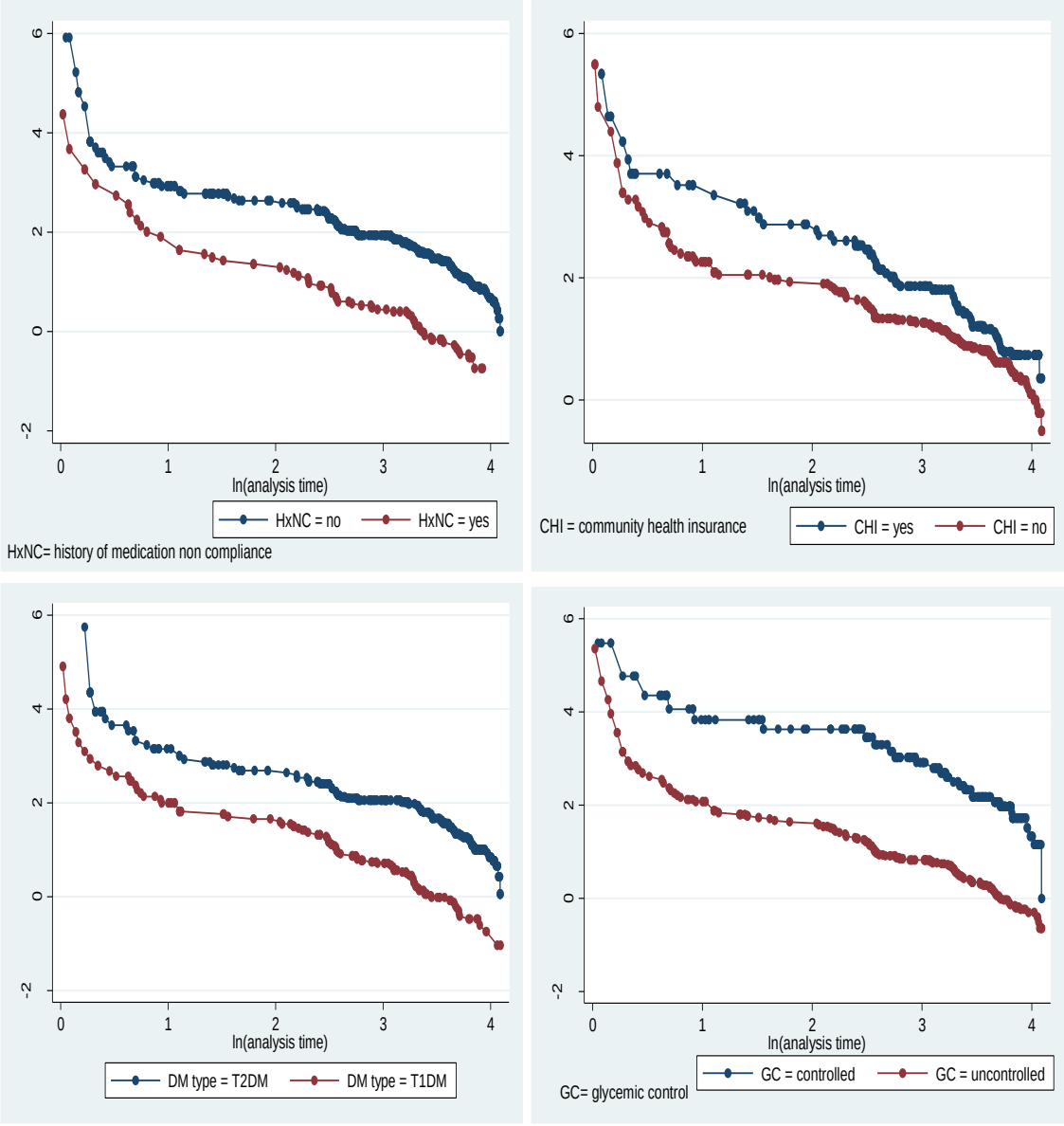


Figure 8: Long – log plot of survival curve for the covariates history of medication noncompliance , community health insurance, DM type and six month glycemic control among adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021

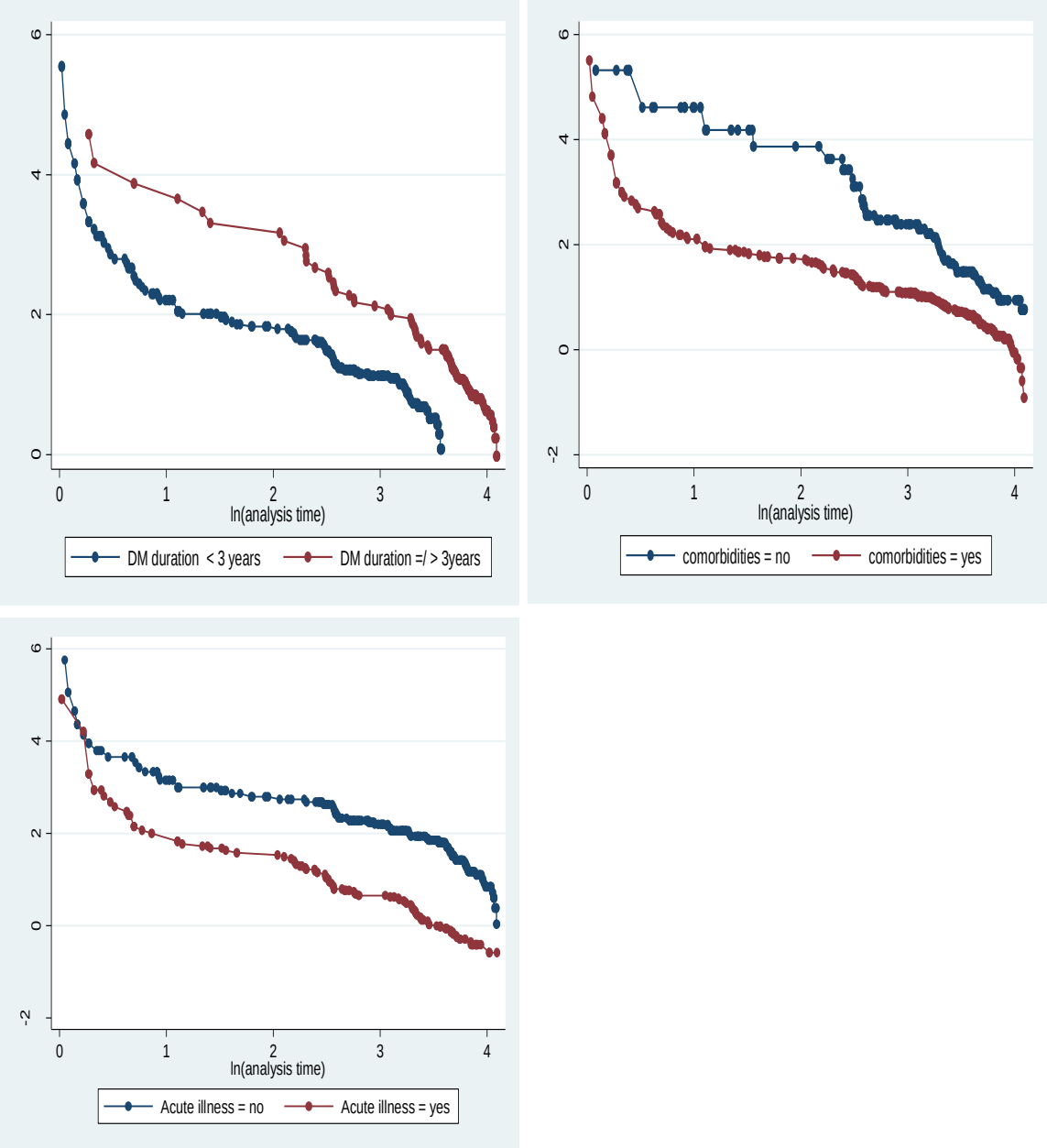


Figure 9: Long – log plot of survival curve for the covariates presence of acute illness, presence of chronic illness and diabetes duration among adult diabetic patients in Bahir-Dar Public Hospitals, North West Ethiopia, 2021

7.6.3. Diagnosis of the Model

The Cox Snell residual plots show the overall model fit. The closer the line of the Cox-Snell residual versus the 45-degree bisector of cumulative hazard line shows a better-fitted model to the data. Our Cox Snell residual test showed the model fitted to the data as observed that cox residual line close to bisector line without strike deviation (see Fig. 8)

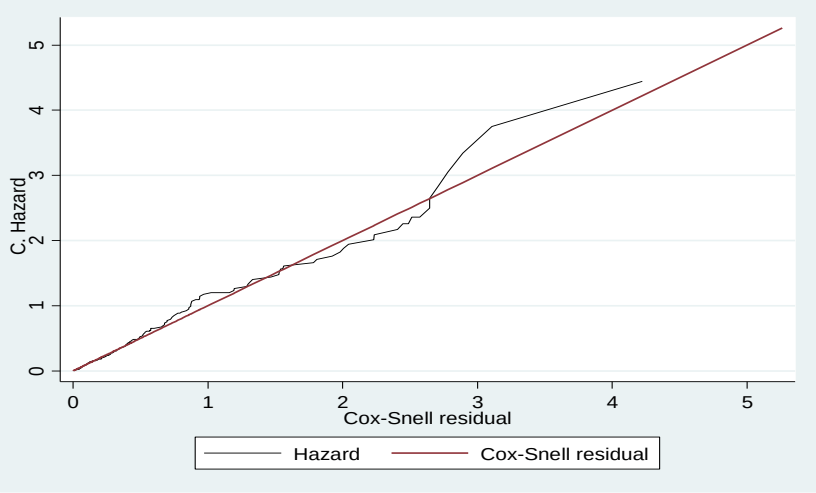


Figure 8: Cumulative hazard versus Cox Snell residual plots for Cox regression model diagnosis of adult diabetic patients data in Bahir Dar Public Hospitals, North West Ethiopia, 2021(n=453)

8. DISCUSSION

In resource-limited countries identifying the incidence and predictors of HGEs for a diabetic patient is important for the prevention and management of HGEs. This retrospective follow-up study aimed to determine the incidence and predictors of HGEs among adult diabetic patients who have a diabetic follow-up in Bahir Dar public hospitals.

Among the total 453 followed adult diabetic patients in this study, the proportion who developed HGEs during the study period was 32.45 %. This finding was lower than a study done in Hawassa, Ethiopia,44.6%[33] and greater than the study in Gurage zone hospitals, Ethiopia,12.7%[68]. This gap might be due to the previous studies were cross-sectional which includes the patients who developed HGEs at the onset of DM diagnosis but this study didn't include them to increase the precision of the survival time for the study. And other possible reason for increased HGEs could be this study was log follow up study but the counter study was crossectional. Additionally, this result was much higher than an institutional-based retrospective study done in Thailand,7.46%[40]. This difference could be explained by the difference in study population lifestyle, culture, level of education, race, environment, and diabetic care service and treatment modality which all affect glycemic control and diabetic management[69]; consequently, could affect the incidence of HGEs.

The incidence of HGEs was 1.22 per 100-person month (14.6 PY) observation this is higher than the study in Korea (2.15 per 1000 PY)[41]. The incidence of DKA was 12.5 per 100 person-year (36 per 100 (T1DM) and 6 per 100 (T2DM)). Which is higher than a systematic study conducted in developed countries (0-263 per 1000 PY of DKA incidence)[14] and in Northern Sweden(5.9 per100,00 per year)[70]. The incidence of HHS was 2.1 per 100 person-year (2.4 per 100 (T2DM) and 0.94 per 100 (T1DM)) which is higher than the national report in the US(0.9 per 1000 PY)[11]. The discrepancy in this study could be explained due to poor access to health care facilities[71], and poor diabetes care in Ethiopian health facilities[72, 73].

Lacks diabetic education for home self-monitoring and management, lifestyle modification, and medication administration[74-76], low level of knowledge, and practice[77] may have contributed to increased incidence of HGEs in Ethiopia. Thus, this increased HGEs incidence will increase diabetic-related morbidity and premature mortality and associated costs as studies [78-80] showed that HGEs are major causes of diabetic morbidity, mortality, and increased health care expenditure in Ethiopia.

In this study, patients who had no community health insurance had a 1.63 times higher hazard of developing HGEs than those who had. This agrees with other studies [13, 53, 54]. This might be due to that patient with no community health insurance were less likely to afford to perform regular self-blood monitoring and other follow up examinations expense[81, 82]

Patients with a history of acute recent illness were 2.99 times hazardous to develop HGEs as compared to those without a history of acute recent illness. This is in line with studies in Ethiopia[24, 32] and Iraq[46]. The reason might be that acute illness is associated with a hyper metabolic state due to the release of cytokines and counter-regulatory hormones[1]. This could induce insulin resistance and increases hepatic glucose production, contributing to the development of HGEs[83, 84].

According to this study, diabetic patients with the presence of comorbidities of psychiatric and chronic medical disorders were 2.36 times more hazard of developing HGEs as compared with diabetic patients without these comorbidities. This is supported by other studies in Ethiopia[24, 32, 33], multicenter analysis conducted in four countries(Germany, Australia, Switzerland, and Luxemburg)[55], and in the USA[43]. This might be because the presence of comorbidities and related treatment medications can directly or indirectly disturb the normal functions of insulin and other counter regulatory hormones. In addition, diabetic patients with chronic medical comorbidities had poor glycemic control[85] and psychiatric comorbidities can compromise adherence to treatment[86]

In terms of diabetic duration, this study showed that diabetic duration is a statistically significant predictor of HGEs among adult diabetic patients. Patients with diabetes greater and equal to 3 years duration had 67% less hazard of developing HGEs as compared to patients with diabetes of shorter durations. Another study in Iraq[46] also showed diabetic duration is statistically significant with HGE. Conversely, a study in Ethiopia[63] revealed diabetic duration was not statistically significant. This discrepancy could be due to methodology and clinical characteristics differences. For example, the counter study had patients with diabetes duration greater than five years whereas in our study the maximum diabetes duration was five years since the study is five years follow-up study. In addition, studies showed that diabetic patients during the early years of diagnosis had stress and anxiety about the disease and low knowledge and practice about the prevention of acute diabetic complications[77, 87]. The decreased hazard of developing HGEs during 3 years duration and longer could reveal that as the diabetic duration increases patients will get adequate knowledge about the disease and prevention of HGEs.

Regarding preceding six-month glycemic control, this study noted that poor glycemic control was a strong predictor of HGEs and this is comparable with studies in the USA[57], in Australia[58]. Adult diabetic patients with poor six-month glycemic control had 3.47 times more hazard of developing HGEs as compared to patients with controlled glycemic control. The reason might be that both lower and higher blood sugar level from the normal range can lead to a point spectrum of hyperglycemic emergency by increasing counter-regulatory hormones, altered glucose production, and lipolysis[1, 4]

Our study revealed that T1DM adult patients had 2.75 times more hazard to develop HGEs than T2DM adult patients. This finding is supported by other studies in Ethiopia [32, 63, 88]. And this could be theorized that DKA is the more frequent HGE and common in T1DM. This is due to that type 1 diabetic patients had a deficiency of insulin to suppress lipolysis in different conditions, resulting in ketone formation[1].

History of medication noncompliance was a significant predictor of HGEs. Other research conducted in Ethiopia showed a similar result (AOR 4.31 95%CI,1.92–9.68)[63]. The risk of developing HGEs among patients who had a history of medication noncompliance was 1.85 times more hazard relative to those who are without a history of medication noncompliance. This is because not taking or not following the prescribed course of anti-diabetic medication treatment could increase the blood glucose level which is the major cause of HGEs[1], and the lower magnitude of risk of developing HGEs in our study could be the result of under documentation as our study was secondary data.

Concerning diabetic follow up frequency, patients who had diabetic follow up of every 2 to 3 months are 1.79 times hazardous to develop HGEs than those who had diabetic follow up every month. Other study[63] also showed that diabetic patients with regular follow up visit had lower risk of developing HGEs. The reason might be due to having shorter diabetic care follow up visit will allow health care providers to ensure that patients are moving forward with the recommended self care and medication use, and also to give education about the prevention of HGEs and modifying risk factors.

Finally, different studies in the world showed that age[43, 46, 89], sex[33, 38, 46] and residence [46, 51, 52] were significantly associated with HGEs, and conversely, other studies showed that age[48], sex[43, 50, 51] and residence[32] were not significant predictors of HGEs. In the same line, our finding showed that these three variables are not statistically associated with HGEs. The variation of our result from others might be due to differences in research methodology, race, residence, Socio-cultural, lifestyle, treatment, and diagnosis modality differences. Another possible reason could be since our data was secondary data there could be under documentation.

9. STRENGTH AND LIMITATIONS OF THE STUDY

Strength

The study has the following strengths:

To the extent of our knowledge, it was the first study to establish the incidence and predictors of HGEs among adult diabetic patients in the study areas, in Ethiopia.

This study was conducted in multi-center facilities of hospitals with large catchment areas.

The study was done with a long follow-up period (around five years).

Limitations

Our study has some limitations:

Since the data were collected from secondary source; some important predictors such as nutritional history, economic factors, behavioral characteristics (use of alcohol, cigarette, and chat abuse), and demographic characteristics (educational status, religion, and marital status) were missed which may have a significant prediction with the incidence of HGEs

Also, this study did not include the recurrence of HGEs.

The finding was based on patient data documented in the medical chart of patients. Sometimes, it might have missed documentation.

10. CONCLUSION

In conclusion, the incidence of HGEs among adult diabetes patients was found to be high especially during the 1st 3 years of DM diagnosis. About fifty percent of adult diabetic patients developed HGEs within 53.85 months of follow-up. Maintaining patients glycemic control, including diabetic patients to community-based health insurance, giving attention to patients (during the early 3 years of DM diagnosis, with T1DM, have a history of medication noncompliance, acute illness, medical and psychiatric comorbidities) could decrease the incidence of HGEs and increase the HGEs-free survival time. Diabetic care follow up visit should with in a month and be focused on over controlling predictors of HGEs and preventing its public health, and economic impacts.

11. RECOMMENDATION

Based on the findings of this study, the following recommendations are forwarded to respective stakeholders:

To the diabetic patients

Diabetes mellitus patients should take extra precautions or visit health care providers during acute illness to avoid HGEs.

Patients should comply with the medication instructions and advice given by the health care team

To health professionals:

Health professionals should give greater attention to preventing HGEs among those who have (T1DM, poor glycemic control, comorbidities, and acute illness)

Careful education and instruction should be given to patients about self glucose monitoring and medication use especially during early diagnosis of DM and acute illness

For respective health facilities

Should strengthen and give especial emphasis to diabetic education about HGEs and their prevention

Should early identify patients at risk for incidence of HGEs and intervention programs targeting identified predictors should be implemented.

For Ministry of health

Shall include diabetic patients in community-based health insurance or develop policies that can make the diabetic medical services affordable to all the patients.

To researchers

Although this research is very useful in identifying the incidence, risk factors of HGEs and HGEs-free survival time; there is a need for further research.

By taking this study as input, research communities are encouraged to conduct further prospective studies to address missed variables.

Finally, we recommend that recurrence HGEs should be investigated with another study design as they were not assessed in our study.

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ANNEXES

ANNEX I: INFORMATION AND CONSENT FORM

A. Information sheet for the institution

Title of the research: Incidence and Predictors of Hyperglycemic Emergencies among Adult Diabetic Patients in Bahirdar city public Hospitals, Northwest Ethiopia, 2021: A Retrospective Follow up Study.

Name of Investigator: Melsew Dagne (BScN, MSc student)

Name of the Organization: Bahir Dar University, College of Medicine and Health Sciences, School of Health Sciences, Department of Adult Health Nursing.

Introduction: This information sheet is prepared for Felegehiwot referral, Tibebegiwon referral, and Addis Alem primary hospital administration, medical directors, and coordinators of emergency, OPD, and medical ward. This form aims to give clear information to the above-concerned bodies about the purpose of research, data collection procedures, and get permission to conduct the research.

Purpose of the Research Project: To assess the incidence and Predictors of hyperglycemic emergencies among adults with diabetes who are attending follow-up care at Bahirdar public hospitals from January 1, 2016, to December 31, 2020.

Procedure: To achieve the above objective, the information will be taken from the Emergency, OPD, and medical ward medical records and patient charts.

Risk and /or Discomfort: Since the study will be conducted by taking appropriate information from the medical chart, it will not cause any harm to the patients. The name or any other identifying information will not be recorded on the checklist and all information taken from the chart will be kept strictly confidential and in a safe place. The information retrieved will only be used for the study purpose.

Benefits: the research has no direct benefit for one whose document/ record is included in this research. But the indirect benefit of the research for the participant and other clients in the program is clear. This is because if program planners are preparing a

predicted plan there is a benefit for clients in the program of getting appropriate care and treatment services. Of all, the research work has a paramount direct benefit for diabetic patients, health care providers, health care planners, and managers.

Confidentiality: to reassure confidentiality the data on the chart will be collected by those individuals who are health care professionals and data collection experiences and information will be collected without the name of the clients. The information collected from this research project will be kept confidential and will only be used for the study purpose.

Person to contact: This research project was reviewed and approved by the institutional review board of the College of Medicine and Health Science, Bahir Dar University. If you have any questions you can contact any of the following individuals (Investigator and Advisors) and you may ask at any time you want.

1. Melsew Dagne: Bahir Dar University, College of Medicine and Health Science, School of Health Science, Department of Adult Health Nursing: principal investigator

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2. Mr. Ayele Smachew (BSc, MSc, Associate professor) Bahir Dar University, College of Medicine and Health Science, School of Health Science, Department of Adult Health Nursing: Advisor

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3. Mr. Solomon Emishaw (BSc, MSc, Assistant professor): Bahir Dar University, College of Medicine and Health Science, School of Health Science, Department of Emergency and Critical Care Nursing: Advisor

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Thank you for your cooperation

ANNEX II: DATA EXTRACTION SHEET (CHECKLIST)

This tool was prepared for the collection of socio-demographic characteristics, clinical, and treatment factors of hyperglycemic emergencies (HGEs), and other related information that is important for the assessment of Incidence and predictors of hyperglycemic emergencies among adult diabetic patients Bahiradr public hospitals from January 1, 2016, to December 31, 2020. All this information was retrieved from individual patient cards without mentioning the name of clients. This information was collected by health care providers (BSc Nurses).

Data collection date----------month----------Year----------

Name of the Hospital ----------

Name of data collector---------- signature----------

Name of supervisor----------signature----------

Code no----------

Part I: Socio-demographic characteristics

S No	Variables	Possible answers Coding Categories	Skip
1	Age	_____ years	
2	Sex	1. Male 2. Female	
3	Residence	1. Urban 2. Rural	
4	Did the patient has community health insurance	1. Yes 2. No	
Part II: Clinical and treatment-related characteristics			
5	Body mass index (baseline)	Ht_____cm, Wt _____kg _____ kg/m^2	
5	Date the patient confirmed as diabetic	--------/-------/----------DD/MM/YY	

6	Did the patient has a family history of DM	1. Yes 2. No	
7	Types of DM diagnosed for?	1. Type 1 Diabetes Mellitus 2. Type 2 Diabetes Mellitus	
8	Is the patient started treatment	1. Yes 2. .No	If no, skip to 11
9	Date the patient started treatment	--------/-------/----------DD/MM/YY	
10	What type of drug the patient used	1. Oral hypoglycemic drugs 2. Lenten insulin 3. NPH insulin 4. Regular insulin 5. Mixed insulin 6. Combination(specify_____	
11	Did the patient developed HGEs during follow up	1. Yes 2. No	If no, skip to 14
12	If yes, when she/he developed HGE?	--------/-------/----------DD/MM/YY	
13	If yes, which HGE he/she developed?	1. DKA 2. HHS	
14	Did the patient has a history of medication non-compliance?	1. Yes 2. No	
15	Did the patient has an acute recent illness proceeding to 2 weeks before HGEs developed or censored?	1. Yes 2. No	If no, skip to 17
16	If, yes what type of acute recent illness had developed? (select all the patient had)	1. Acute febrile illness 2. Respiratory infections 3. Urinary tract infection 4. Gastrointestinal infection 5. Myocardial infarction	

		6. Other Specify _____	
17	Presence of comorbidities	1. Yes 2. No	If no, skip to 21
17	If, yes what Co-morbidity had the patient(select all the patient had)	1. Hypertension 2. Asthma 3. COPD 4. Cardiac disease 5. HIV/AIDS 6. Renal disease 7. liver disease 8. Psychiatric disorder 9. Stroke 10. Others ----------	
18	Presence of chronic diabetic complications	3. Yes 4. No	If no, skip to 20
19	If yes, what type of chronic DM complication? (select all the patient had)	1. Retinopathy 2. Nephropathy 3. DFU 4. Neuropathy 5. Other specify_____	
20	Recent six-month glycemic control	1. Controlled 2. Uncontrolled	
21	Follow up frequency	1. Weekly 2. Monthly 3. Every 2 to 3 months 4. ≥ 4 month 5. Irregular follow-up	
22	Diabetes duration(for how long the patient live as a diabetic patient)	_____ in date/month	
23	Status of the patient at last observation	1. Censored 2. Developed HGEs	

24	The last follow up observation date	--------/-------/----------DD/MM/YY	
25	If the last observation is "censored" what is the last conclusion	1. On follow up 2. Transferred out 3. Loss to follow up 4. Died with HGEs 5. Died with other causes 6. Other(specify)_____	