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Time-to-Recovery from Type 2 Diabetic Patients and Associated Aspects at Debre Berhan Specialized Hospital

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Abstract: Background: Diabetes mellitus, more often known as diabetes, is a dangerous, long-term (or "chronic") disorder that manifests as elevated blood glucose levels when the body is unable to create, sufficient amounts of, or utilize the insulin that is produced. Due to the fact that a single patient may recover from more than one type 2 diabetes throughout time, recovery is usually recurring. Worldwide, type 2 diabetes was expected to affect 422 million adults in 2014, up from 108 million in 1980. By 2045, the International Diabetes Federation (IDF) projects that there will be a 143% rise in the population of diabetics in Africa. Ethiopia had 80,000 cases of diabetes in 2000, and the WHO projects that number will increase to 1.8 million cases by 2030. The aim of this research was to evaluate the type 2 diabetes recurrence (time to recovery) along with associated variables at Debre Berhan Specialized Hospital in Ethiopia. Methodology: An institutional-based retrospective study design was carried out on data obtained from Debre Berhan Specialized Hospital, in Jimma zones with type 2 diabetic patients who started treatment and were on follow-up in this Hospital. The study included 151 patients in total, and the Cox proportional hazard model was employed to look at diabetes patients' survival times. The log-rank test was performed to compare the categories of the variables, and Kaplan-Meier estimators were employed to predict the survival curves of diabetes patients. Result: Patients with type 2 diabetes had a median recovery time of 38 weeks, with the lowest and highest recovery times of 1 and 316 weeks, respectively. Patients with type 2 diabetes who took HCT and Regularly had a better probability of recovering from the condition sooner than those who took Doanied as prescribed by a doctor. Additionally, the likelihood of early recovery from type 2 diabetes mellitus improves by 1.7% as the patient's weight rises. Conclusion: Sex, age, family history, complications, smoking status, weight, and Spdrty (being HCT and Regular) were statistically significant variables at 0.05 p-values and are the key predictors for the recovery duration of type 2 DM patients. Therefore, future efforts to combat type 2 DM recovery should take all of these aspects into consideration. Prevention is crucial in the fight against type 2 diabetes. Adopting a healthy lifestyle, eating a well-balanced food, and getting enough exercise on a regular basis can help lower the chance of acquiring the illness. Furthermore, boosting awareness about the need of early identification and diabetes control education is critical in fostering a healthier society.

Keywords: Type 2 Diabetes Mellitus, Recovery Time, Cox Proportional Hazard

1. Introduction

1.1. Background of the Study

Diabetes mellitus, more simply called diabetes, is a serious, long-term (or “chronic”) condition that occurs when raised levels of blood glucose occur because the body cannot produce any or enough of the hormone insulin or cannot effectively use the insulin it produce [1, 2]. Insulin is an essential hormone produced in the pancreas. It allows glucose from the bloodstream to enter the body’s cells where it is converted into energy or stored. Insulin is also essential for the metabolism of protein and fat. A lack of insulin, or the inability of cells to respond to it, leads to high levels of blood glucose

(hyperglycemia), which is the clinical indicator of diabetes [3].

Type II diabetes is recognized as a serious public health concern with a considerable impact on human life and health expenditures. In many regions of the world, the prevalence of diabetes is increasing due to urbanization and rapid economic growth. Diabetes has a negative impact on a person's functional abilities and quality of life, which causes severe morbidity and early mortality. Concerns about the fact that over one-third of fatalities from diabetes occur in those under 60 have recently been voiced. These changes have been attributed to rising levels of poor diet intake and sedentary behavior, which result in raised Body Mass Index (BMI) and fasting plasma glucose [3].

There are two types of diabetes that are commonly encountered (type 1 and type 2). Type 2 diabetes mellitus is the most common type of diabetes, accounting for 90–95 percent of all cases. Globally, the twin epidemics of diabetes and obesity are escalating [3]. Obesity rates are thought to have a direct relationship with the rapid prevalence of type 2 diabetes. In the year 2000, there were approximately 300 million obese adults. Type 2 diabetes is potentially reversible before permanent beta cell failure has occurred. Elevated waist circumference, elevated triglycerides, reduced high-density lipoprotein cholesterol, elevated blood pressure, and elevated fasting blood glucose were considered major indicators of type 2 diabetes [4].

International Diabetes Federation (IDF) predicts a 143% increase in the number of people with diabetes in Africa by 2045. Several factors, as well as the prevalence of type 2 diabetes, have been steadily rising over the last few decades. In 2014, an estimated 422 million adults worldwide had type 2 diabetes, up from 108 million in 1980 [5]. Type 2 diabetes is becoming more prevalent in Africa, and the disease's scope is expanding. Over 12 million people in Sub-Saharan Africa are expected to have type 2 diabetes mellitus, with 330,000 dying as a result of its complications [6]. Ethiopia is plagued by a slew of diseases, the majority of which are caused by transmissible infectious diseases and nutritional deficiencies. Currently, it is dealing with an increase in the number of chronic non transmittable diseases [7]. According to WHO estimates, the number of diabetic cases in Ethiopia in 2000 was 80,000, and this figure is expected to rise to 1.8 million by 2030.

1.2. Statement of the Problem

Diabetic patients may live longer and may get into different medical complications. This can be a challenge for the quality of life of the patient. Nevertheless, the deterioration of the patients' quality of life and even death can be much delayed with the knowledge of factors that may contribute to it [8]. Acceptable diabetes care has an inclusive and more comprehensive scope. This it also includes preventing and treating life-threatening end organ damage due to diabetic complication [9].

Even though health workers try to control fasting blood sugar level, there are many questions which can be raised by everyone that what factors contribute for controlling fasting blood sugar level of diabetes patients. Past researches shows that initial weight, BMI, alcohol use, tobacco use, BP, type of diabetic disease diagnosed, cholesterol level, complication of DM, FBS and family history of DM were major factors related to survival time of diabetic patient [1]. However, most of the studies in Ethiopia focused on the prevention and about factors that increase the chance of contracting the disease. And little work has been done on survival time of diabetic patients so this study used Cox proportional hazard model were used to examine recovery time of diabetic patient [10]. Kaplan- Meier estimators were applied to estimate survival curves of diabetic patient and the log rank test will use for the comparison between the variable categories [9]. Therefore, the objective this study looked for variables that were strongly related to how quickly type 2 diabetes patients recovered after their treatments at Debre Berhan Specialized Hospital.

Hence, the current study is supposed to answer the following basic questions:

1. What are the factors that affect recovery time of type 2 diabetic patient?
2. What is the estimated recovery and survival time of type 2 diabetic patients among some covariates?
3. How to compare survival and recovery time of type 2 diabetic patients by using log rank test?

2. Methodology

2.1. Data Source

For this study, longitudinal retrospective cohort follow up (retrospective cohort design) of type 2 diabetic patients data is collected from Debre Berehan Specialized Hospital Diabetic Patient Clinic located in of Ethiopia. The data is extracted from the patient's chart which contains epidemiological, laboratory and clinical information of all diabetic patients under treatment follow-up.

2.2. Study Population

All type 2 diabetic patients greater than or equal to 18 years old and placed under treatments that have followed. The data for this study consists of 151 individuals. Patents' follow up time was one, two or three months gap according to the order of the doctor and the data was collected from patients' medical follow up card by assigning an identification number per individual by health workers in the chronic follow up clinic, which helps to find the patients profile easily during the study time.

2.3. Sampling Design and Technique

Retrospective research designs were used for this investigation. A sample of 151 individuals with type two diabetes was selected for this investigation at the specialized hospital in Debre Berehan using secondary data.

2.4. Target Population

The target populations for this study were type 2 diabetic patients who start treatment in Debre Berehan Specialized Hospital. Patients who are enrolled within the study period

were included in the study and those Patients who were referred or transferred to another place were excluded.

2.5. Data Collection Instrument and Procedure

The study is based on the review of follow up cards of type 2 diabetic patients taking the treatment. The patient charts are prepared by Federal Ministry of Health to be uniformly used by clinicians to early identify and document clinical and laboratory measurement. Thus, this study will use secondary data obtained from patient follow up card based on the questionnaire designed to extract only the variables to be considered in this study.

2.6. Variables Considered In the Research

The response variables:

The outcome variable in this study was the time to recovery of type 2 diabetic patients. Patient's recovery from diabetes is an event of interest.

1. "Time" (Survival time of patients in weeks) and
2. "Status" (Recovered=1, Censored=0)

The independent variables:

1. Gender (sex)
2. Age
3. Past medical history (PastMed_H)
4. Family history (FamilyH)
5. Complication (Is there any Complication Status?)
6. Regimen type
7. Specific drug(treatment) type order by Physician (Spdrty)
8. SBP (Systolic blood pressure)
9. DBP (Diastolic blood pressure)
10. Weight
11. smoker(yes/no)

2.7. Statistical Analysis

Survival analysis a statistical analysis that used to describe the analysis of data in the form of a well- defined time origin until the occurrence of some particular event or end point. Generally, survival analysis is a collection of statistical procedures for data analysis for which the outcome variable of interest is time until an event occurs. If the end point is the recovery of a patient, the resulting data are literally survival times. In this study the Cox proportional hazard model were used to examine survival time of diabetic patient [12]. Kaplan-Meier estimators were applied to estimate survival curves of diabetic patient and the log rank test were used for the comparison between the variable categories. And with this understanding, we start our method by giving the definition of censoring, Kaplan- Meier and Cox proportional model; we then proceed to model building and assessments [10]. First Kaplan-Meier and Bivariate cox proportion hazard for each independent variables were done and significant association was measured at p value of less than 0.2 for selection of multivariate analysis candidate variables. Then multivariate Cox PH regression model was fitted by including independent variables which were associated in bivariate cox PH regression or had p value less than 0.25. Then association was measured to be statistically significant predictor of time to recovery from type 2 diabetes mellitus if p-value was less than 0.05.

2.8. Operational Definitions and Definition of Terms

1. Diabetic mellitus: Diabetes mellitus (DM) also known as simply diabetes, is a group of metabolic diseases in which there are high blood sugar levels over a prolonged period This high blood sugar produces the symptoms of frequent urination, increased thirst, and increased hunger.
2. Type II diabetes mellitus (DM): begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease progresses a lack of insulin may also develop. This form was previously referred to as "non-insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes" [7].
3. Time to recovery from type 2 Diabetes mellitus: means a period of time it take until blood glucose level will become in normal range after exacerbation of type 2 diabetes mellitus [13].
4. Regimen Group: - Diabetic patients were classified into regimen groups according to the medication they took in follow-up time as:-
   1) Oral Agents Only: - all are administered orally in diabetic patients.
   2) Insulin Agents Only: - is provided in a constant proportion to remove excess glucose from the blood, which otherwise would be toxic. It is given by injecting patients with the dose level ordered by the physician.
   3) Both Oral and Insulin agents: - is another regimen group when patients are ordered to take both oral and insulin agents at the same time in the follow-up period.
5. Blood Pressure (BP) in (mm/Hg): - measures the pressure in blood vessels of diabetic patients. It can be classified as Systolic and Diastolic Blood Pressure.
6. Family History of Diabetes: - having a family who had Diabetic Disease or not.
7. Censoring: Due to time period confinement, censoring and truncation are common in survival data analysis and need to take into considerations. A censored observation is one whose value is incomplete due to random factors for each subject [14]. The most common form of censoring for incomplete data is right censoring when a subject's follow-up time terminates before the outcome of interest is observed. The second type of censoring is left censoring which is observed when an individual had developed the event of interest prior to the beginning of the study. An observation is categorized into an interval censored if it is only known that the event of interest occurs within an interval of time without the knowledge of when exactly it occurs. In this study by construction, we can have all types of censored data.
8. Kaplan-Meier Estimation: is a product limit estimation of the survivorship function which is developed by

Kaplan-Meier (1958). Kaplan-Meier (KM) estimator is used by most software packages because of the simplistic step approach [15]. The KM estimator incorporates information from all of the observations available, both censored and uncensored, by considering any point in time as a series of steps defined by the observed survival and censored times. When there is no censoring, the estimator is simply the sample proportion of observations with event times greater than t. The technique becomes more complicated but still manageable when censored times are included [8]. The KM estimator consists of the product of a number of conditional probabilities resulting in an estimated survival function in the form of a step function. It is a nonparametric estimator of the survivor function S(t).

9. Proportional Hazards Model: The basic model for survival data to be considered in this study is the proportional hazard model. This model was proposed by *David Cox (1972)* and has also come to be known as the Cox regression model. The model is also referred to as a semi-parametric model. Semi-parametric models are models that parametrically specify the functional relationship between the lifetime of an individual and his characteristics but leave the actual distribution of lifetimes arbitrary [15]
10. Basic Definitions: Let T denote a nonnegative random variable, representing time taken for recovery to occur. Let f(t) and F(t) be the respective density and cumulative distribution functions of T. The distribution of survival times is characterized by the survival and the hazard functions [5].
    1) Survival Function: is defined as the probability that the survival time is greater or equal to t……..S(t)= P(T≥t), t≥ 0
    2) Hazard Function: gives the instantaneous failure rate at t given that the individual has survived up to time t, i.e.
    3) $h(t)=f(t)/S(t)=-d\ logS(t)/d_t$ Or the hazard function is the probability that an individual will experience an event.

11. Relationship between S(t) and h(t)

1) h(t)=f(t)/S(t)
2) S(t)=exp(-(H(t)), t≥0 Where H(t) is called the cumulative hazard function, which can be obtained from the survival function since, H(t)= -log S(t)

12. The survival function is most useful for comparing the survival progress of two or more groups [10].
13. The hazard function gives a more useful description of the risk of failure at any time point.

3. Result

3.1. Socio-Demographic Characteristics Descriptive Result

Out of 151 type 2 diabetic patients included in the study, 116 (76.8%) participants were recovered and the remaining 35 (23.2%) were censored. There were 71(47%) male and 80(53%) female participants in the study. Out of 71 male and 80 female participants 55(77.5%) males and 61(76.2%) females recovered within the study period and the remaining were censored. From 151 participants 54(35.8%) of has past medical history and 97(64.2%) has no past medical history. The majority of the participants (107=70.9%) have no family history of the disease (type 2 diabetes mellitus). About 74.2% (112) of the study participants have medical complication of diabetes mellitus. As well as 72 participants (47.7%) were smokers and it is shown in table 1.

Table 1. *Descriptive Statistics Summary of type 2 diabetic patients.*

Variables	Categories	Patient status				Total	
		Censored		Event (survive)			
Sex	Male	16	(10.6%)	55	(36.4%)	71	(47%)
	Female	19	(12.6%)	61	(40.4%)	80	(53%)
Past medical history	Yes	14	(9.3%)	40	(26.5%)	54	(35.8%)
	No	21	(13.9%)	76	(50.3%)	97	(64.2%)
Family history	Yes	8	(5.3%)	36	(23.8%)	44	(29.1%)
	No	27	(17.9%)	80	(53%)	107	(70.9%)
Complication	Yes	25	(16.6)	87	(57.6%)	112	(74.2%)
	No	10	(6.6%)	29	(19.2%)	39	(25.8%)
Regimen	Oral agents	10	(6.6%)	32	(21.2%)	42	(27.8%)
	Insulin agents	21	(13.9%)	64	(42.4%)	85	(56.3%)
	Oral and Insulin agents	4	(2.7%)	20	(13.2%)	24	(15.9%)
	Doanied	11	(7.3%)	28	(18.5%)	39	(25.8%)
	HCT	0	(0.0%)	2	(1.3%)	2	(1.3%)
	Metformin	0	(0.0%)	1	(0.7%)	1	(0.7%)
Spdrty	Monotend	21	(13.9%)	59	(39.1%)	80	(53%)
	Lute	1	(0.7%)	0	(0.0%)	1	(0.7%)
	Regular	0	(0.0%)	3	(2%)	3	(2%)
	All oral	2	(1.3%)	23	(15.2%)	25	(16.5%)
Smoker	Yes	18	(12%)	54	(35.8)	72	(47.7%)
	No	17	(11.2%)	62	(41%)	79	(52.3%)

3.2. Time-to-Recovery of Type 2 Diabetes Mellitus

The mean and median weeks of an event (recovery from type II diabetes mellitus) were 56.69 weeks and 38 weeks respectively. The first individual recovered from the disease at week one (1) and the last individual recovered at 316 weeks as shown in Table 2. The median time to recovery from type 2 diabetes mellitus for all observations was 38 weeks without adjusting for another factors (shown by figure 1), but it is different when compared between categories of different variables. The median time to recovery from type 2 diabetes mellitus for male and female participants were 27 weeks and 66 weeks respectively. The median time to recovery for participants who has diabetic complications were 56 weeks while for those who have no complication it was 28 weeks. The median time to recovery of type 2 DM with family history of the disease was longer than those without family history of the disease (57 weeks and 48 weeks respectively), but this difference was insignificant since log-rank p-value is greater than 0.05.

Table 2. *Time to recovery in weeks.*

Status	Frequency	Percent (%)	Mean	Median	St. Deviation	Min.	Max.
Event	116	76.8	56.69	38	57.104	1	316

Table 3. *Comparison of survival experience of type 2 diabetic mellitus patients for socio-demographic and health variables.*

Variables	Categories	Median survival time (in weeks)	95% CI for the Median Survival time	Log-rank p-value
Sex				0.027
	Female	66	47.246 – 84.754	
	Male	27	18.883 – 35.117	
Past medical history				0.056
	Yes	58	37.177 – 78.823	
	No	48	33.344 – 62.656	
Family history				0.635
	Yes	57	41.286 – 72.714	
	No	48	34.257 – 61.743	
Complication				0.070
	Yes	56	45.490 – 66.510	
	No	28	14.485 – 41.515	
Regimen				0.303
	Oral agents	49	29.736 – 68.264	
	Insulin agents	47	21.821 – 72.179	
	Oral and insulin agents	83	61.208 – 104.792	
Spdrty				0.0006
Smoke cigarette				0.705
	No	58	46.071 – 69.929	
	Yes	42	17.269 – 66.731	

3.3. Kaplan-Meier Survival Estimate Graph of Type 2 Diabetes Patients

The non-parametric analysis was conducted using plots of the Kaplan Meir curves to the survival cumulative survival experience for the time to survive of type 2 diabetes patient as shown in Figure 1 respectively. The result revealed that the survival plot decreased at an increasing rate at the beginning and decreased further from time to time. This implies that most patient of type 2 diabetes highly soon after start treatment.

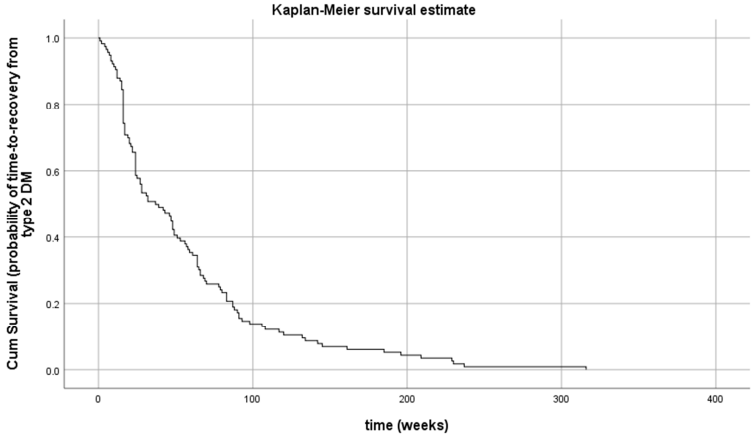

Figure 1. *Over-all Kaplan-Meier survival estimate of time-to-recovery from type 2 DM at JUSH, SW Ethiopia September 1 2017 to May 30 2023.*

The plot indicates that the probability of recovery is similar for both patients whose sex female and male at the beginning of the recovery. However, the difference becomes slightly visible at the middle of the curve and comes closer at the end. This implied that the probability of time to survive for female patient is higher than male patient see Figure 2.

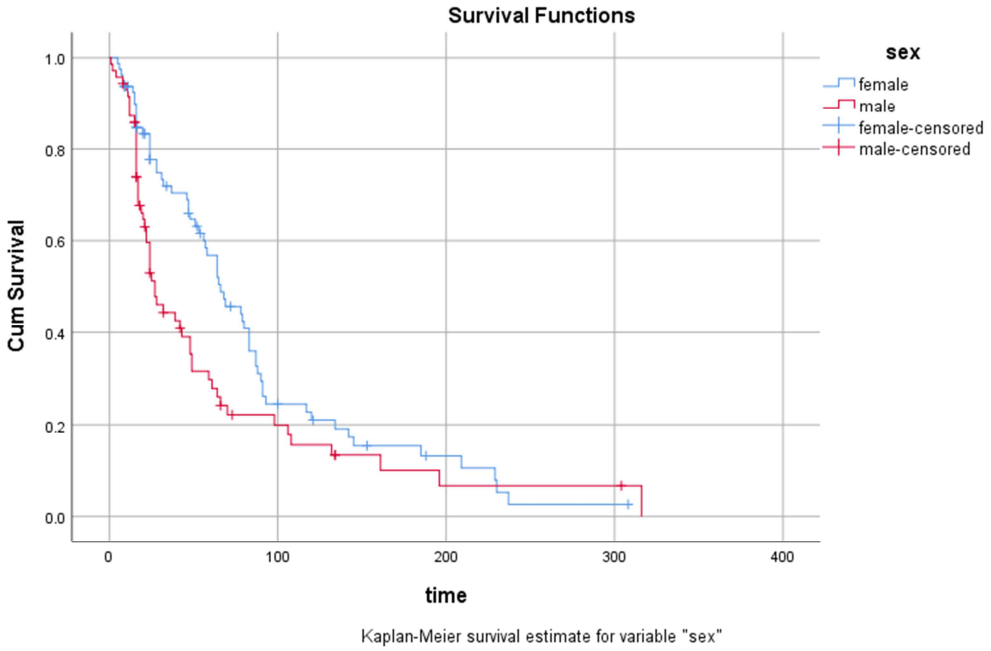

Figure 2. *Kaplan-Meier survival estimate of variable "sex" against time-to-recovery from type 2 DM.*

The survival for past medical history of the patients is lower than that the survival for the none-past medical history patient specially in the mid times, but all most the same at the beginning and at the ending time and this indicates that the probability of the curing time for patient have past medical history is lower than when we compared to the patient haven't past medical history or probability of curing time for patient haven't past medical history are higher than that of the patient have past medical history see Figure 3.

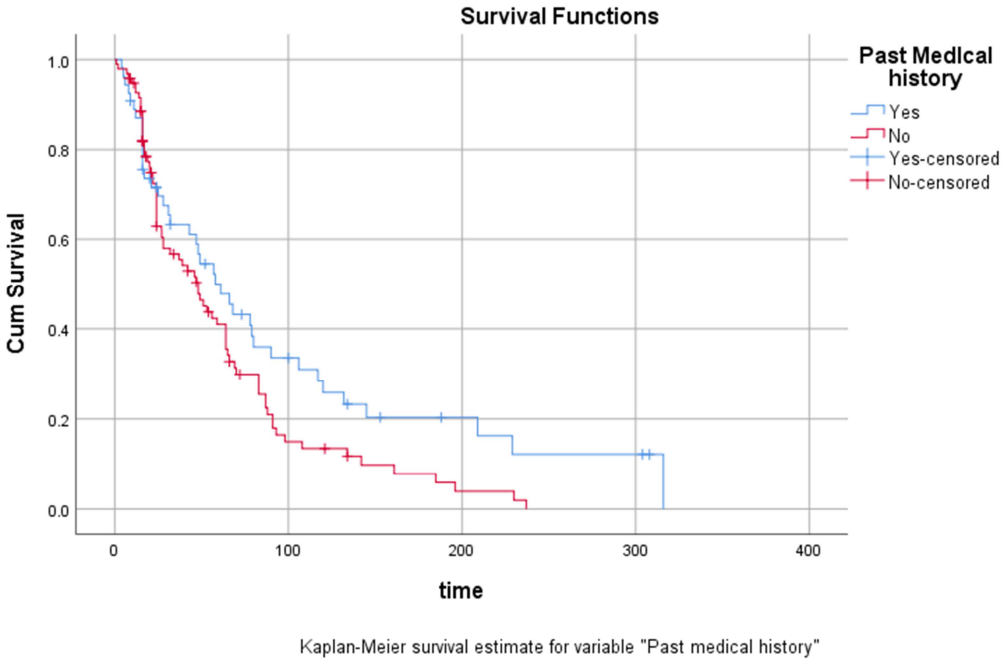

Figure 3. *Kaplan-Meier survival estimate of variable "Past Medical history" against time-to-recovery from type 2.*

Figure 4 showed that the survival for patient who have family history is lower than that the survival for the patient who haven't family history specially in the mid times, but all most the same at the beginning and at the ending time and

this indicates that the probability of the curing time for patient have family history is lower than when we compared to the patient haven't family history or probability of curing time for patient haven't family history are higher than that of the patient have family history.

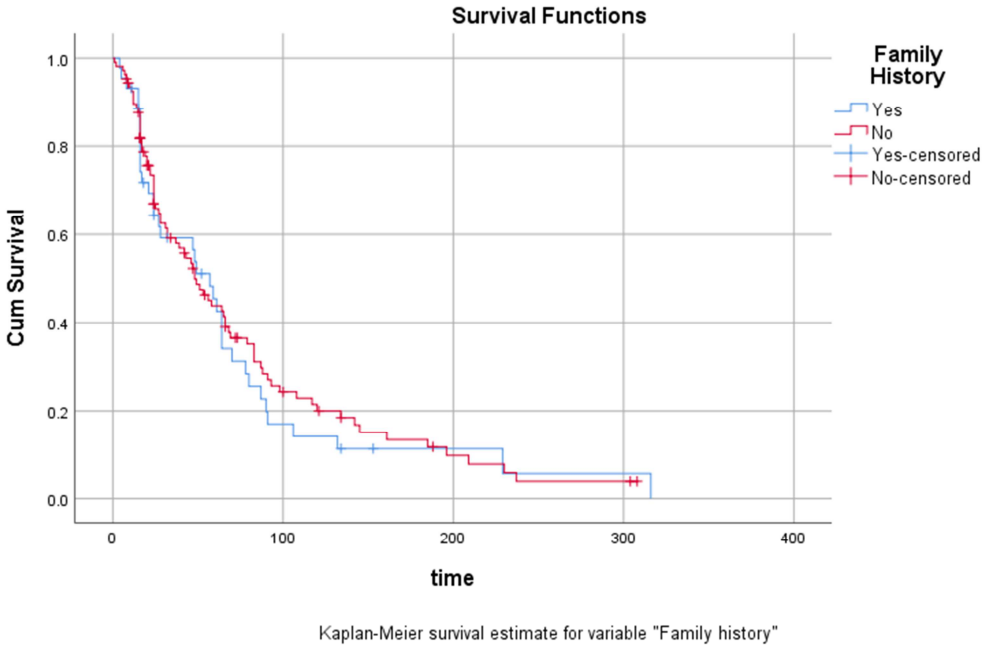

Figure 4. *Kaplan-Meier survival estimate of variable "Family History" against time-to-recovery from type 2 DM.*

Figure 5 showed that the probability of time to survive was very different for both groups Complication (Complication and no Complication) from the begging months to the end of survive. However, the difference visible at the begging of the curve and the end of the curve like similar. At the middle point of the curve, the surviva1 time to survive for patient who did not Complication is higher than that of the no Complication patient. This implied that the time to recovery of Complication patient is lower than that of who didn't Complication.

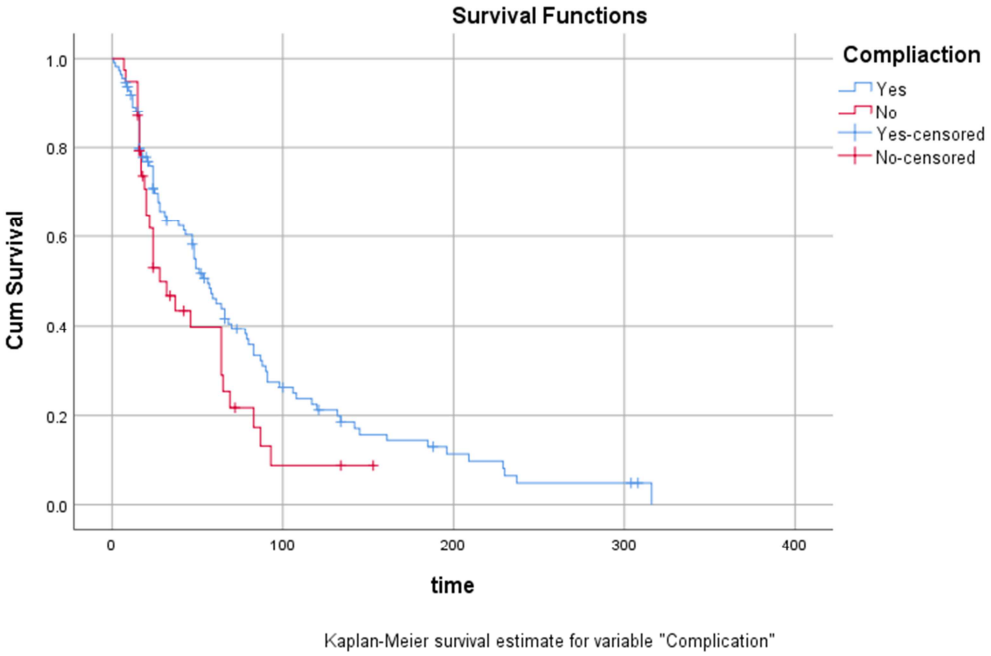

Figure 5. *Kaplan-Meier survival estimate of variable "Complication" against time-to-recovery from type 2 DM.*

Figure 6 showed that the probability of time to survive was very different for both groups smoking (smoking and no smoking) from the begging months to the end of survive. However, the difference visible at the begging of the curve

and the end of the curve like similar. At the middle point of the curve, the survival time to survive for patient who did smoking is higher than that of the no smoking patient. This implied that the time to recovery of smoking patient is lower than that of who did not smoking.

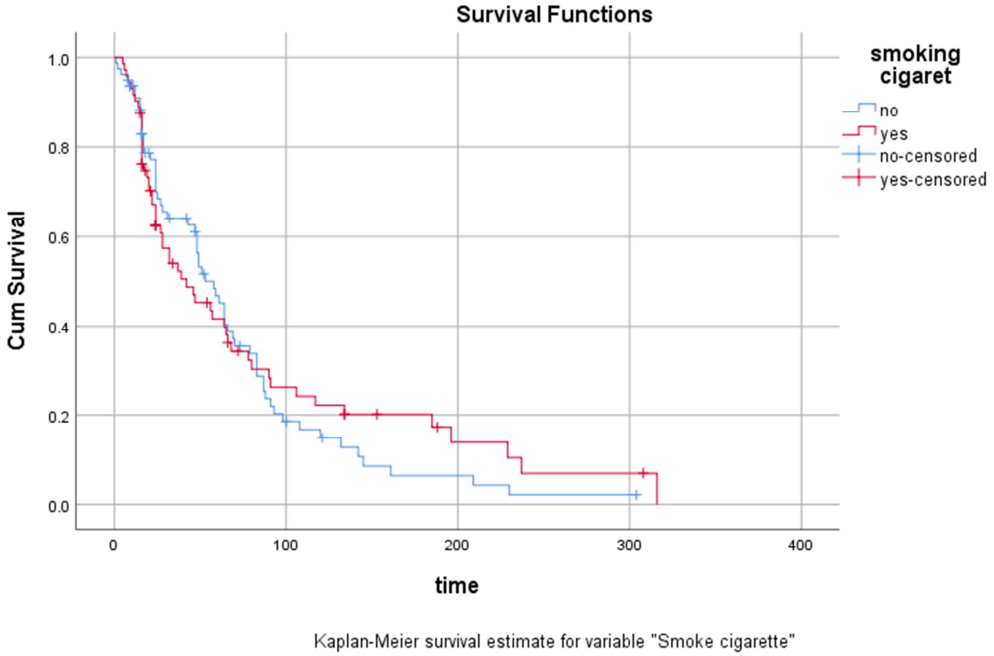

Figure 6. *Kaplan-Meier survival estimate of variable "Smoking cigarette" against time-to-recovery from type 2 DM.*

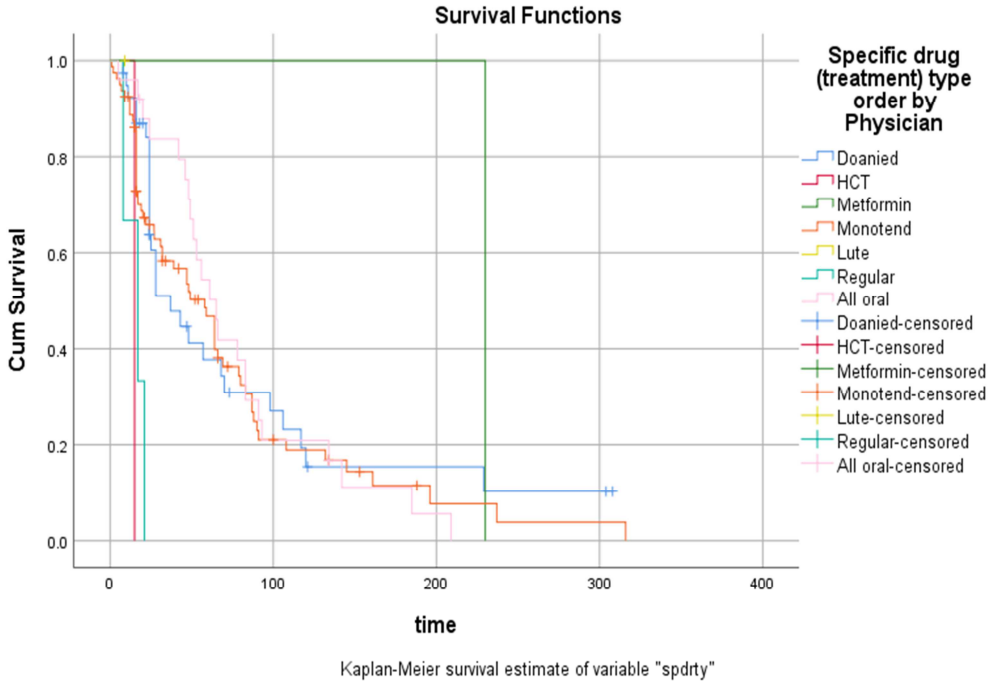

Figure 7. *Kaplan-Meier survival estimate of variable "Spdrty" against time-to-recovery from type 2 DM.*

3.4. Model Diagnosis for COX Proportional Hazard Model

3.4.1. Test of Proportional Hazard Assumption

Table 4. *Proportional hazard assumption test based on schoenfeld residuals (phtest).*

Variables	Rho	chi2	df	Prob>chi2
Sex	-0.17351	3.48	1	0.0620
Age	0.16095	2.98	1	0.0842

Variables	Rho	chi2	df	Prob>chi2
PastMed_H	0.15652	3.16	1	0.0755
FamilyH	-0.06273	0.52	1	0.4720
Compliaction	0.00659	0.00	1	0.9464
Regimen	0.03678	0.17	1	0.6802
Spdrty	0.07778	0.80	1	0.3710
SBP	-0.02872	0.09	1	0.7676
DBP	-0.06502	0.51	1	0.4744
Weight	-0.04571	0.20	1	0.6532
Smoker	-0.18909	4.70	1	0.301
global test		17.62	11	0.0908

It is the fact that the violation of proportionality of hazard assumption is the critical problem of Cox proportional hazard analysis. Thus, checking the assumption of the model and its validity is a must. The assumption of the Cox proportional hazard model can be checked by global test and graphical techniques (Schoenfeld residuals). The chi-square =17.62 with the degree of freedom 11 and p-value=0.0908 is statistically insignificant. Thus, the assumption of the Cox proportional model is met (Table 4).

3.4.2. Model Goodness of Fit

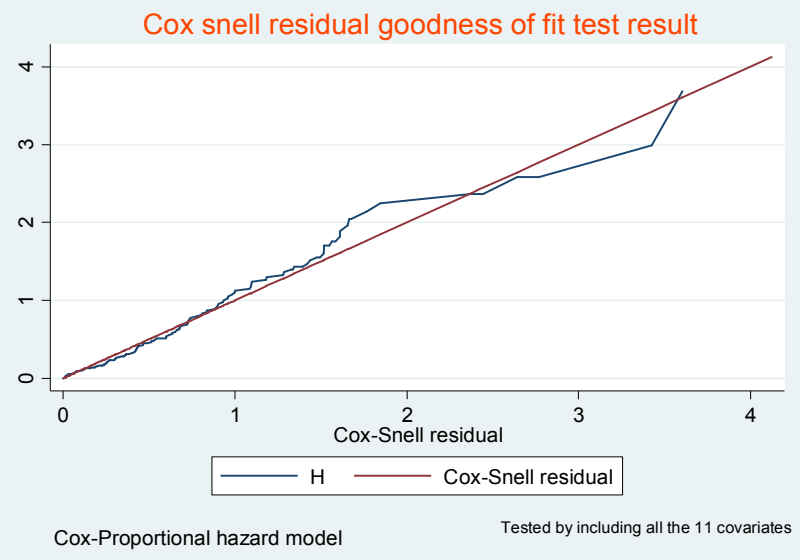

Figure 8. *Cox-snell residual goodness of fit graph for Cox-PH model.*

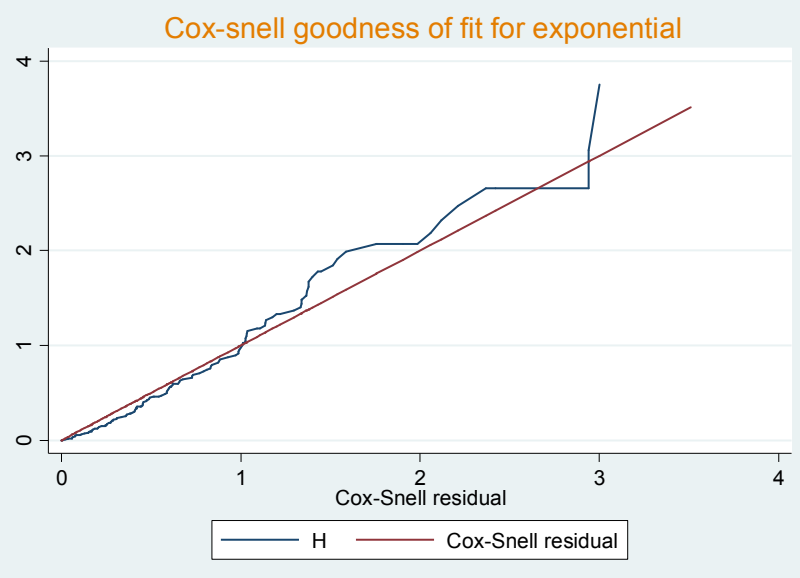

Figure 9. *Cox-snell residual goodness of fit graph for Exponential distribution.*

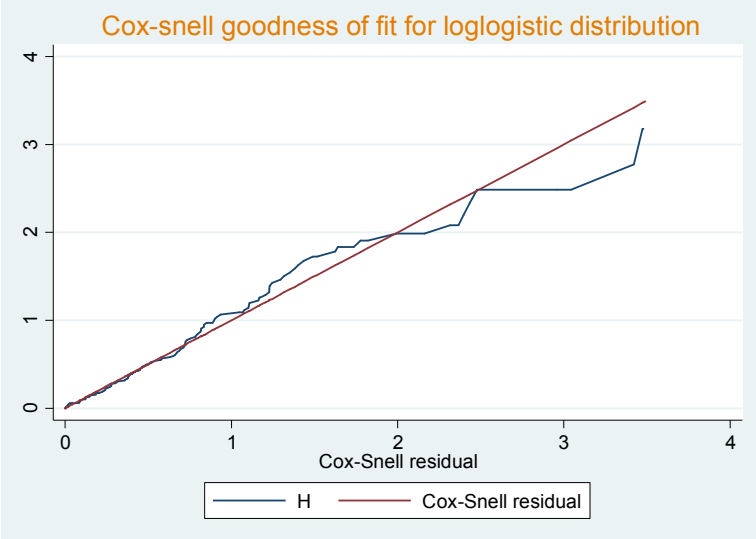

Figure 10. *Cox-snell residual goodness of fit graph for Log-logistic distribution.*

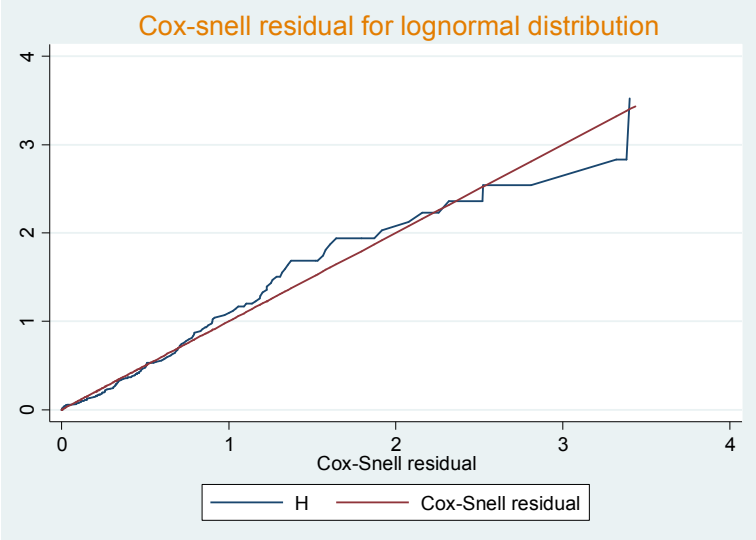

Figure 11. *Cox-snell residual goodness of fit graph for Log-normal distribution.*

So Cox-snell residual goodness of fit graph also shows that Cox proportional model is the good model which fit our data when compared with other parametric survival distribution as the line follows 45° slightly even if there is some deviation at some point as shown above (Figures 8-11).

3.5. Predictors of Time-to-Recovery from Type II Diabetic Patients

In order to select variables in the model, first bivariate Cox regression analysis was used to check all the covariates associated with time to recovery. Accordingly, the Univariate Cox proportional hazards regression models were fitted for every covariate shown on table 5. In this study, Predictors that had association at a p-value of <0.2 in bivariate Cox regression and non-collinear independent variables were included in multivariable Cox regression. Variables which are associated at this p values were: sex (p=0.03), Past Medical hx (p=0.061), Complication (p=0.076), Spdrty (p=0.009) and Weight (p=0.042). Then the multivariate Cox PH model is fitted including the five (5) covariates which are significant at 0.25 p-values. So from Multivariate analysis the following covariates were identified as a significant predictors of time to recovery from type II diabetes mellitus: weight (p=0.042, AHR=1.017), Spdrty (p=0.022, AHR=6.141) and Regular (p=0.015, AHR=4.739) (Table 6).

For every 1 unit (1kg) increase in weight of the patient, the probability of early recovery from type 2 diabetes mellitus will increase by 1.7% weeks (AHR=1.017, 95%CI=1.001-1.033). Form Specific drug (treatment) type order by Physician (Spdrty variable), Type 2 diabetic patients who taken "HCT (hydrochlorothiazide)" had 6.141 times more chance of early recovery from the disease compared to those patients who have taken "Doanied". This implies that those type 2 diabetic patients whom "HCT" was ordered by physician for them were 6 times more chance of early recovery from type 2 DM. Similarly type 2 diabetic patients who taken "Regular" had 4.739 times more chance of early recovery from the disease compared to those patients who

have taken “Doanied”.

Table 5. *Bivariate Cox-PH model for diabetic patients.*

Variables	Category	B	SE	Wald	df	Sig.	Exp(B)
Sex	Female	Reference					
	Male	0.409	.189	4.690	1	0.030*	1.505
Age		-0.001	.007	.012	1	0.913	.999
Past Medical hx	Yes	Reference					
	No	0.375	.200	3.515	1	0.061*	1.455
Family History	Yes	Reference					
	No	-0.095	.203	.220	1	0.639	.909
Complication	Yes	Reference					
	No	0.391	.220	3.152	1	0.076*	1.478
Systolic blood pressure		-0.004	.005	.614	1	0.433	.996
Diastolic blood pressure		0.003	.009	.150	1	0.699	1.003
Weight		0.016	.008	4.116	1	0.042*	1.016
smoking cigarette	Yes	Reference					
	No	-0.071	.189	.140	1	0.708	.932
	Oral agent	Reference					
Regimen	insulin agent	0.139	.218	0.407	1	0.524	1.149
	Oral and Insulin agents	-0.249	.287	0.752	1	0.780	1.368
Spdrty	Doanied	Reference					
	HCT	2.277	.770	8.754	1	.003	9.749
	metformin	-1.002	1.025	.956	1	.328	.367
	monotend	.093	.232	.160	1	.690	1.097
	Lute	-7.717	214.206	.001	1	.971	.000
	Regular	1.758	.625	7.906	1	.005	5.800
	all oral	-.012	.285	.002	1	.967	.988

Table 6. *Multivariable Cox-PH model for diabetic patients.*

Variables	Category	B	SE	Df	Sig.	AHR	95.0% CI for AHR	
							Lower	Upper
sex	Female	Reference				1		
	Male	.860	.193	1	.004*	1.428	.590	1.256
age		1.03	0.45	1	0.004	1.060	0.361	2.651
smoking cigarette	No	Reference						
	Yes	2.28	.216	1	0.001	5.198	0.126	2.456
Family history	No	Reference				1		
	Yes	.573	.255	1	.001	.331	.348	.944
Compliaction	No	Reference				1		
	Yes	1.37	1.93	1	0.043	1.876	0.94	.996
Weight		.017	.008	1	.042*	1.017	1.001	1.033
	Doaneied	Reference				1		
	HCT	1.815	.791	1	.022*	6.141	1.302	28.960
	Metformin	-.996	1.045	1	.340	.369	.048	2.862
Spdrty	Monotend	.000	.239	1	1.00	1.00	.626	1.597
	Lute	-7.17	216.98	1	.974	.001	.000	3.8E+181
	Regular	1.556	.638	1	.015*	4.739	1.358	16.539
	All oral	.036	.299	1	.904	1.037	.577	1.863

4. Discussion

The main aim of this study was to identify factors affecting the recovery time of type 2 diabetic patients data set, which was obtained from Debre Berhan Specialized Hospital clinical register of type 2 DM patients. The Cox-PH model was applied for this data since the assumption of the Cox-PH model was not violated and after comparison of models Cox-snell residual for the model goodness of fit graph is sketched. So the final model which fitted our data sets well was the Cox-PH model.

From 151 type 2 diabetic patients included in the study, 116 (76.8%) participants were recovered and the remaining 35 (23.2%) were censored. The minimum and maximum recovery times of type II diabetes were 1 and 316, weeks respectively. The median recovering time of the type 2 diabetic patients was 38 weeks.

By considering multivariable analysis results from Standard Cox-PH, the recovery time of type 2 diabetic patients was significantly affected by the weight of the patient and Specific drug(treatment) type order by Physician (Spdrty) variables specifically those who taken HCT and Regular when compared with those who taken Doanied [16].

In this study, the recovery time of diabetic patients was significantly affected by Spdrty and the expected hazard is 6.141 times higher among type 2 DM patients who taken HCT than diabetic patients who taken Doanied [13, 17]. As

well as expected hazard is 4.739 times among type 2 diabetic patients who took Regular than diabetic patients who took Doanied. This implies two result implies that there is early recovery time for type 2 diabetic patients who have taken HCT and Regular when compared with those patients who have taken Doanied [17, 18]. However, the study done in Addis Ababa at Minlik Referral Hospital showed that the recovery time of diabetic patients was significantly affected by Spdrty and the expected hazard was 1.164 times higher in the patients who had taken Lute than diabetic patients who took Doanied. Or, there is a 16.4% increase in the expected hazard in the patients who took Lute relative to diabetic patients who had taken Doanied. This study was consistent with the current study. This difference might be due to a difference in sample size [5, 8].

Additionally in this study weight of the patient was another variable which was significantly associated with time to recovery from type 2 diabetes mellitus and the expected hazard is 1.017. This implies that for one (1) unit increase in the weight of the patient the expected hazard increases by 0.017. Or for a 1 unit increase in weight of the patient, there is a 1.7% higher chance of early recovery from type 2 Diabetes Mellitus [19, 20]. However, a study done in Jimma University Specialized Hospital showed that body weight was one of the variables which was significantly associated with time to recovery from DM and the expected hazard was 0.979, indicating that for 1 unit increase in weight of the patient the chance of early recovery from diabetes mellitus reduced by 2.1%. This difference might be the difference in sample size and analysis model used [13, 18, 21].

5. Conclusion

This study used current data sets from diabetic patients who had received treatment at Debre Berhan Specialized Hospital for more than one time, with the goal of determining the time-to-recovery of type 2 diabetic patients and associated factors. The study comprised 151 type 2 diabetes patients, of which 116 (76.8%) were recovered and the remaining 35 (23.2%) were censored. Without controlling for other covariates, the median time to recovery from type 2 diabetes mellitus for all observations was 38 weeks, however it differed when examined between categories of different variables. Male and female participants recovered from type 2 diabetes mellitus at median times of 27 and 66 weeks, respectively. The median length to recovery for those with diabetes complications was 56 weeks, whereas those without complications took 28 weeks.

From statistical results, Spdrty, all (100%) of patients who had taken "HCT" were recovered from type 2 diabetes mellitus within the study period and neither of the patients had interrupted their follow up from study. Similarly all (100%) of the patients who had taken "Regular" were recovered from the disease within the study period. The assumption of the Cox-PH model has been checked by GLOBAL-test and the assumption of the model is not violated (table 4). In the multivariable Cox-PH model, Sex, age, family history, complications, smoking status, Weight and Spdrty being HCT and Regular are statistically significant variables at 0.05 p-values. Thus increasing of body weight and Spdrty (taking HCT and Regular) are associated with early time of recovery from type 2 DM.

The development of type 2 diabetes continues to expand in frequency, incidence, and as the main cause of human misery and mortality. Despite enormous investments in clinical treatment, research, and public health measures, there appears to be little evidence of a reduction of the rate of rise. Prevention is crucial in the fight against type 2 diabetes. Adopting a healthy lifestyle, eating a well-balanced food, and getting enough exercise on a regular basis can help lower the chance of acquiring the illness. Furthermore, boosting awareness about the need of early identification and diabetes control education is critical in fostering a healthier society. In order to reduced the overall incidence of type 2 diabetes in the country of Ethiopia, we recommend that all physicians responsible for diabetes mellitus diagnosis and therapy provide focused on people with diabetes health education as well as stringent self-care counseling. We also urge educational institutions, the Ministry of Science and Higher Education, and the Ministry of Health to educate and deploy people with diabetes health educators. facilities and promote physical exercises and enhancing social support will strongly help to overcome diabetes problem.

Limitation of the Study

Respondents may have overestimated health-related factors while underestimating socio-demographic aspects because the study employed secondary data (retrospective). To obtain aspects connected to diseases, it is best to use primary data. Another drawback was that only one institution was studied, and other hospitals in the area were not taken into account. Therefore, it is important to keep these constraints in mind while comparing and making judgments using this information.

List of Acronyms

AIC: Akaike's Information Criteria
DBP: Diastolic Blood Pressure
DM: Diabetic Mellitus
FBS: Fasting Blood Sugar
HR: Hazard Ratio
IDDM: Insulin- Dependent Diabetes Mellitus
KM: Kaplan-Meier
LR: Likelihood Ratio
NIDDM: Non-Insulin- Dependent Diabetes Mellitus
PH: Proportional Hazard
SBP: Systolic Blood Pressure
SPDRTY: Specific Drug (treatment) Ordered by Physician
T2DM: Type 2 Diabetes Mellitus
WHO: World Health Organization

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References

[1] T. F. Gebabo, T. H. Zewdie, S. S. Shagaro, and F. Haile, "Determinants of peripheral neuropathy among diabetic patients under follow-up in chronic care clinics of public hospitals at Gamo and Gofa zones , southern Ethiopia," pp. 1–9, 2021.

[2] G. Hospitals, "Determining The Recurrence of Diabetic Patients Recovery Time in Benishangul-," vol. 7, no. 1, pp. 35–47, 2022.

[3] M. Abdul *et al.*, "Epidemiology of Type 2 Diabetes – Global Burden of Disease and Forecasted Trends," vol. 10, pp. 107–111, 2020.

[4] A. Belay, B. Derebew, and S. Abebaw, "Survival Analysis on Time-To-Recovery of Diabetic Patients at Minlik Referral Hospital, Ethiopia: Retrospective Cohort Study," 2021, doi: 10.21203/rs.3.rs-1015864/v1.

[5] O. W. K. Handayani, E. Nugroho, and B. Hermawati, "Determinant of Diabetes Mellitus Focusing on Differences of Indonesian Culture: Case Studies in the Java and Outer Java Region in Indonesia," *Open Public Health J.*, vol. 13, no. 1, pp. 323–340, 2020, doi: 10.2174/1874944502013010323.

[6] H. A. Shouip, "Diabetes mellitus:," no. January, 2015.

[7] P. Metrics, "Progress in health among regions of Ethiopia, 1990 – 2019: a," vol. 6736, no. 21, pp. 1990–2019, 2022.

[8] H. Sun *et al.*, "IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045," *Diabetes Res. Clin. Pract.*, vol. 183, no. January, pp. 6–10, 2022, doi: 10.1016/j.diabres.2021.109119.

[9] N. Hamba, K. Kene, D. A. Bedane, and G. Etana, "Journal of Diabetes Research," vol. 2020, pp. 1–18, 2020.

[10] "Hosmer D. W., Lemeshow S. Applied Survival Analysis (1). pdf."

[11] A. Services, *share announcement format _ quote question _ answer search menu thumb _ up textsms share announcement format _ quote question _ answer thumb _ up textsms zoom _ out _ map*.

[12] S. Lognormal and F. Models, "Academic Editor: Patrizia D ' Amelio International Journal of Endocrinology International Journal of Endocrinology," vol. 2022, pp. 1–13, 2022.

[13] F. E. Tarekegne, M. Padyab, J. Schröders, and J. S. Williams, "Sociodemographic and behavioral characteristics associated with selfreported diagnosed diabetes mellitus in adults aged 50+ years in Ghana and South Africa: Results from the WHOSAGE wave 1," *BMJ Open Diabetes Res. Care*, vol. 6, no. 1, pp. 1–18, 2018, doi: 10.1136/bmjdrc-2017-000449.

[14] "Add to my library Page 36 Write review GET PRINT BOOK," p. 36.

[15] P. M. E. L. Kaplan, "Nonparametric Estimation from Incomplete Observations Author (s): E . L . Kaplan and Paul Meier Source: Journal of the American Statistical Association , Vol . 53 , No . 282 (Jun ., 1958), pp . 457- Published by: American Statistical Association Sta," *Am. Stat. Assoc.*, vol. 53, no. 282, pp. 457–481, 1958.

[16] C. C. Thon and C. W. Lian, "Academic Editor: Marcus Pezzolesi Journal of Diabetes Research," vol. 2016, pp. 1–12, 2016.

[17] R. Cannataro and E. Cione, "International Journal of Diabetes & Metabolic Disorders," *Researchgate. Net*, vol. 1, no. 2, pp. 1–5, doi: 10.33140/IJDMD.

[18] A. Legesse, "Retrospective Study of Recurrence and Associated Factors of Type 2 Diabetes Treated at Adama General Hospital , Oromia , Ethiopia: A Comparison of Cox-PH and Shared Lognormal Frailty Models," vol. 2022, 2022.

[19] J. P. Lea and S. B. Nicholas, "Diabetes mellitus and hypertension: key risk factors for kidney disease.," *J. Natl. Med. Assoc.*, vol. 94, no. 8 Suppl, p. 12152917, 2002.

[20] M. A. Zeru, E. Tesfa, A. A. Mitiku, A. Seyoum, and T. A. Bokoro, "Prevalence and risk factors of type-2 diabetes mellitus in Ethiopia: systematic review and meta-analysis," *Sci. Rep.*, vol. 11, no. 1, pp. 1–22, 2021, doi: 10.1038/s41598-021-01256-9.

[21] A. T. Kharroubi, "Diabetes mellitus: The epidemic of the century," *World J. Diabetes*, vol. 6, no. 6, p. 850, 2015, doi: 10.4239/wjd.v6.i6.850.

[22] Y. Gurmu, D. Gela, and F. Aga, "Factors associated with self-care practice among adult diabetes patients in West Shoa Zone, Oromia Regional State, Ethiopia," *BMC Health Serv. Res.*, vol. 18, no. 1, pp. 1–16, 2018, doi: 10.1186/s12913-018-3448-4.