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Time to First Optimal Glycemic Control and its Predictors Among Type 1 Diabetic Children<15 Years In Bahir Dar City Public Referral Hospitals, North West, Ethiopia, 2021

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DECLARATION

This is to certify that the thesis entitled “Time to first optimal glycemic control among type one diabetic children in Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021”, submitted in partial fulfillment of the requirements for master of degree in pediatrics and child health nursing,in Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation have been duly acknowledged.

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Approval of thesis for defense

I hereby certify that I have supervised, read, and evaluated this thesis entitled with "Time to first optimal glycemic control among type one diabetic children in Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021" by Fentahun Meseret prepared under my guidance. I recommend the thesis/dissertation be submitted for defense.

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ABSTRACT

Background: Recognizing the level of glycemic control of a client is an important predictor of the development of complication and risk of death from diabetes. However, the other most important predictor which is the time that the patient stayed in that poor glycemic level before reaching optimal glycemic control has not been studied so far.

Objective: The aim of this study was to estimate time to first optimal glycemic control and identify predictors among type 1 diabetic children<15 years in Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021

Methods: Retrospective cohort study was conducted at Bahir Dar city public referral hospitals among randomly selected sample of 385 patients with type 1 diabetes who were on follow up from January1, 2016 to February30, 2021.Data were collected by using data abstraction tool and then entered into Epi-data version 3.1 and exported into STATA 14.2 statistical software. Descriptive statistics, Kaplan Meier plots and median survival times, Log-rank test and Cox-proportional hazard regression were used for analysis. After performing Cox-proportional hazard regression, model goodness-of-fit and assumptions were checked. Finally, association between independent variables and time to first optimal glycemic control in months were assessed using multivariable Cox Proportional Hazard model and Variables with p-value < 0.05 were considered as statistically significant.

Result: Median survival time to first optimal glycemic control among type 1 diabetic client was 8 months (95%CI: 6.9-8.9).First optimal glycemic achievement rate was 8.2(95%CI: 7.2-9.2) per 100 person/month observation. Factors that affect time to first optimal glycemic control were age (AHR=0.32;95%CI=0.19-0.55),weight(AHR=0.96;95%CI=0.94-0.99),primary care giver(AHR=2.09;95%CI=1.39-3.13), insulin dose (AHR=1.05;95%CI=1.03-1.08),duration of diabetes (AHR=0.64;95%CI=0.44-0.94), adherence (AHR=9.72;95%CI=6.09-15.51),carbohydrate counting(AHR=2.43;95%CI=1.12-5.26),and comorbidity (AHR=0.72;95%CI=0.53-0.98).

Conclusion and Recommendation: Median survival time to first optimal glycemic control among type 1 diabetic clients were too long.which, indicates that clients are being unprotected for complication. Hence, diabetic care should be strengthen to shorten time to first optimal glycemic control.

Key words: type 1 diabetes mellitus, First optimal glycemic control, Time, children, Ethiopia

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LIST OF ACRONYMS AND ABBREVIATIONS

ADA	American Diabetic Association
BGM	Blood Glucose Monitoring
CGM	Continuous Glucose Monitoring
DCCT	Diabetes Control and Complication Trial
DCT	Diabetic Care Team
DM	Diabetes Mellitus
EDIC	Epidemiology of Diabetes Interventions and Complications
FBS	Fasting Blood Glucose
HbA1c	Glycated Hemoglobin A1 C
IDF	International Diabetic Federation
ISPAD	International Society of Pediatrics and Adolescent Diabetes
NCDs	Non Communicable Diseases
SMBG	Self-Monitoring of Blood Glucose
SSA	Sub Saharan Africa
T1DM	Type 1 Diabetes Mellitus
URTI	Upper Respiratory Tract Infection
WHO	World Health Organization
EMoH	Ethiopian Ministry Of Health

1. INTRODUCTION

1.1. Background

Glycemic control is a level of glucose in diabetic clients and it is a cornerstone of diabetes mellitus(DM) management, in which, it requires extensive attention to balance insulin with diet and exercise to reduce the risk of diabetic complication(1).DM is a serious, chronic and progressive disease that occurs either when the pancreas does not produce enough insulin or the body can not properly use the insulin it produces(1).There are three classification of diabetes mellitus commonly accepted by different scholars(1,2).These are: type one diabetes mellitus(T1DM) ,type two diabetes mellitus(T2DM) and gestational diabetes(3).According to American diabetic association(ADA) type one is the commonest type in pediatrics age categories(2).

Type 1 diabetes also known as insulin dependent, juvenile or child hood onset DM which is characterized by deficient insulin production in the body(1). It encompasses a group of metabolic disease causing in hyperglycemia(2). Juvenile diabetes is currently not preventable but we can control and prevent its complication. Otherwise, uncontrolled diabetes over time may lead to a serious damage to the heart, blood vessels, eyes, kidneys and nerves(1-5) .

A patient indicating any of the following can diagnosed as having diabetes based on ADA and international society of pediatrics and adolescent diabetes(ISPAD) recommendation: fasting blood glucose(FBG) ≥126 mg/dL (11.1mmol/L), poly symptoms of diabetes plus random blood sugar ≥200 mg/ (7 mmol/L) or 2 hour plasma glucose during glucose tolerance test. ≥200 mg/ (7 mmol/L) and glycosylated/glycated (Hb A1) ≥6.5 %.(2,6).

Gglycemic control followed by the diagnosis was reflected by optimal and poor metabolic control as mean HbA1c <7.5% and >7.5% respectively and /or average FBG level between 80-150mg/dl and either < 80 or >150 mg/dl respectively(6- 8,80) and HbA1c can be calculated from the following formula, if HBA1c is not consistently available for some of the clients; estimated average glucose level in (mg/dl)=28.7*HbA1c-46.7(8).

In general, there have been significantly numerous advances in the quality of T1DM care including more physiologic insulin, continuous subcutaneous insulin pump therapy, and sophisticated blood

glucose monitoring and newer educational strategy[7].But, glycemic control leftovers poor and suboptimal for many of the patients with T1DM (7,8).

Clients with equivalent level of poor glycemic control can have different prognosis because of the difference in the time the patient retain on that poor glycemic level. Meaning the hazard of complication and death occurrence rises as the client remain longer in that poor glycemic state(3).

Therefore, if efforts are not made to recognize the contributing factors for optimal glycemic control with possible time frame, the number of children affected will preserve growing and this in turn lead to an emotional and economical burden on both the clients and the families at large(6).And it will also disturb the sustainability of our health care system which is still over burdened with communicable diseases.

1.2. Statement of the problem

Diabetes mellitus pandemic have become one of the largest global health emergencies among non-communicable disease in this century(3). In many countries, over 500 000 children < 15 years old are diagnosed with T1DM(4,6-8)with an average incidence of around 3% to 4% per year worldwide(6,7).This increment is also noted more alarmingly in other developing countries(9,10-14).

Although there are a lots of advanced management of T1DM,more than 70% of them were unable to maintain their glycaemia(10,11). More over noncompliance rate escalating 50% that highlights the need for focusing on timely optimal glycemic control during management(10). Many children had also suffered from T1DM which is associated with high morbidity, mortality rate and most of the time the poor has been highly affecting by this disease (9,15,16). Both In developed and developing nations the prognosis of children with T1DM is poor (14). As a result, optimal glycemic control were oscillating from 2.6% to 39.1%(11,15,17). Many are not detected and those diagnosed have dramatically reduced their life expectancy by one year,(17-19)and poor glycemic control was much higher among type one patients(82.9%) as compared with type two diabetics(57.7%)(14, 20, 21).

A varieties of factors that predict glucose control in children with T1DM have documented (7,18-22).High proportion of patients with uncontrolled glycemic level were due to sociodemographic factors, concomitant disease, personal and other clinical factors (16,17,23); health care system with limited resources, lack of trained health personnel and in ability of the patient or family to use and afford treatment expenditures (10,24).

Uncontrolled glycemic situation results complication which can hurt many parts of the body including growth failure later in time(3,22–24). As a result, both acute and chronic complications were reported in different studies(24).Adverse effects like lipodystrophy is one of the clinical complication which may occur related to insulin injection and leads to insulin absorption problems, which ultimately can hinder first optimal glycemic control achievement in short period of time(25,26).The most common complication prior in three months were hypoglycemia which accounts 21-42% followed by 31.5%-39% diabetic keto acidosis(DKA),10.5%-32.9% nephropathy,13.6% neuropathy,10.5% convulsion,10.3% retinopathy and 5.2% includes the

cumulative of hypokalemia, cerebral edema and coma (27–29). Majority of diabetes morbidity and mortality rate were related to this complication(30-32).Sustained abnormal blood sugar fluctuation for periods of greater than two months can also contribute to high burden of the disease, hospitalization and negative consequences of disease out comes(30,32).

Similarly, study in Ethiopia highlights the difficulty of achieving glycemic control early in time. As a result, early occurrence of both retinopathy and maculopathy among diabetic children were reported(13). Another study In Ethiopia specifically in Gojjam, also indicates 58.5% DKA among 354 T1DM children with the incidence rate of 2.27/100 children/month of observation.(31).

However, strict glycemic control minimizes the incidence and progression of such possible complication(14–17).The Diabetes Control and Complication Trial (DCCT) and the follow-up study Epidemiology of Diabetes Interventions and Complications (EDIC) shows that, good glycemic control with in short duration after onset the disease delays the development of both acute and chronic complication in T1DM patients by 35-76% (9).Novel treatment are emerging to manage T1DM with the ultimate goal being to achieve glycemic control, limit weight gain, reduce comorbidities and improve quality of life(7).T1DM treatment is based on frequent monitoring of blood glucose and administration of insulin, in line with their meal and exercise(33-35).It was recommended that T1DM children should check their blood glucose at least four times a day(6).And which expected to bring 26.2% satisfactory glycemic control level (7,35).People with diabetes can live longer and have a healthy life if their diabetes is become aware of early and well-managed by multidisciplinary approach by highly specialized team members with the allocation of accessible resources(10,36,37).Being updated about the recent diabetes care can also help in improving first glycemic control (15,38).

In Ethiopia a little studies were conducted to recognize level of glycemic control among type one diabetic children(16).Though recognizing the level of glycemic control is an important predictor of the development of complication and risk of death from diabetes, the other most important predictor which is the time, in which, the patient stayed on that poor glycemic level before reaching optimal glycemic control has not studied so far.

Therefore, this study was aimed to estimate time to first optimal glycemic control among type 1 diabetic children in Bahir Dar city public referral hospitals, Northwest, Ethiopia.

1.3. Significance of the study

This study can bring out positive implications for clinical care, health service management and researches with in an area of diabetic specialization.

Clinically the health care worker can identify predictors associated with time to first optimal glycemic control among type one diabetic children at clinical setup.

The findings from this study could create valuable data for the healthcare system potentially by helping policy makers, health care managers and other responsible persons such as families and other stockholders of the registry to adjust their approaches

Researcher can also motivated to conduct further researches in this area by taking this study as preliminary findings.

1.4. Objective

1.4.1. General objective

To assess time to first optimal glycemic control and identify predictors among type 1 diabetic children<15 years in Bahir Dar city public referral hospitals, Northwest Ethiopia, 2021

1.4.2. Specific objectives

1. To estimate time to first optimal glycemic control among type 1 diabetic children<15 years
2. To identify predicting factors among type 1 diabetic children<15 years
3. To determine level of glycemic control

2. LITERATURE REVIEW

2.1. Incidence of first glycemic control among type 1 diabetic children

Incidence and prevalence of optimal glycemic control among T1DM children were varied by age, gender, geographic location and other clinical condition(28).A prospective study followed for 18-24 months among 150 children in 2015 in California revealed that, only one third of them were meet treatment targets(39) and 20.9%-39.1% of optimal glycemic control were reported in recent study(2019) among Asian diabetic children(36).

A study conducted for six month in Kenya indicated that, the overall optimal glycemic control was 28% (40)which is reasonably low than expected. A 31 year trend retrospective analysis of data on diabetes admission ,morbidity and mortality rates at tertiary referral hospitals in Ghana recognized that, females were predominantly admitted with T1DM in the ratio of 1.3:1.0 (41)and inpatient diabetes admission rate increased from 2.36 to 14.94 per 1000 with the average mortality rate of 18.5%(41).A study in Tanzania in 2016 with seventy five participants also discovered that, children less than 10 years(9.8%) were found to have better glycemic control compared to 10-14 and >14 years old(11.4-11.5%)(32).Another recent study(2019) in Tanzania among 150 participants revealed that, only four(2.6%) of them had optimal glycemic control (HbA1c<7.5%) (26).A study from 300 children in Nigeria also reported that, both hypoglycemia and hyperglycemia (20.7% and 39%)respectively covers the highest incidence of emergency admitted cases related to poor glycemic control; which significantly associated with mortality(42).Other analogous study in Tanzania published in 2020 also showed that, 32.9% nephropathy, 10.3% retinopathy and 13.6% neuropathy were documented(27).Almost similar finding was reported in in Malawi with high incidence of poor glycemic control among the study population(43).

A systematic review which was published on august 27/2019 indicated that, poor glycemic control among all age categories of diabetic patients in Ethiopia is 64.72%-66.2% based on HbA1c and FBG measurements respectively(17). Another study conducted in 2016 at Addis Ababa among diabetic children also showed that, 52.3% of them had poor glycemic control from a total of 86 clients with 4.7% retinopathy(13).

A retrospective cohort study in Gojjam Ethiopia also indicates 58.5% of DKA among 354 T1DM children with the incidence rate of 2.27/100 children/month of observation.(31).

2.2. Predictors associated with glycemic control among type 1 diabetic children

2.2.1. Socio demographic predictors of glycemic control

Studies indicated that, discrepancies of glycemic control among diabetic children by their age, gender and geographic location were still not as such certain (28).A prospective study in California University and Thailand have proved that, demographic factors may call for proactive efforts to prevent deterioration, while family engagement could be used as an opportunities for clinical intervention to promote better diabetes management and control in older children(44,45).Glycemic control level with in the age pattern among Bulgarian children in 2017 showed that, teenagers had higher HbA1c levels as compared from the other age groups.8.8%±1.87%(46).

A recent study (2019) in Iraq indicated that, glycemic control was significantly affected by the children's age, while it had no significant association with other demographic factors including sex, parent education level and family economic status(47).whereas a study conducted in Iran recognized that, being female sex is a risk factor on glycemic control and type one diabetes associated complication.(48).A retrospective study in Taiwan similarly reported that, glycemic control among type 1 diabetes had an association with in both sex, age groups and in residents particularly more in urban area (49).A recent retrospective cohort study in middle east Jordan published on July 2019 also revealed that, poor metabolic control was associated with age and absence of direct mother care(50).Another study in Saudi Arabia also recognized that, fathers educational level and employment status had a positive relation with glycemic control among type 1 diabetic children than mothers education and employment status(51).

As a child with diabetes develops, he/she under goes a varieties of physical, psychological, and life style changes(24).This Changes together with his /her interaction to the environment, tends to influence the glycemic control with long or short period of time in these children(12,24).Multi-disciplinary health care team(DCT) with expertise in supporting, handling and treating a child and family is required when they face with varies challenges(10,19, 40,52).Two contemporary longitudinal population based pediatrics cohort study of T1DM in boys and girls among injection therapy/pump regimen groups revealed, as there was concurrent improvements in HbA1c and /or average FBG level and decreasing sever hypoglycemia rates (53).

A study in Tanzania reported that, younger age, having the mother as the primary care giver, better care giver knowledge of diabetes and better adherence to blood glucose monitoring regimen were associated with better glycemic control(32). In other ways, Retrospective cohort study conducted among 188 participants in Tunisia shown that, mean HbA1c was higher in T1DM patients with negative correlation among age at onset of diabetes(15).Study in Uganda also reported that, poor nutrition knowledge among care givers especially on carbohydrate counting was associated with poor glycemic control among type 1 diabetic children(54).

Whereas, in Ethiopia specifically in Gojjam, Age <5 years among T1DM children were significantly associated with the occurrence of acute complication(31).

2.2.2. Comorbidity associated predictors of glycemic control

A study indicates that, T1DM had an association with another non communicable diseases in both sex, age groups(49).A population study in Denmark in 2018 indicated that, psychiatric comorbidity in children with T1DM increases the risk of poor metabolic level during the first 24 months after onset of the diabetes and it was found to be a risk factor for hospitalization with diabetic keto acidosis(55,56).

A clinical based prospective cohort study in T1DM patient recognized that, impairment of glucose metabolism and deteriorating diabetes control can be related to anemia, renal insufficiency, vitamin D deficiency, different type of infection and other autoimmune diseases (57–60).But in Iraq celiac disease was not significantly association with glycemic control among type 1 diabetic children(47).Other synthesis of data in brazil published on October 2019 also recognized that, in addition to the usual community disease, other different type of infections have been occurred predominately in diabetic patients particularly when there is in adequate glycemic control and most of the infections can be sever in this patients and interferes glucose control with high possibility of leading to complication(18).Poor glycemic control is associated with a significantly increased risk of both microvascular and cardio vascular complication(61).Evidence indicated that, improved glycemic control reduces the risk of both micro and macro vascular complication(60). Despite improvements in glycemic control and reduced microvascular complications by using intensive insulin therapy, weight gain becomes frequently encountered side effect that may contribute to increased cardio metabolic risk such as increased dyslipidemia and blood

pressure(62).In line with this, another controlled study also reported that,T1DM patients with normal weight preschool children have better glycemic control with short period of time than age matched overweight children(63,64).

Retrospective cohort study conducted in Tunisia publicized that, mean HbA1c was higher in T1DM patients subjects with lipohyperthrophy and those with known celiac disease(15).

Survival study in Ethiopia made known that, clients with T1DMs had high hazard of death with the main predictive factors for survival time of diabetic patients such as hypertension, over weight, high blood cholesterol level(65).Another study in Ethiopia also shows that ,glycemic control was significantly associated with predictors like upper respiratory tract infection(URTI) and preceding gastroenteritis(31).

2.2.3. Personal and clinical predictors of glycemic control

A prospective study in developed nation verified that, clinical related factors may call for proactive efforts to prevent worsening, while family assignation and psychological symptoms could be taken as chances for clinical intervention to promote better diabetes management and control in older children(44,55).

A healthy diet in children using low gastric load and dietary instruction based on the food pyramid/carbohydrate count integrated in to insulin therapy to the usual eating and exercise pattern can significantly results better glycemic control within expected time(35,64,66).

A follow up study conducted in united states(2019)strongly suggest that, early initiation of diabetes devices could improve glycemic control in children who were newly diagnosed T1DM with in the first 12 months of diabetes(38).The progressive nature of the disease requires regular monitoring of the glycaemia(12). The results of self-monitoring aids, the diabetics in decision making on the food, exercise and use of medication including dose adjustment(6,34,35,37). Optimal glycemic control with insulin therapy for T1DM is fundamental which should be aiming to achieve good glycemic control with achievement of HbA1c <7.5%, pre meal self-monitoring blood glucose (SMBG) of 90-130mg/dl, bedtime SMBG of 100-140mg/dl, mean blood glucose level of 120-160 mg/dl(66,67).The use of Pediatrics continuous glucose monitoring(CGM) increased the chance of lowering HbA1c/average FBG level and improves time in target regardless of insulin delivery modality (68-70). However, this novel techniques like CGM including insulin

pump are not accessible for most of the clients(70).In addition to this, there is limited availability of experts to manage this complex disease(10,20,52) .As a result, the need for clients to travel long distance is a must in order to get guidance. But it is usually not feasible at regular intervals (71).

Prospective Follow-up study in Germany, Austria, and Luxembourg among Patients with T1DM <15 years old confirmed that, insulin pump compared with insulin injection therapy was associated with lower risk of hypoglycemia and DKA; which ultimately brings better glycemic control in short period of time(37).In other ways, numerous daily subcutaneous insulin injections route using syringe and vial and sometimes insulin pens remains the most predictable route for insulin administration among diabetic children(72). However, this routes have been associated with compromised client compliance, fear of injection and unacceptability; which results un ability of achieving optimal glycemic control on time; again which endorse the demand for another route of insulin administration(72).

A recent retrospective cohort study in Jordan also revealed that, poor metabolic control was associated with number of clinic visit, frequency of blood glucose testing per day, absence of carbohydrate count, body mass index(BMI),dietary noncompliance, not receiving insulin at school(50).But in Iraq body mass index(BMI) was not significantly association with glycemic control among type1 diabetic children(47).

Chronic care health system in SSA have been established significantly in the last decade, but the potential for managing and approaching diabetes case remains still unsatisfactory(73).This poor glycemic control is mainly determined by diabetes duration(73)Particularly for those recently diagnosed cases as compared from diabetes diagnosed more than 2 years as it was reported by study in Cameron in the year of 2017(74,75).But, in Tanzania children with diabetes duration less than one year were associated with better glycemic control(32).Which was slightly different on the finding conducted at Cameron(75).Retrospective cohort study in Tunisia shown that, mean HbA1c was higher in T1DM patients with poor compliance to insulin therapy, in those with less than 3 clinic visit per year, but no relationship observed with number of daily insulin injection(15).A retrospective record review in Nigerian teaching hospital identified that, having more than one complication, lipid abnormality, retinopathy, ethnicity, body mass index(BMI) and self-reported physical activity in adolescents were independently associated with optimal glycemic control(11,64).Another study in Sudan revealed that, relationship was not observed between

nutritional status and glycemic control. However, there was an association between socioeconomic status and glycemic control(76).

Survival study among diabetic patients in Ethiopia reported that, clients with T1DMs had high hazard of death with the main predictive factors for survival time of diabetic patients such as hypertension, diabetic complications, overweight, high blood cholesterol level and other substance abuse related behaviors especially on adolescents; with the recommendation of regular checkup of blood glucose level and proper use of insulin to achieve optimal glycemic control in short period of time(65).Another study in Ethiopia acknowledged that, non-adherence and in appropriate insulin storage were significant predictors for the occurrence of acute complication particularly diabetic keto acidosis(DKA)(31).

Generally, the rising of T1DM and poor glycemic control in children implies that, there is a need for continuous monitoring of incidence thereby, approving prevention strategies to fight against diabetes problem in children(77).However, achieving and sustaining a good glycemic control among diabetic children in the follow up clinic is too challenging; specially in developing countries even with more intensive education on the risk factors for diabetes care, as well as launching hospital guide lines for diabetes management(78).As a result, identification of other prognostic factors that hinders time to first optimal glycemic control where indicated.

2.3. Conceptual frame work

This conceptual frame work has been adapted from previously conducted study on predictors/associated factors that affect glycemic control either negatively or positively. Demographic factors like age, institutional related variables like number of clinic visit and treatment related variables such as adherence, noncompliance and other self-monitoring practice including other concomitant disease may affect time to first optimal glycemic control as shown on the fig 1 bellow.

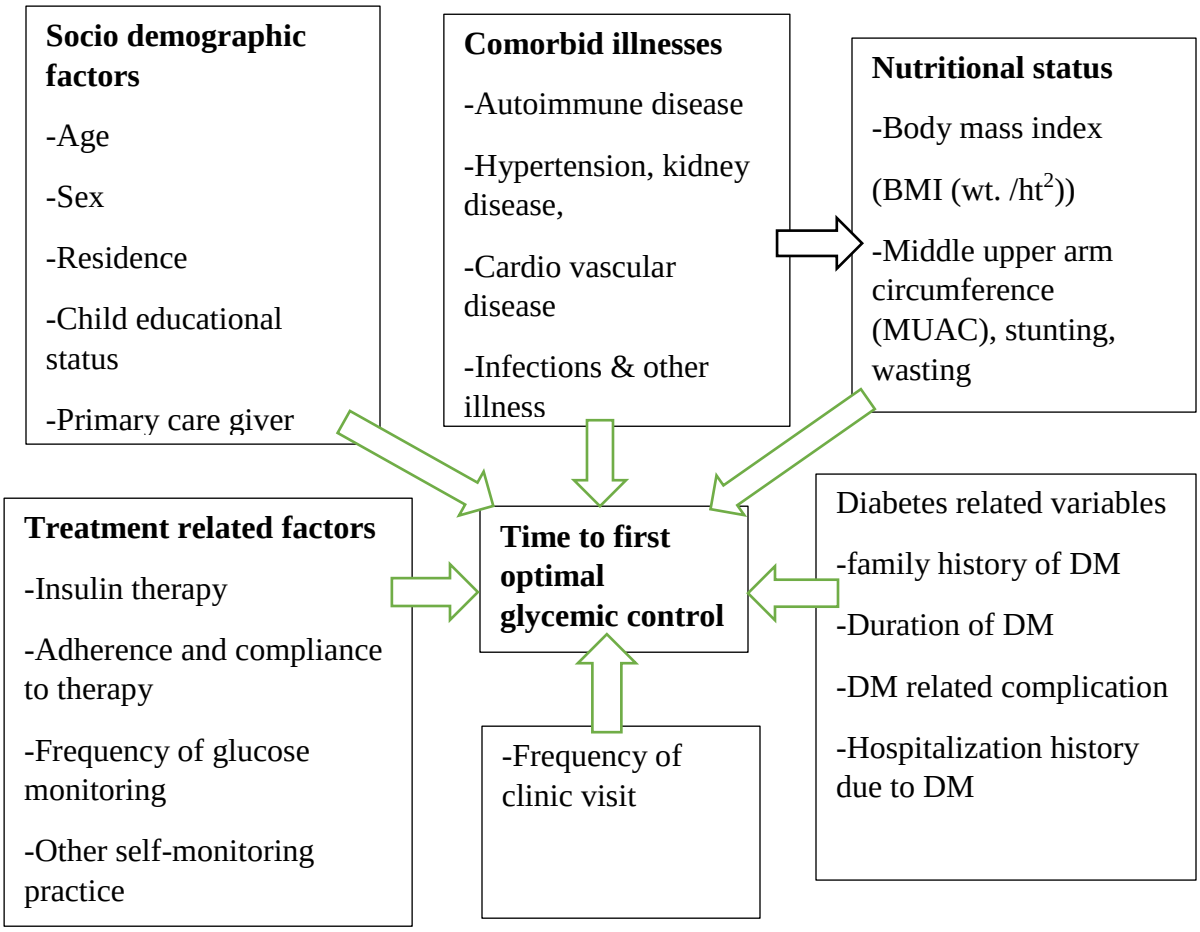

Figure 1:Time to glycemic control concept map among type 1 diabetic children in Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021; adapted from(,36,40,50,79)

3. METHODS AND MATERIALS

3.1. Study area and period

The study was conducted in Bahir Dar city; located 565Km far from Addis Ababa, the capital city of Ethiopia, at Amhara national regional state, North West Ethiopia. In Bahir Dar city there are two public referral hospitals, one primary hospitals, ten health center and four private hospitals. And this study was conducted in the two public referral hospitals, namely: Felege Hiwot comprehensive specialized referral hospital (FHCSH) and Tibebe Ghion specialized teaching hospital (TGSTH). Each of this hospital can be expected to serve for more than 10 million populations coming from Bahir Dar city, west Gojjam zone, east Gojam zone, awi zone, north and south wollo zones, south& north Gondar zones, partial part of Benshangul Gumuz and Oromia region. FHCSH has currently a total of 1431 man power in each discipline with 500 formal beds, 11 wards, 39 clinical and non-clinical departments /service unit / providing Diagnostic, curative, Rehabilitation and preventive service at outpatient &inpatient based. Similarly TGSTH is a teaching hospital under Bahir Dar University College of medicine and health sciences that has 459 bed capacity and with around 14 outpatient departments.

Apart from other services both referral hospitals provide diabetic treatment services by nurse practitioners, pediatrics residents and pediatricians.
The study period address from1stJanuary, 2016 to February 30 /2021.

3.2. Study design

An institution based retrospective follow up study was employed

3.3. Source, study population and study unit

3.3.1. Source population

The source population were all type 1 diabetes mellitus children<15 years old who had follow up at diabetes clinic of the two referral hospitals.

3.3.2. Study population

The study population were all type 1 diabetes mellitus children <15 years old who were on follow up during the study period.

3.3.3. Study unit

All type one diabetic children's chart that were selected randomly for investigation

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

Children age less than 15 years old and diagnosed with T1DM with regular follow up and had at least one HbA1c and/or a three month consecutive measurements of fasting blood sugar (FBS) with clear date of diagnosis between January 1/2016 to February 30/2021 were included.

3.4.2. Exclusion criteria

Children's medical record/chart with incomplete information (such as HbA1c/average FBG and other relevant predictors like age with date of diagnosis, sex, treatment modality, frequency of follow up visit and last visit health condition of the children), those having less than 3 month follow up during the study period and those cases transferred in with unclear date of diagnosis from other institution were excluded from the study.

3.5. Sample size determination

Sample size was determined by double proportion formula after taking of predictors associated to optimal glycemic control from previous study conducted by retrospective cohort design (50)with the help of epi info version 7 by considering the following statistical assumptions: 95% Confidence Interval (CI), power 80%,percent of outcome in unexposed group 8.93%,risk ratio 0.253, marginal error 5%(50) .The calculated total sample size is 378, then by adding 10% for data incompleteness from the client chart, the final sample size became 416.

As shown below in the table 1 from major independent predictors conducted to identify predictors associated with glycemic control among diabetic children by retrospective cohort study design carbohydrate count yields relatively adequate and feasible sample size to perform this study.

Table 1: Calculated sample size to estimate time to first optimal glycemic control among type one diabetic children in Bahir Dar city public referral hospitals, North West Ethiopia, 2021

Variable		Proportion	Total sample size
Carbohydrate count	Yes	P1 8.93%	378(50)
	No	P2 2.3%	
		RR 0.253	
Age	≤5	P1 0.1%	182(50)
	>5-10&10-15	P2 26.5%	
		RR 0.004	

Where

P_1: is percent of exposed with outcome of glycemic control

P_2: is percent of non-exposed with outcome of glycemic control.

RR: risk ratio

Finally 416 type 1 diabetic children were recruited among the study population in the study area.

3.6. Sampling technique and procedure

The study participants were selected from the registration book. The medical records of children who were on follow up with type one diabetes mellitus from January 2016 to February 2021 were selected. A total of 721 children were recorded from the registration book of the two referral hospitals (sampling frame). Of which 416 cards were sampled using a simple random sampling technique by a computer generating method. Finally, cards that fulfilled the criteria were reviewed.

3.7. Study variables

3.7.1. Dependent variables

Time to first optimal glycemic control

3.7.2. Independent variables

Socio demographic (age, gender, Residence); Institutional related variable (frequency of clinic visit); Diabetic related variables (duration of diabetes, diabetes related complication.); Comorbidities (preceding infections and other pathology) and treatment related variables (insulin therapy and adherence, noncompliance and other self-monitoring practice)

Age of the participants, frequency of glycemic control, body mass index and duration of diabetes were categorized in to groups in order to alien with the other literatures(36,40,50)

3.8. Operational definitions

Optimal glycemic control: Optimal glycemic control is defined as the three consecutive month HbA1c <7.5% and/or average FBG of 80–150 mg/dl with more or less stringent glycemic goals for individual clients based on age/life expectancy, comorbid condition, advanced complication, hypoglycemia unawareness and individual patient considerations (6- 8,80).

Event: Achieving first optimal glycemic control during the study period

Survival time: The time starting from date of diagnosis to first optimal glycemic control was determined for each participant

Censoring: Patients died, lost to follow up, transferee out, and complete the follow up period without achieving optimal glycemic control

Time to event: Time between diagnosis up to achieving first optimal glycemic control or censoring with measure of interest in month

Carbohydrate counting: Practicing healthy diet at home by non-refined carbohydrate utilization and eating consistent amount of food regularly with application of food pyramid as a meal planning tool to optimize blood sugar level (35).

3.9. Data collection procedure

The data were collected from patients chart that visit Felege Hiwot comprehensive specialized referral hospital and Tibebe Ghion specialized teaching hospital. Data that were relevant to measure the association between times to first optimal glycemic control among diabetic children were collected by two BSc nurses supervised by one senior nurse having second degree in public health.

Patient records were retrieved using their medical registration number identified in the total DM case load in the logbook of registration follow up form. Then medical registration number (MRN) of all diabetic pediatric patient were sorted. After that, the sample selection mechanism was simple random sampling technique, in which each of the patients had equal chance of being selected to be part of study.

A structured data extraction tool adapted by considering study variables such as socio demographic, personal and clinical predictors from patients' charts.

3.10. Data quality assurance

Training was given for data collectors and supervisors about the objective and process of data collection by the principal investigator. Pretest was done on 5 % of sample size. Then pretested data abstraction tool/check list that comprises of questions to measure the relevant variables were used to collect the necessary data from the patient medical chart by those trained data collectors. Data quality was also assured by designing proper data abstraction tool and through continuous supervision. All collected data were checked for completeness and clarity.

3.11. Data processing and statistical analysis

The collected data was coded, enter, cleaned and stored into Epi-data version 3.1 and exported into STATA 14.2 statistical software for analysis. Descriptive statistics were presented with frequency tables, Kaplan Meier (KM) plots and median survival times. Months are used as a time scale to calculate time to first optimal glycemic control. The outcome of each participant was dichotomized in to censured or event (first optimal glycemic control)

Kaplan-Meier technique was used to measure survival experience of diverse groups of patients by using survival curves. Log-rank test was used to assess significant difference among survival distributions of groups for equality. After performing the Cox-proportional hazard regression, model goodness-of-fit was checked by Cox Snell residuals & assumptions was checked by using Shenfield residual test and graphically by using log minus log function survival curves.

Bivariable analysis was performed to calculate crud hazard ratio (CHR) and to screen out potentially significant independent variables at p value < 0.25 level of significance.

Association between the significant independent variables and the time to first optimal glycemic control was assessed using multivariable Cox Proportional Hazard (PH) model.

Adjusted hazard ratio (AHR) and 95% CI for HR were used to test significance and interpretation of results.

Variables with p-value < 0.05 were considered as statistically associated with the time to first optimal glycemic control in months.

3.12. Ethical considerations

Ethical clearance was obtained from the institutional review board (IRB) of Bahir Dar University (IRB number 01-008).Written supportive letter was taken from pediatrics department of the hospitals on behalf of the patients. This study had no any danger or negative consequences for the study participants. Medical record numbers were used for the data collection and personal identifiers of the client were not used in this research report. Access to collected information was limited to the principal investigator and confidentiality had preserved throughout the time.

3.13. Dissemination of the result

The finding of this study is presented to Bahir Dar university department of nursing as partial fulfillment of master's degree in pediatrics and child health nursing. The finding will be also announced to Felege Hiwot comprehensive specialized referral hospital as well as Tibebe Ghion specialized teaching hospital. Hard and soft copies will be available in the library of Bahir Dar University, for graduate students and for other researchers and readers.

4. RESULT

4.1. Socio demographic characteristics

Four hundred sixteen (416) medical records were reviewed; off which, thirty one (7.5%) cases were excluded from the study due to pertinent data being missing. As a result, 385 clients were included in the study which is 92.5% in response rate.

Mean age of the study participant was 8.2±4.7 years with 2.4 years mean duration of diabetes. More than half of the patients were male (53%) and proportion of first optimal glycemic achievement among male is (72%) which is almost proximal to female (71.3%).

Majority of the patients (64.7%) were from rural area. However, the Proportion of patients who achieved first optimal glycemic control among rural is (68.7%) which is lower than clients from urban area residents (77.2%).

Those clients having >4 clinical visit for the last year of their follow up had higher proportional glycemic control (82.3%) than clients having clinical visit <=4(663%). (Table 2).

Table 2: sociodemographic and institution related variable with censuring and event status among type 1 diabetic clients, Bahir Dar, 2021(n=385)

Variables	Category	Event and censured status		Total
		No. of event	No.of censured	
Age group in years	<=5	83(68%)	39(32%)	122(31.7%)
	>5-10	79(85.9%)	13(14.1%)	92(23.9%)
	>10-14	114(66.7%)	57(33.3%)	171(44.4%)
Sex	Male	147(72%)	57(27.9%)	204(53%)
	Female	129(71.3%)	52(28.7%)	181(47%)
Resident	Urban	105((77.2%)	31(22.8%)	136(35.3%)
	Rural	171(68.7%)	78(31.3%)	249(64.7%)
Number of clinic visit during the last year of follow up	<=4	169(66.3%)	86(33.7%)	255(66.2%)
	>4	107(82.3%)	23(17.7%)	130(33.8%)

4.2. Median survival time to first optimal glycemic control

The estimated median survival time to achieve first glycemic control was 8 months with inter quartile range of (6.9-8.9).

The median survival time to first optimal glycemic control among type one diabetic children were varied by various categories of predictors. For example, the median survival time to achieve first optimal glycemic control among under 5 children was 6.8 where as in above 5-10 and >10-14 years was 8, 8.5 respectively. (Table 5).

4.3. Incidence rate of optimal glycemic achievement rate

From 385 study participants, 276(71.7%) of the clients have achieved glycemic control with mean value of FBG&HA1c (112±3mg/dl, 5.6%) respectively; whereas 109(28.3%) were censored. The lowest and the highest length of follow up were 2.9 and 36.4 months respectively, and the total person-time risk was 3373 months.

The overall first optimal glycemic control rate was 8.2(95%CI: 7.2-9.7) per 100 person/month observation. Optimal glycemic achievement rate among male and female children with type 1 diabetes was 7.9(95%CI: 6.7-9.3) per 100 person/month and 8.4(95%CI: 7.1-10.0) per 100 person/month observation respectively which is nearly comparable in both sex.

4.4. Diabetes related variables

Concerning complication,83.4% of the patients had history of one or more diabetes related complication .Majority of the clients had diabetic keto acidosis(DKA)(81%) including the episodes at the time of diagnosis followed by hypoglycemia(19.7%),other complication(4.9%) and chronic complication(0.8%).mixed insulin(lent &regular) drugs had given for the majority of the patients(62.9%)during the initiation of treatment as compared to other regimens like NPH with regular and NPH alone(20%,17.1%)respectively.

The proportion of patients who achieved optimal glycemic control is relatively higher among those with no history of diabetes related complication (76.6%) as compared to those with history of complication (70.7%).(Table 3).

Table 3: Diabetes related variable with censuring and event status among type 1 diabetic clients, Bahir Dar, 2021(n=385)

Variables	Category	Event and censured status		total
		No. of event	No.of censured	
History of diabetes related complication	NO	49(76.6%)	15(23.4%)	64(16.6%)
	Yes	227(70.7%)	94(29.3%)	321(83.4%)
DKA	NO	53(72.6%)	20(27.4%)	73(19%)
	Yes	223(71.5%)	89(28.5%)	312(81%)
Hypoglycemia	NO	211(68.3%)	98(31.7%)	309(80.3%)
	Yes	65(85.5%)	11(14.5%)	76(19.7%)
Chronic complication	NO	274(71.7%)	108(28.3%)	382(99.2%)
	Yes	2(66.7%)	1(33.3%)	3(0.8%)
Other complication*	NO	259(71.9%)	101(28%)	360(93.5%)
	Yes	12(63.2%)	7(36.8%)	19(4.9%)
More than one complication	NO	245(72%)	95(27.9%)	340(88.3%)
	Yes	31(68.9%)	14(31.1%)	45(11.7%)
Diabetes related hospitalization	NO	52(74.3%)	18(25.7%)	70(18.2%)
	Yes	224(71.1%)	91(28.9%)	315(81.8%)
Insulin Regimen	Mix(regular &lent)	154(63.6%)	88(36.4%)	242(62.9%)
	NPH &regular	70(90.9%)	7(9%)	77(20%)
	NPH only	52(78.8%)	14(21.2%)	66(17.1%)
Non Compliance (dose omission, drug skipping, inappropriate insulin storage)	NO	219(85.5%)	37(14.5%)	256(66.5%)
	Yes	56(43.8%)	72(56.3%)	128(33.2%)
Duration of diabetes	<2	75(0.5%)	75(0.5%)	150(39%)
	[2-4)	80(80.8%)	19(19.2%)	99(25.7%)
	>=4	121(89%)	15(11%)	136(35.3%)
Adherence to diabetic care	NO	91(46.7%)	104(53.3%)	195(50.6%)
	Yes	185(97.4%)	5(2.6%)	190(49.4%)
Family history of diabetes mellitus	NO	238(71.7%)	94(28.3%)	332(86.2%)
	Yes	38(71.7%)	15(28.3%)	53(13.8%)

**other complication includes insulin injection site swelling together with lipohypertrophy and dystrophy*

4.5. *Comorbidity* related variables

In regard to comorbidity, 69.6% of the patients had history of comorbid illness and only 30.4% of them didn't have recognized history of comorbid illness. Majority of the clients had malnutrition (38.7%) followed by pneumonia (16.1%), urinary tract infection (13.8%), acute gastro enteritis (10.1%), fungal infection (7%) and upper respiratory tract infection (6.5%).Nearly half (48%) of the patients had more than one comorbid illness.

The proportion of clients who achieved first optimal glycemic control is higher among those with no history of comorbid illness (74.4%) than those with one or more comorbid illness (70.5%). (Table 4).

Table 4: comorbid illness related variable with censuring and event status among type 1 diabetic clients, Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021(n=385)

Variables	Category	Event and censured status		total
		No. of event	No.of censured	
History of comorbid illness	NO	87(74.4%)	30(25.6%)	117(30.4%)
	Yes	189(70.5%)	79(29.5%)	268(69.6%)
Cardio vascular	NO	273(72%)	106(28%)	379(98.4%)
disease(CVD)	Yes	3(50%)	3(50%)	6(1.6%)
Hypertension(HTN)	NO	272(71.8%)	107(28.2%)	379(98.4%)
	Yes	4(66.7%)	2(33.3%)	6(1.6%)
Urinary tract infection(UTI)	NO	244(73.5%)	88(26.5%)	332(86.2%)
	Yes	32(60.4%)	21(39.6%)	53(13.8%)
Pneumonia(CAP)	NO	234(72.4%)	89(27.6%)	323(83.9%)
	Yes	42(67.7%)	20(32.3%)	62(16.1%)
Upper respiratory tract	NO	264(72.5%)	100(27.5%)	364(94.5%)
infection(URTI)	Yes	15(60%)	10(40%)	25(6.5%)
Acute gastro enteritis(AGE)	NO	248(71.7%)	98(28.3%)	346(89.9%)
	Yes	28(71.8%)	11(28.2%)	39(10.1%)

Table 4: comorbid illness related variable with censuring and event status among type 1 diabetic clients, Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021(n=385 cont..

Malnutrition	NO	191(71.5%)	76(28.5%)	267(69.4%)
	Yes	107(71.8%)	42(28.2%)	149(38.7%)
Autoimmune disease	NO	270(72.2%)	104(27.8%)	374(97.1%)
	Yes	6(54.5%)	5(45.5%)	11(2.9%)
Tuberculosis(TB)	NO	273(72%)	106((28%)	379(98.4%)
	Yes	3(50%)	3(50%)	6(1.6%)
Meningitis	NO	274(73%)	101(26.9%)	375(97.4%)
	Yes	2(20%)	8(80%)	10(2.6%)
Malaria	NO	268(72%)	104(28%)	372(96.6%)
	Yes	8(61.5%)	5(38.5%)	13(3.4%)
Fungal infection	NO	262(73.2%)	96(26.8%)	358(93%)
	Yes	14(51.9%)	13(48.1%)	27(7%)
More than one comorbid	NO	146(73%)	54(27%)	200(51.9%)
illness	Yes	130(70.3%)	55(29.7%)	185(48%)

4.6. Survival estimates for time to first optimal glycemic control

The survival status of children with type 1 diabetes was estimated by the Kaplan-Meier survival curve.

The curve tends to decrease rapidly with in the first one year indicating that most children achieved first optimal glycemic control within this time (Figure 2).

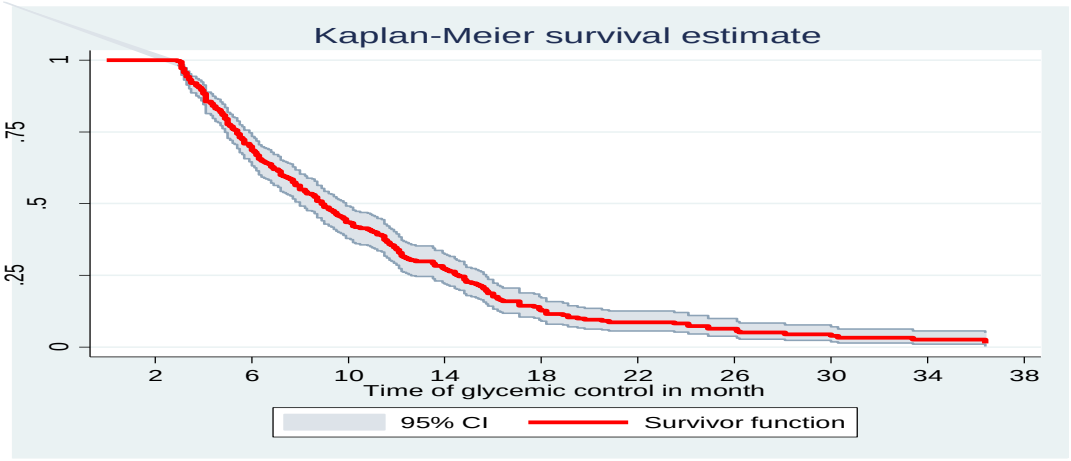

Figure 2: Kaplan-Meier survival estimate of time to first optimal glycemic control among type 1 diabetic children having follow up at Bahir Dar city public referral hospitals, 2021

The survival estimates of clients were varied in relation to different predictors. (Figure 3).

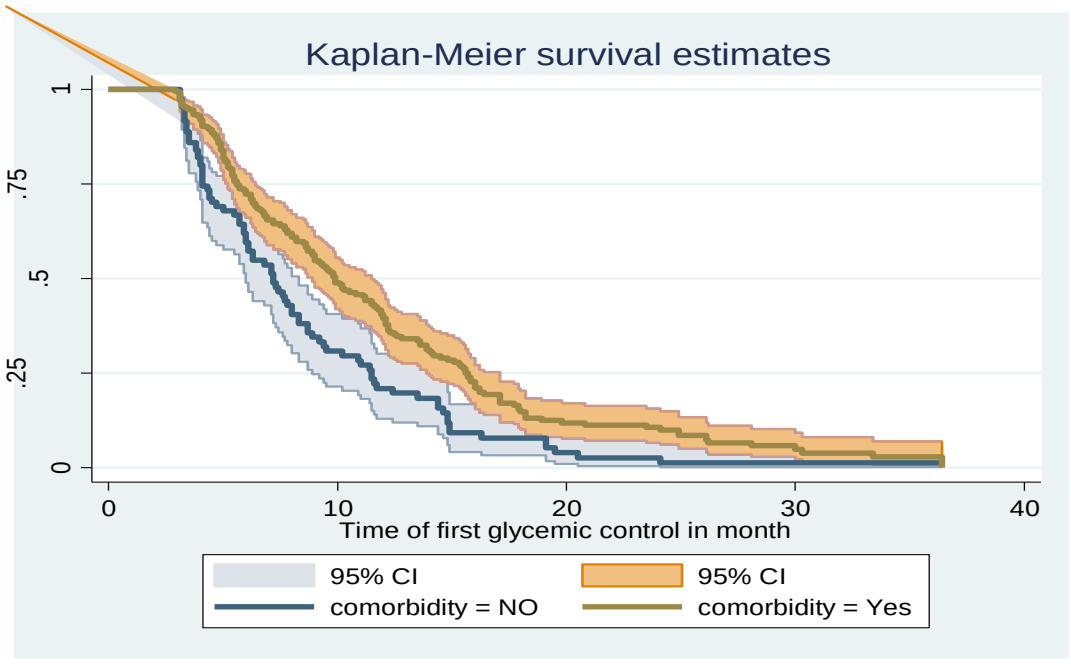

Figure 3: Kaplan Meier survival estimate for time to optimal glycemic control among type 1 diabetic children with history of comorbidity in Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021

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4.7. Comparison of survival experience

The long rank test was used to assess differences in equality of survival distribution among diverse groups. The median survival time to achieve first optimal glycemic control among clients in the age groups of <=5 years showed shorter median time to achieve first optimal glycemic control (6.8 months) as compared with patients whose age group between 6-10 years (8months) and 11-14 years (8.5 months).and the survival time was significantly different among the age groups($X^2(2)$) = 6.05, P-value = 0.0486).whereas, the median survival time to achieve first optimal glycemic control among male participant showed relatively longer time (8.5 months) than females (7.2 months).But the long rank test was not statistically significant($X^2(1)$)=0.92,p-value=0.3378). (Table 5).

Table 5: comparisons of optimal glycemic control among type 1 DM clients, Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021(n=385)

Variables	Category	Test of equality over groups				
		Median survival time(months)	Mean survival time(months)	Log rank X^2	DF	P-value
Age group in years	<=5	6.8	8.5	6.05	2	0.0486
	>5-10	8	9.8			
	>10-14	8.5	10.2			
Sex	Male	8.5	9.9	0.92	1	0.3378
	Female	7.2	9.2			
Resident	Urban	7.6	9.6	0.02	1	0.8911
	Rural	8	9.6			
Education status of children	KG/not started	7.1	8.9	11.23	2	0.0036
	Primary school	9	10.6			
	High school	14.8	13			
Family history of diabetes	NO	7.8	8.7	0.28	1	0.5987
	Yes	8	9.4			
Number of clinic visit	<=4	7.7	8.5	1.31	1	0.2521
	>4	8	9.4			
Adherence to diabetic care	NO	14.9	10.9	131.75	1	<0.0001
	Yes	5.7	6.7			
Insulin regimen	Mixed(lent &Regular)	7.1	8.4	15.87	2	0.0004
	NPH& Regular	9.2	10.1			
	NPH only	9.8	12.3			

Table 5: comparisons of optimal glycemic control among type 1 DM clients, Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021(n=385) cont...

Duration of Diabetes in year	< 2	5.5	6.2	54.93	2	<0.0001
	[2-4)	8.6	10			
	>=4	11.1	11.4			
Carbohydrate count	NO	10.2	11.1	40.26	1	<0.0001
	Yes	5.5	6.9			
Noncompliance	NO	6.4	8.2	42.30	1	<0.0001
	Yes	14.8	14.9			
Diabetes related acute complication	NO	7.7	9.5	2.94	1	0.0862
	Yes	8	9.6			
Diabetic ketoacidosis	NO	6.2	9.5	0.12	1	0.7289
	Yes	8	9.6			
Chronic complication	NO	7.8	8.7	0.59	1	0.4434
	Yes	12.1	18.5			
Other complication	NO	7.8	9.5	1.02	1	0.3131
	Yes	10.2	11.3			
More than one complication	NO	7.8	9.3	0.21	1	0.6448
	Yes	8.9	10			
History of comorbidity	NO	6.3	8.3	10.85	1	0.0010
	Yes	8.9	10.1			
Wasting	NO	8.2	8.9	1.07	1	0.3003
	Yes	6.8	8.6			
Stunting	NO	7.8	8.8	0.15	1	0.7019
	Yes	9.8	8.4			
Cardio vascular disease	NO	7.8	8.8	0.01	1	0.9229
	Yes	12.1	10.2			
Pneumonia	NO	7.7	8.9	0.89		0.3460
	Yes	9	8.1			
Acute gastro enteritis	NO	7.7	9.4	2.05	1	0.1524
	Yes	10.2	11.5			
More than one comorbid illness	NO	7.7	9.5	0.21	1	0.6448
	Yes	8.7	9.7			

X^2:chi-square, DF: Degree of freedom, KG: kindergarten

Regarding adherence, those clients who adhere to the management had shorter duration of time (5.7 months) to achieve first optimal glycemic control than those who didn't adhere towards the

management of the disease(14.9 months).The long rank test was statistically significant($X^2(1)$) = 131.75, P-value <0.0001).As shown in the figure.5, the Kaplan Meier survival function also showed that those clients with adherence have satisfactory survival experience by achieving their glycemic targets early in time. The figure also showed that, clients direct chance of achieving first optimal glycemic control increases for both group as the duration of treatment increases.

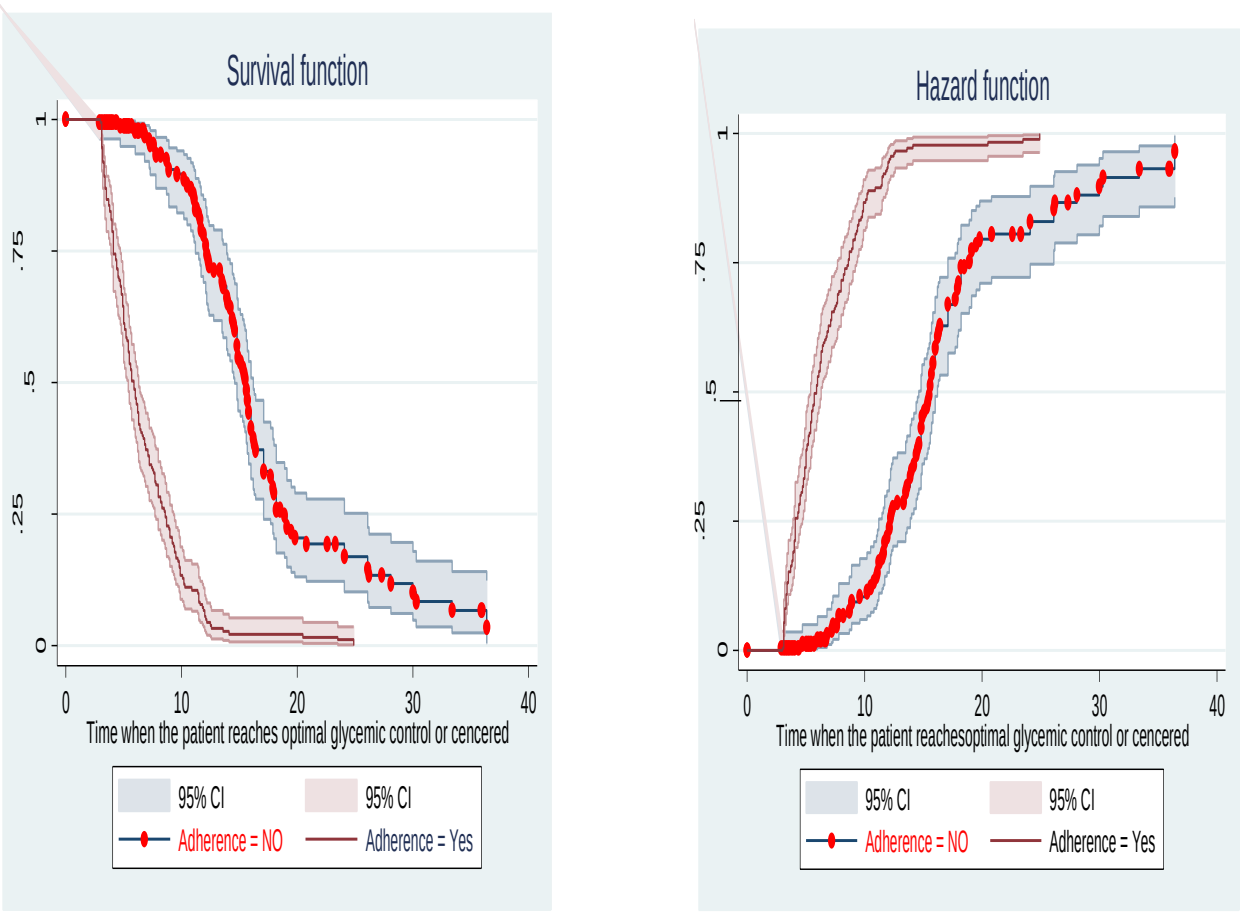

Figure.4: survival and hazard function of adherence by time (in month), Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021

Those patients having comorbid illness appears to extend time to first optimal glycemic control. The median survival time to achieve optimal glycemic control was shorter among patients with no history comorbid illness (6.3 months) than patients who had comorbid illness (8.9 months) with statistical significant difference among the group ($X^2(1)$) = 10.85, P-value = 0.0010). (Table 5).

However, no statistically significance difference were shown for sex, residence, family history of diabetes militias ,number of clinic visit ,DKA as presentation and being malnourished in determining time to first optimal glycemic control. (Table 5 & Table 6).

4.8 Results of multivariable cox proportional hazard model

Goodness of fit checked by cox Snell residuals by plotting cox Snell residual against the cumulative hazard function. You can observe in figure 6 as residuals follow unit of exponential distribution or a linear line through the origin with a unit gradient, which indicates a well fitted model to the observed data point and expected value.

Proportional assumption of cox proportional hazard model was tested by using Schoen field residual test and graphically by using log minus log function on Stata version 14.2 (Table 6& Fig 7).Figure 7 indicates that, the survival curve looks like parallel throughout the study time; which shows equitable fitting to the proportional hazard assumption.

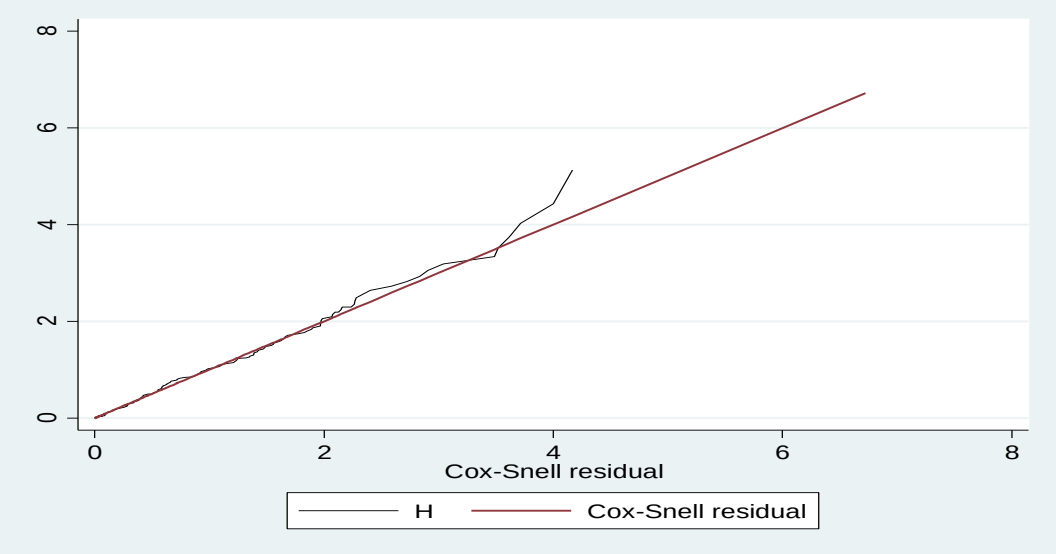

Figure.5: Model goodness of fit by cox Snell residual *among type 1 DM clients, Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021(n=385)*

Table 6:Test of proportional-hazards assumption by Schoen field residual test (Global test) *among type 1 DM clients, Bahir Dar city public referral hospitals, Northwest, Ethiopia, 2021(n=385)*

Variables	Rho	X^2	DF	P-value
Age	0.03898	0.39	1	0.5310
Educational status of children	0.06785	1.01	1	0.3138
Primary care giver	0.13921	3.91	1	0.050
Weight the client	0.06590	0.97	1	0.3253
Duration of diabetes	0.01613	0.08	1	0.7784
Insulin regimen	0.12133	2.82	1	0.0934
Dose of insulin	0.07640	1.21	1	0.2715
Frequency of glycemic control	-0.00730	0.01	1	0.9230
Carbohydrate counting	0.13800	3.28	1	0.0700
Exercise	0.02123	0.09	1	0.7580
Noncompliance	0.08636	1.37	1	0.2410
Adherence	-0.03696	0.25	1	0.6154
Diabetes related complication	0.01547	0.06	1	0.8037
Comorbidity	-0.08886	1.89	1	0.1689
global test		42.48	19	0.5368

Rho: spearman rank correlation coefficients, X2: chi Square, DF: Degree of freedom

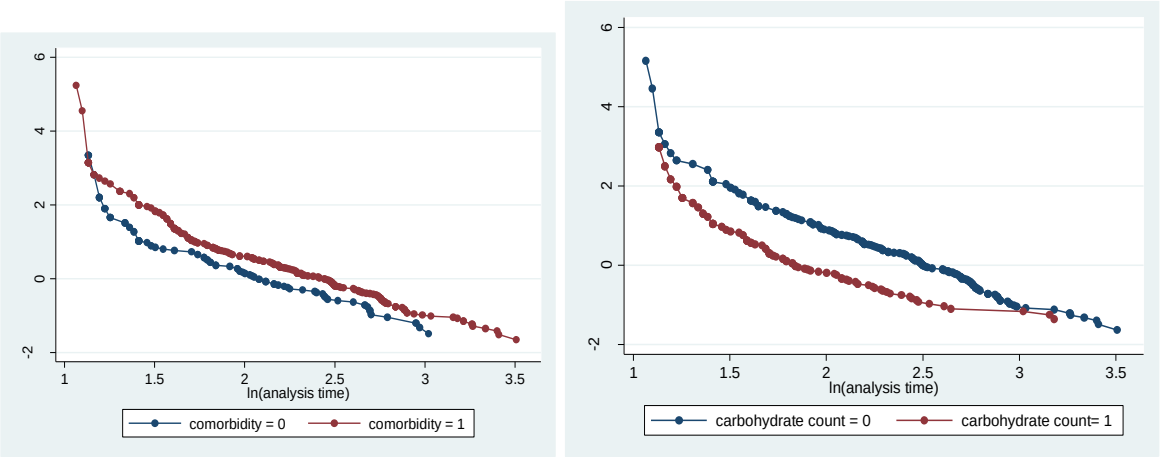

Figure.6: log of minus the Log of survival function by comorbidity and carbohydrate count for time to first optimal glycemic control among type 1 diabetic children, Bahir Dar, 2021

The independent variables such as age client educational status, primary care giver, dose of insulin at initiating of treatment, duration of diabetes, first insulin regimen, current insulin regimen, frequency of glycemic control, carbohydrate count, exercise, noncompliance, adherence, diabetes related acute complication, having history of comorbidity were significantly associated with time to first optimal glycemic control at the point less than 0.25 level of significance from bivariable analysis. However, only age, duration of DM, dose of insulin at initiating of treatment, weight, primary care giver, adherence to DM care, carbohydrate counting and history of comorbidity were found to be significantly associated with time to first optimal glycemic control in the multivariable cox regression hazard model less than 5% level of significance.

The presence of interaction among independent variables were checked by multicollinearity test but there was no significant interaction as it was confirmed by the value of variance inflation factor (VIF) which is less than ten.(Annex IV).

Consequently, after adjusting other predictor, the hazard of achieving optimal glycemic control among the age groups >10-14 years were lower by 67.6% as compared with the age groups of the client<=5 years(AHR=0.324,95%CI=0.192-0.546).

Likewise, the hazard of achieving optimal glycemic control among clients with history of comorbid illness was lower by 24.3% compared to clients with no history of comorbid illness (AHR= 0.722, 95%CI=0.530-0.981).this means, the time needed to reach optimal glycemic control

among clients with history of comorbid illness was significantly longer compared with clients with no history of comorbid illness.

However, the rate of achieving first optimal glycemic control among clients who adhered to diabetic care had 9.7 times increment than clients who didn't adhered to diabetic management (AHR=9.723, 95%CI=6.094-15.513). (Table 6).

Table 7: Results for the final cox regression hazard model among type 1DM clients Bahir Dar city public referral hospitals,Northwest,Ethiopia,2021(n=385)

Variable	CHR(95%CI)	AHR(95% CI)	P-value
Insulin dose at initiation of Rx	0.982(0.969-0.993)*	1.053(1.029-1.078)	< **0.001****
Weight of the client	0.978(0.965-0.992)*	0.964(0.939-0.989)	**0.005****
Age group in years at diagnosis			
<=5®			
>5-10	0.802(0.587-1.097)	0.926(0.619-1.384)	0.707
>10-14	0.599(0.448-0.801)*	0.324(0.192-0.546)	**<0.001****
Sex of the participant			
Male®			
Female	1.116(0.879-1.416)		
Resident			
Urban®			
Rural	1.010(0.790-1.292)		
Primary care giver			
Mother alone®			
Mother and Father	0.848 (0.617-1.165)	2.092(1.397-3.132)	**<0.001****
Father alone	0.824 (0.493-1.378)	1.171(0.631-2.171)	0.617
Other	0.685 (0.475-0.988)*	0.801(0.491-1.305)	0.372
Educational status of children			
K/not started®			
Primary school	0.746 (0.527-1.057)	0.868(0.574-1.314)	0.505
High school	0.684 (0.471-0.992)*	1.333(0.745-2.386)	0.333
Insulin regimen			
Lent& regular®			
NPH& regular	0.840(0.631-1.118)*	0.757(.538-1.066)	0.111
NPH alone	0.704(0.511-0.970)*	1.305(0.856-1.990)	0.216

Results for the final cox regression hazard model among type 1DM clients Bahir Dar city publ hospitals,Northwest,Ethiopia,2021(n=385 cont.……

Carbohydrate counting			
NO®			
Yes	4.173(2.332-7.468)*	2.433(1.124-5.263)	**0.024****
Frequency of glycemic control per day			
<3®			
>=3	1.904(1.409-2.574)*	1.259(0.887-1.788)	0.198
Physical exercise			
NO®			
Yes	2.574 (1.991-3.326)*	1.178(0.841-1.649)	0.341
Noncompliance behavior assessed by clinician at health care visit			
NO®			
Yes	0.334 (0.248-0.451)*	1.222(.805-1.853)	0.346
Adherence to diabetic care			
NO®			
Yes	6.522(4.901-8.679)*	9.723(6.094-15.513)	**<0.001****
Duration of DM in years			
<2®			
[2-4)	0.559(0.401-0.781)	0.736(0.509-1.063)	0.102
>=4	0.486(0.356-0.664)*	0.642(0.436-0.944)	**0.024****
Diabetes related acute complication			
NO®			
Yes	1.591(1.031-2.457)*	1.084(.653-1.799)	0.755
Other complication			
NO®			
Yes	0.746(0.456-1.221)		
History of comorbidity			
NO®			
Yes	0.627 (0.484-0.811)*	0.722(0.530-0.981)	**0.038****

*CHR=Crud hazard ratio, AHR=Adjusted hazard ratio, Rx=Treatment, ®=Reference group and *&** *indicates statistically significant variable with bivariable& multivariable cox regression hazard model respectively.*

5. DISCUSSION

In the meantime there is no adequate former similar study in pediatrics age categories, as a result the finding of this study is compared with studies conducted with exactly analogous factors that affect optimal glycemic control among type 1 diabetic children from diverse literature in different part of the country.

Time to first optimal glycemic control finding in this study is in line with another study conducted among type 1 diabetic children in united states (38) but a little bit shorter than previous study conducted in Ethiopia(9.5months) (3).This could be due to differences in age pattern, type of diabetes and comorbidity among study participants(28,31,47,49,50,55,57-60).

The finding related to overall incidence rate to achieve glycemic target in this study is less than other studies conducted in Kenya (28%),Jordan (20.9%), Saudi Arabia (39.1%), and California(33%)(39,40,50,51) but greater than a study done in Tanzania(2.6%)(26).This discrepancy can be due to differences in population characteristics, sample size, study methodology and overall health care system including resource allocation(10, 16,17,23,24,52).

In regard to predictors, the age of the participant was found to be significantly associated variables that determine time to first optimal glycemic control. The study showed that, the time needed to reach first optimal glycemic control is longer among clients of age group >10-14 years followed by the age group 6-10 years compared to clients in the age group<=5 years, indicating that for children older than 10 years, the rate of achieving optimal glycemic control decreases as age increases which is in line with study done in Tanzania ,Bulgaria, Iraq, Taiwan and Jordan (26,46,47,49,50). This can be due to the fact that As a child develops, he/she under goes a varieties of physical and life style changes(24). In addition to this, it can be also due to hormonal effect at pubertal age of the child and decline in parental supervision over different clinical aspects of diabetic care in the adolescents(46,50).

Weight of the client also significantly associated with time to first optimal glycemic control. Rate of glycemic achievement decreases by 3.6% as weight increase by one unit which means the weight of the client is 0.964 times less likely associated with optimal glycemic achievement rate.

This could be due to, weight gain may contribute to increased insulin resistance and cardio metabolic risk such as increased dyslipidemia and blood pressure(62).It is in line with another controlled study among T1DM patients which stated previously as “normal weight preschool children have better glycemic control than age matched overweight children (63,64).’’It can significantly implies that, body weight status may impede achievement of glycemic targets with in the expected time in this group of patients. Therefore, having regular exercise which is non-strenuous can be encouraged. The recommendation is supported by the study conducted in United Kingdom and the authors of International society of pediatrics and adolescents diabetes (ISPAD) guide line revised since 2018 GC (6,34).

Dose of insulin at initiation of treatment increases first optimal glycemic achievement rate by 1.053 times as dose of insulin increases by one unit. This finding is supported by the study done in many countries such as India, china, Germany, Austria, and Luxembourg (66-70).

This study also showed that, primary care giver during the follow up period was significantly associated with optimal glycemic control. Especially those clients whose care giver mother and father was two times more likely associated with first optimal glycemic control as compared with clients supported by their mothers alone. The finding was supported by the study conducted in Tanzania and middle east Jordan(32,50).

In regard to adherence to diabetic care, those clients with adherence had 9.7 fold of instantaneous chance of increasing their glycemic achievement rate as compared with those clients with no adherence to wards their diabetic management. Which is in line with the study conducted in Ethiopia entitled with incidence of diabetic keto acidosis and its predictors among type one diabetic children (31).Correspondingly, those clients well adhered to Diet counseling specifically on food pyramid and non-refined carbohydrate utilization were found to have increasing their glycemic achievement rate by 2.4 folds as compared with those clients with no habit of practicing healthy diet at home and the finding is in line with the study conducted in Uganda (35, 54, 64).

Duration of diabetes was also significantly associated with time to first optimal glycemic control in this study. Those clients living with diabetes for more than or equal to four years were 35.8% times less likely to achieve optimal glycemic control as compared with clients who were living

with diabetes less than two years. This could be due to age maturation with advancement of the disease following to diabetic duration as it was explained above (24, 46,50).This finding is similar with the study done in Tanzania(31) but different with study done in cameron(75).

In addition to the above factors, having comorbid illness is another important predictors that can affect time to optimal glycemic control. The rate of achieving optimal glycemic control among clients with history of comorbid illness were 27.8% times less likely as compared with clients with no comorbid illness. This is because having comorbid illness has an influence on diabetes disease progress with impairment of glucose metabolism possibly lead to deterioration of glycemic control. Comorbid illness such as infection might also cause high level of counteracting hormones which triggering an episode of hyperglycemia and could also be due to the effect of taking many drugs which can lead to drug interaction and also can decrease drug adherence which interferes with drug effectiveness. This finding is in line with the studies conducted in Saudi Arabia, Brazil and university of California, San Francisco(18,57-60).

6. STRENGTH AND LIMITATION OF THE STUDY

6.1. Strength of the study

Since the data were collected from two referral hospitals, the finding can have more power in regard to generalizability.

6.2. Limitation of the study

Since the data were collected from medical records, variables like parental socio economic factors cannot be addressed through card review which may affect the outcome of the study.

Fasting blood glucose level (FBG) measurements obtained from medical records might be subjected to measurement errors that lead to underestimated or overestimated of the result. However, effort was made to overcome this issues by taking the mean value of three month consecutive value of FBG measurements.

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

Median survival time to first optimal glycemic control among type one diabetic children in the study area was too long. Which indicate that, clients are unprotected for both acute and chronic complication of type one diabetes mellitus. This increased risk remains higher for those clients achieving their glycemic control with in long period of time compared to those who achieved optimal glycemic control in a short period of time.

This study also showed that age, weight, dose of insulin, diet, adherence to diabetic management, primary care giver, duration of diabetes and having comorbid illness were significantly associated with time to first optimal glycemic control among type 1 diabetic children.

7.2. Recommendation

For health care worker in the hospitals

Health care provider during diabetic care monitoring at follow up clinic should focus on adherence analysis by encouraging the clients to have logbook.

Either titration of the dose or multiple daily injection of insulin at the very beginning is essential with possible close observation and precaution of hypoglycemia or if it is possible, another insulin delivery method such as continuous subcutaneous insulin infusion and insulin pump should be taken into consideration.

Children who cannot manage their diabetes effectively by their own have to get help from all family members including siblings and other family members other than their parents should be paid more attention. This is because, involving all family members in the care plan with appropriate education and knowledge until the child can reach an age where he/she can manage diabetes can significantly increase the chance of achieving optimal glycemic targets with in an intended period of time

Health care worker should also give high emphasis for clients those having comorbid illness to manage with proper integrated manner with respect to their diabetic duration.

For policy makers

Treatment guide line is recommended to prepare based on local research findings about type 1DM specifically on pediatrics age category since glycemic control was vary though age groups.

Policy maker should follow the health care services for proper implementation of developed strategies and guidelines or standards for type 1DM treatment and their follow up with active surveillance.

For future researchers

More comprehensive prospective follow up study involving factors like parental socio economic predictors and other resources relevant to manage diabetes should be carried out to provide more universal insight for possible association with time to optimal glycemic control since such factor is difficult to access only through patient medical record review.

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ANNEXES

ANNEX-I: INFORMATION SHEET FOR STAFFS WORKING ON PATIENT'S CARD ROOM AT BAIR DAR CITY PUBLIC REFERRAL HOSPITALS, 2021

I am MSC student from Bahir Dar University College of medicine and health science, department of pediatrics and child health nursing. I want to kindly ask you to observe the following questions from patient registry/follow up card. The main aim of this data collection is to estimate time to first optimal glycemic control and identify its predictors among type one diabetic children. Confidentiality of the information is well secured. Because of this, it is not requested to write clients name. The finding of this credible information uses not only for accomplishment of this study, but also results obtained from this study will potentially help health care managers and professionals to develop a new strategy for the prevention and management of both acute and chronic complication of DM in children and it will give a new insight for a national program of research team for further interventional studies in the country.

ANNEX-II: CHECK LIST TO COLLECT RELEVANT INFORMATION TO MEASURE ASSOCIATION BETWEEN TIME AND OPTIMAL GLYCEMIC CONTROL AMONG DIABETIC CHILDREN IN BAHIR DAR CITY REFERRAL HOSPITALS,2021 (ADOPTED FROM(3,15,36,40,50))

Part I: socio demographic characteristics			
S.No.	Questions	Responses	Skip
1.	Age at diagnosis	----------	
2.	current age (years)	----------	
3.	Sex	1. male 2. female	
4.	Residence	1. urban 2. rural	
5.	Hospital in which the data obtained	1. Felege Hiwot 2. Tibebe Ghion	
6.	Educational status of the children	1. KG/not started 2. Primary school (1-8) 3. Grade 9 -12 4. other(specify)------	
7.	Primary care giver	1.Mother alone	

		2.Mothe&Father 3.Father alone 4.Other(specify)--------	
part II :Personal and clinical related variables			
8.	BMI and MUAC in the latest clinic visit	Wt----------kg Ht----------cm MUAC----------cm	
9.	Family history of diabetes	0.NO 1.Yes	
10.	Duration of diabetes (years)	----------	
11.	Number of clinic visits during the last year of follow up	----------	
12.	First insulin regimen	- ----------	
13.	Current insulin regimen	----------	
14.	Number of insulin injection per day	----------	
15.	dose of First insulin	----------	
16.	Current insulin dose	----------	
17.	Frequency of daily glucose control	----------	
18.	Carbohydrate count	0.NO 1.Yes	
19.	parental/self-reported physical activity	0.NO 1.Yes	
20.	Presence of noncompliance behaviors assessed by the clinician at the time of health care visit	0 NO 1 Yes	
Part III: diabetes related complication			
21.	History of diabetes related complication	0.NO 1.Yes	
22.	Diabetes related acute complication	0.NO 1.Yes	
23.	Diabetic keto acidosis	0.NO 1.Yes	
24.	hypoglycemia	0.NO 1.Yes	
25.	Diabetes nephropathy	0.NO 1.Yes	
26.	Diabetes neuropathy	0.NO	

		1.Yes	
27.	Diabetes retinopathy	0.NO 1.Yes	
28.	Other complications	0.NO 1.Yes	
29.	More than one complication	0.NO 1.Yes	
30.	Diabetes related hospitalization	0.NO 1.Yes	
Part IV: comorbidity related Variables			
31.	History of co-morbid illness	0.NO 1.Yes	
32.	Autoimmune disease(Celiac, graves' disease etc)	0.NO 1.Yes	
33.	Hypertension	0.NO 1.Yes	
34.	Cardiovascular disease	0.NO 1.Yes	
35.	dyslipidemia	0.NO 1.Yes	
36.	Other co-morbid illness(TB,HIV, anemia ,and other infections)	0.NO 1.Yes	
37.	More than one co-morbid illness	0.NO 1.Yes	

Part V: Glycemic value with respect to time

Time	2016	2017	2018	2019	2020
1					
2					
3					
4					
5					
6					
7					

ANNEX-III: LIFE TABLE TO ESTIMATE CUMULATIVE SURVIVAL PROBABILITY AFTER DIAGNOSIS

Interval	Total	Deaths	Lost	Survival	Std.Error	[95% Conf. Int.]
2 3	385	1	2	0.9974	0.0026	0.9817 0.9996
3 4	382	36	50	0.8968	0.0161	0.8604 0.9241
4 5	296	32	12	0.7979	0.0218	0.7510 0.8369
5 6	252	30	16	0.6998	0.0255	0.6467 0.7465
6 7	206	23	8	0.6201	0.0274	0.5638 0.6713
7 8	175	16	3	0.5629	0.0284	0.5053 0.6164
8 9	156	18	2	0.4975	0.0290	0.4395 0.5528
9 10	136	17	0	0.4353	0.0290	0.3779 0.4913
10 11	119	8	0	0.4061	0.0289	0.3493 0.4620
11 12	111	16	2	0.3470	0.0282	0.2922 0.4023
12 13	93	13	2	0.2980	0.0273	0.2456 0.3521
13 14	78	6	3	0.2746	0.0268	0.2235 0.3280
14 15	69	12	0	0.2268	0.0254	0.1790 0.2782
15 16	57	10	0	0.1870	0.0239	0.1428 0.2360
16 17	47	7	0	0.1592	0.0225	0.1180 0.2059
17 18	40	7	0	0.1313	0.0209	0.0938 0.1753
18 19	33	5	1	0.1111	0.0195	0.0765 0.1529
19 20	27	4	0	0.0947	0.0183	0.0628 0.1343
20 21	23	2	0	0.0864	0.0176	0.0560 0.1249
22 23	21	0	1	0.0864	0.0176	0.0560 0.1249
23 24	20	1	1	0.0820	0.0173	0.0524 0.1199
24 25	18	4	0	0.0638	0.0156	0.0377 0.0991
26 27	14	3	1	0.0496	0.0141	0.0268 0.0826
27 28	10	0	1	0.0496	0.0141	0.0268 0.0826
28 29	9	1	1	0.0438	0.0136	0.0223 0.0762
30 31	7	2	0	0.0313	0.0123	0.0132 0.0623
33 34	5	1	0	0.0250	0.0113	0.0092 0.0550
35 36	4	0	1	0.0250	0.0113	0.0092 0.0550
36 37	3	1	2	0.0125	0.0105	0.0017 0.0493
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ANNEX: IV TEST OF INTERACTION BY MULTICOLLINEARITY

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. vif
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Variable	VIF	1/VIF
currenid	6.19	0.161523
dosi	5.47	0.182835
agegroupd	4.63	0.216154
wt	4.33	0.230861
adhernce	4.15	0.241222
morethal	4.14	0.241548
curentageg	4.08	0.244930
sammam	3.87	0.258372
frquofgg	3.63	0.275159
primarc	3.24	0.308482
othercbd	2.97	0.336315
morethlc	2.92	0.342784
coplianc	2.85	0.350985
BMIcat	2.84	0.351538
hypog	2.84	0.352237
hxcdty	2.70	0.370860
dka	2.62	0.381242
durDMcat	2.57	0.389033
freqdglcat	2.47	0.404224
hospital	2.47	0.404664
diabetes	2.21	0.453310
firir	2.17	0.461761
otherc	2.12	0.471449
ccdm	2.08	0.481602
cvsd	2.07	0.483513
educatio	2.06	0.486103
exercis	1.95	0.513262
cap	1.89	0.528226
urti	1.84	0.544794
stunting	1.83	0.545131
residenc	1.83	0.547942
currenti	1.81	0.553894
place	1.78	0.562501
uti	1.74	0.573998
htn	1.70	0.589494
sex	1.68	0.594985
age	1.65	0.607017
diec	1.63	0.615089
hep	1.62	0.618014
autoimdi	1.59	0.629182
om	1.58	0.631063
malaria	1.56	0.642475
fungali	1.54	0.648018
tb	1.52	0.657317
mengitis	1.44	0.695909
noclvisi	1.42	0.702323
familyhx	1.31	0.761318
Mean VIF	2.52	