COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE

DEPARTMENT OF STATISTICS

RISK FACTORS OF MORTALITY OF HIV/AIDS POSTIVE PATIENTS IN ATATHOSPITAL

A SENIOR RESERCH PROPOSAL SUBMITTED TO DEPARTMENT OF STATISTICS

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Abbreviation and Acronym

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral therapy
BMI	Body mass index
CD4	cluster of differentiation 4
EPHI	Ethiopian Public Health Institute
FDRE	Federal Democratic Republic of Ethiopia
FF	Freedom Foundation
HAART	Highly Active Antiretroviral Therapy
HAPCO	HIV/AIDS Prevention and Control Office
NCI	National Cancer Institute

OI	Opportunistic Infections
TB	Tuberculosis
UNAIDS	United Nation AIDS
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Mortality rate or death rate is a measure of the number of deaths (in general, or due to a specific cause) in a particular population, scaled to the size of that population, per unit of time. Mortality rate is typically expressed in units of deaths per 1,000 individuals per year. A mortality rate of 9.5 (out of 1,000) in a population of 1,000 would mean 9.5 deaths per year in that entire population, or 0.95% out of the total (Porta, M, 2014).

Human immune deficiency virus is a cause of reducing a person's ability to fight infection by reducing CD4 cell which is responsible for the body's immune response to infectious agents. Virus that is transmitted through certain body fluids and weakens the immune system by destroying cells that fight disease and infection, specifically CD4 cells (often called T cells). HIV reduces the number of CD4 cells in the body, making it more difficult for the immune system to fight off infections and other diseases. HIV can lead to the development of AIDS, acquired immunodeficiency syndrome (Zeger SL and Diggle PJ, 2016).

The human immunodeficiency virus (HIV) is the virus that causes acquired immune deficiency syndrome (AIDS). Once the virus is in the human body, it multiplies and acts by weakening the immune system. The immune system produces special cells called antibodies to stave off microorganisms that might infect the body. With a weakened immune system, however, the body is highly susceptible to infections and is less able to fight off disease eventually AIDS is case of deaths. And affect among the primary public health challenges that have affected the world's social, economic and political system in the recent past. During the last three decades, millions of people died due to HIV infection. In the year 2012, more than 1.6 million AIDS deaths were recorded (UNAIDS, 2013).

HIV/AIDS continues to be a major global public health issue and thus far, has claimed the lives of more than 34 million people worldwide. In 2014, approximately 1.2 (1.0–1.5) million people died from HIV-related causes (FDRE, 2014).

Since the start of the epidemic, an estimated 74.9 million people have become infected with HIV and 32 million people have died of AIDS-related illnesses. In 2018, 770,000 people died of AIDS-related illnesses. This number has reduced by more than 55% since the peak of 1.7 million in 2004 and 1.4 million in 2010(UNAIDS, 2019).

Human immune deficiency virus (HIV) infection causes a large proportion of morbidity and mortality worldwide despite the availability of highly active antiretroviral therapy (HAART). Since the first outbreak of HIV in 1981, an estimated 39 million individuals have lost their lives to this illness (UNAIDS, 2014). However, there has been a decline as can be seen by the 35% drop in HIV-related deaths since its peak in 2005(UNAIDS, 2014). Organizations such as UNAIDS and the World Health Organization (WHO) responded to the global burden of HIV/AIDS as they began to invest money and resources into combating this disease, focusing efforts on antiretroviral drug distribution. Though significant progress has been made towards the goal of controlling HIV/AIDS worldwide, 38.0 million [31.6 million–44.5 million] people globally were living with HIV in 2019. And 1.7 million [1.2 million–2.2 million] people became newly infected with HIV in 2019. 690 000 [500 000–970 000] people died from AIDS-related illnesses in 2019. And 770 000 [570 000−1 100 000] people died of HIV-related illnesses worldwide in 2018. Expanded access to antiretroviral therapy (ART) and a declining incidence of HIV infections have led to a steep fall globally in the number of adults and children dying from HIV-related causes. The estimated 770 000 [570 000−1 100 000] people dying from HIV globally in 2018 were 56% fewer than in 2004 (the peak) and 33% fewer than in 2010 in spite of a period of substantial population growth in many high burden countries (WHO,2015).

AIDS in Africa is one of the biggest humanitarian disasters of our time more than one million adults and children die every year from HIV/AIDS in Africa alone. HIV/AIDS originated in Africa in the early 20th century and is a major public health concern and cause of death in many African countries. AIDS rates vary dramatically although the majority of cases are concentrated in Southern Africa. Although the continent is home to about 15.2% of the world's population more than two-thirds of the total infected worldwide – some 35 million people – were Africans, of whom 15 million have already died(Appiah A and Gates HL, 2010).

The vast majority of people living with HIV are located in low- and middle- income countries, with an estimated 68% living in sub-Saharan Africa. Among this group 20.6 million are living in East and Southern Africa which saw 800,000 new HIV infections in 2018(UNAIDS, 2019).

HIV/AIDS is one of the most fatal infectious diseases across Sub-Saharan Africa, where the disease has had a massive impact on health outcomes and life expectancy in recent decades. Sub alone accounted for an estimated 69 percent of all people living with hived 70 percent of all AIDS deaths in 2011(UNAIDS,2013). In the countries of sub-Saharan Africa most affected, AIDS has raised death rates and lowered life expectancy among adults between the ages of 20 and 49 by about twenty years (Appiah A and Gates HL, 2010).The burden of the disease is, very high in the Sub-Saharan African region. Even though only 12.5% of the world's population is living in this region, about 68% of the world's HIV infected population is found there (B. Sibhatu et al, 2015). According to a 2013 report, the sub-Saharan African region covers 74% of HIV-related deaths (WHO, 2013).

Ethiopia, as one of the sub-Saharan region countries, has one of the largest populations of HIV infected people in the world (HAPCO, 2010). There are about 1.2 million HIV infected people in Ethiopia. An estimated prevalence of HIV/AIDS in the adult Ethiopian population is 2.4% with the incidence rate of 0.29% (Negassi N.T, et al, 2016).

In Ethiopia, it has been estimated that approximately 45,200 (36,500–55,200) deaths were related to AIDS and that 793,700 (716,300–893,200) people were living with HIV in 2013 (FDRE, 2013). In Amhara region, it has been estimated that approximately 21967(38.54%) deaths were related to AIDS and that 56993 (61.46%) people were living with HIV in 2017(EPHI, 2017).

Effective treatment with antiretroviral drugs can control the infection and the disease, and allow HIV-infected people to enjoy healthy and productive lives. Different clinical, demographic, socio-economic, and behavioural factors have been reported to be related to the survival of HIV positive-infected patients under ART (Madhavan S., et al, 2014).

The burden of HIV/AIDS remains high in Ethiopia despite a considerable scale up of comprehensive HIV/AIDS interventions during the MDG period. In 2016, there were about 718,500 people living with HIV/AIDS (FMOH, 2015). The 2017 UNAID global AIDS report revealed that the number of new HIV infections in Ethiopia were higher in 2016 than in 2010 (UNAIDS, 2016).

In Ethiopia, factors such as severe anemia, a history of co-infection with tuberculosis (TB), marital status, WHO stage, low CD4 counts, poor adherence to ART, substance use, and opportunistic infections, were also found to be important determinants of HIV positive -related deaths (Tachbele E, et al,2016).

Lastly, the aim of this proposed study is to determine overall mortality rate of HIV positive patient.And also helps decision makers to allocate resources based on the burden of HIV/AIDS. And summarize the main predictors of mortality in these patient groups in Atat Hospital.

1.2Statement of the Problem

The scale of the HIV positive patient epidemic has exceeded all expectations since its identification 20 years ago. Globally, an estimated 36 million people are currently living with HIV, and some 20million people have already died, with the worst of the epidemic centered on sub-Saharan Africa. But just as the spread of HIV has been greater than predicted, so too has been its impact on social capital, population structure and economic growth. Responding to AIDS on a scale commensurate with the epidemic is a global imperative, and the tools for an effective response are known. Nothing less than a sustained social mobilization is necessary to combat one of the most serious crises facing human development (Bartos M, et al, 2017)

Despite massive national efforts to scale up Antiretroviral Therapy (ART) access in Ethiopia since 2010, the AIDS death rate was 17.2 per 100,000 persons during 2010. In the era of HAART in resource poor settings, it is imperative to understand and address the causes of AIDS related mortality. This proposed study aimed at defining the predictors of mortality among people living with HIV/AIDS.

The research questions which address by the study will be:

- What are the determinants of mortality of HIV positive patient in Atat Hospital?
- What is the overall mortality rate of HIV positive patient in Atat Hospital?
- Is there any association between mortality status of HIV positive patients with their covariates or risk factor?

1.3 Objectives of the study

1.3.1 General objective

- The general objective of this study is to identify the risk factor of mortality of HIV positive patient in Atat Hospital.

1.3.2 Specific objectives

- To identify the main risk factors for mortality of HIV positive patients.
- To determine the prevalence of mortality associated with of HIV positive patient in Atat Hospital
- To assess predictors of mortality in HIV-infected patients starting ART in Atat Hospital

- To investigate the association between mortality status of HIV positive patients with their covariates

1.4Significance of the Study

This study was focuses on the risk factor of mortality of HIV/AIDS patients in Atat Hospital. The study was providing the possible way to identify and describe factors associated with mortality among HIV infected patients. And to asses prevalence of death among HIV infected patients in Atat Hospital.

1.5The Scope of the Study

This study was covered only the HIV positive patient in Atat Hospital. Would be conducted using the possible risk factor of mortality relate with HIV positive patients.

1.6 Limitation of study

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of HIV/ AIDS

HIV/AIDS is among the primary public health challenges that have affected the world's social, economic, and political system in the recent past. And millions of people died due to HIV infection. In the year 2012, more than 1.6 million AIDS deaths were recorded (UNAIDS, 2013). The burden of the disease is very high in the sub-Saharan African region. Even though only 12.5% of the world's population is living in this region, about 68% of the world's HIV infected population is found there (Sibhatu, N. et al,2015). According to a 2013 report, the sub-Saharan African region covers 74% of HIV-related deaths (WHO, 2013). Ethiopia, as one of the sub-Saharan region countries, has one of the largest populations of HIV infected people in the world (HAPCOF,2010). There are about 1.2 million HIV infected people in Ethiopia. An estimated prevalence of HIV/AIDS in the adult Ethiopian population is 2.4% with the incidence rate of 0.29% (Negassi N.T, et al, 2016).

Human immune deficiency virus is a cause of reducing a person's ability to fight infection by reducing CD4 cell which is responsible for the body's immune response to infectious agents. Virus that is transmitted through certain body fluids and weakens the immune system by destroying cells that fight disease and infection, specifically CD4 cells (often called T cells). Left untreated, HIV reduces the number of CD4 cells in the body, making it more difficult for the immune system to fight off infections and other diseases. HIV can lead to the development of AIDS, "acquired immunodeficiency syndrome (Zeger SL and Diggle PJ, 2016).

2.2 Overview of Mortality

Mortality refers to the state of being mortal (destined to die). In medicine, a term also used for death rate, or the number of deaths in a certain group of people in a certain period of time. Mortality may be reported for people who have a certain disease, live in one area of the country, or who are of a certain gender, age, or ethnic group (NCI, 2017).

Mortality statistics, including causes of death, are the foundation of public health planning, monitoring and evaluation of interventions. Yet, the overwhelming majority of low- and middle-income countries do not have reliable mortality statistics. Out of 119 countries reporting causes of death to the WHO, only 34 countries – representing 15% of the world population – produce high-quality cause-of-death data, and almost all of these countries are in Europe and the Americas. A further 85 countries representing 65% of the world population produce lower-quality cause-of-death data, while 74 countries, mostly in Sub-Saharan Africa lack such data altogether. The 1990s saw a substantial increase in the number of people infected with HIV and dying of AIDS. In 1997, almost 3.5 million people were diagnosed with HIV per year. After 1997, the number of new diagnoses began to decline and in 2015 it was reduced to 2.1 million per year. The number of AIDS-related deaths increased throughout the 1990s and reached a peak in 2004, 2005 when in both years 2 million people died. Sincethe annual number of deaths from AIDS declined as well and a decade later it was almost halved when 1.1 million people died in 2015(WHO, 2015)

The vast majority of people living with HIV are located in low- and middle- income countries, with an estimated 68% living in sub-Saharan Africa. Among this group 20.6 million are living in East and Southern Africa which saw 800,000 new HIV infections in 2018(UNAIDS, 2019).

2.3Empirical Literature Review

According to (Mugusi SF, et al, 2011) common presenting symptoms in HIV-only patients were weight loss, while in HIV-TB patients the symptoms were weight loss. HIV-TB patients had significantly lower body mass index compared to those infected with HIV only, despite similar baseline CD4 (+) T-cell counts. Overall, HIV patients developed TB and HIV-TB patients had worsening of their TB symptoms during the study period. Mortality was similar in HIV-only and HIV-TB patients. Overall, more males died compared to females. Predictors of mortality were presence of low baseline white blood cell and CD4 (+) T-cell counts. The mortality of outcomes following well-supervised treatment of HIV-TB patients is similar to those in patients with HIValone.

A study conducted by (Mohammed B.A., 2017) usingdemographic and clinical characteristics as a predictor for death in his studies, the most frequently mentioned were advanced stage disease (stage III and stage IV), nonworking functional status (bedridden and ambulatory), low CD4 count, TB confection, older age, lower weight, and lower baseline BMI. Patients who started ART after they developed advanced stage disease are more likely to die than patients who started ART while they are in stage I or II. Patients who are bedridden and ambulatory are more likely to die than those who have a working functional status. Some studies express the effect of CD4 count as a continuous variable and demonstrated that the risk of death decreases as the CD4 at initiation of ART rises. Other studies reported that CD4< 50 cells/micro litter at ART initiation increases the risk of death. TB-HIV confection increases the risk of mortality fold and the higher rate of mortality in males than females because of the males' higher tendency for drug abuse than females in Ethiopia. Earlier health seeking behaviour of females might also be a reason for lesser mortality among females than males. Furthermore, the risk of death is higher for patients with low baseline CD4 count. The CD4 count is a reflectionof the patients' immune status, so when it becomes low, the risk of developing opportunistic infections will increase, which may finally lead to death. Low CD4 count at initiation of ART was mentioned as the main predictor of death in HIV patients in various studies.

According to Melaku T. (2018) there were 91 deaths from 600 patients, yielding death prevalence density are around 16 out of 100. The independent predictors of mortality were WHO clinical stage, low weight, low CD4 count and TB co-infection. The estimated survival probability live of the cohort in 14 years were 84%. The result from this study shows patients with higher CD4 level have a smaller risk of mortality which is directly related with the study. A weight increase cause to reduce mortality. Body mass index may be affected by late WHO clinical stage AIDS conditions. A patient with TB co morbidity was highly associated with an increased risk of mortality. The probability of death for patients with world health organization stage one lower than those patients who were world health organization stage IV the risk of death may have an impact on the study result consequently an investigation with the reason behind dropout from ART is also highly appreciated

CHAPTER THREE

METHODOLOGY

3.1Study Area

This study would be conducted in Atat Hospital, Cheha district, Gurage zone, southern nation nationality of people regional states (SNNPR) of Ethiopia. This is located 187km away to the south west of Addis Ababa. Located in latitude of 8° 10’ 35” N and longitude of 37° 47’ 21” E. The Hospital has been providing services since 1969, owned by the Ethiopian Catholic Church, and managed by medical mission sisters, an international religious congregation.

3.2 Study population

The target population in this study was the number of HIV positive patients in Atat Hospital.

3.3 Study design

Hospital based retrospective cross sectional study design would be used.

3.4 Sampling Techniques

Sampling techniques helps a lot in research. It is one of the most important factors which determine the accuracy of your research/survey result. If anything goes wrong with your sample then it will be directly reflected in the final result.In this study we used simple random sampling method.

3.4.1Sample Size Determination

The target population of this study was the mortality status of HIV positive patients inAtat hospital. Determining the sample size is the key on the overall statistical process. An appropriate sample is one of the means of gaining high precisions, accuracy and confidence with minimum cost Cochran (1977).

Since there is no prior work in this area regarding to our title. As result we use

$\alpha = 0.05,\ Z\alpha/_2 = 1.96, p = 0.5, q = 1 - p = 0.5$ and $d = 5\%$

Where

P=proportion of success which is the patient death

Q=proportion of failure which is the patients alive

d=marginal error

α=level of significant which is 0.05

$z_{\alpha/2}$ =the accuracy level of significance taken as 1.96

$n_0 = \frac{Z_{\alpha/2}{}^2 pq}{d^2}$ $n_0 = \frac{Z_{.05/2}{}^2 0.5*0.5}{0.05^2} = \frac{1.96^2 0.5*0.5}{0.05^2}$ = 384.16≈384

Then:

$$n = \frac{n_0}{(1 + n_0/N)}$$

$n = \frac{384}{(1+\frac{384}{807})} = \frac{384}{1+0.4758364}$ =260.19141≈260

3.5Method of data collection

There are two major methods of data collections namely; the Primary method of data collection and secondary method of data collections. Primary data collation is used to collect raw data from respondents through observation, personal interview, and questioner. On the other hand, data which are not originally collected but obtained from published or unpublished sources are known as secondary data. In this proposed study we use the secondary (recorded) data which is obtained from Atat Hospital.

3.6Study Variable

3.6.1 Response Variable

Dependent variable: - The mortality status of HIV positive patient following ART which is binary variable (y= 1, if the patient's death) and (y = 0 if they are alive).

3.6.2Explanatory variable

Also known as the independent or predictor variable. The appropriate predictor variable for the mortality status of HIV positive patients are:

- ✓ Sex (male, female)
- ✓ Age
- ✓ Functional status (Working, Ambulatory, Bedridden)
- ✓ Weight in kilo gram
- ✓ WHO clinical stage (Stage I, Stage II, Stage III, Stage IV)
- ✓ Marital status

- ✓ Baseline Body mass index (BMI)
- ✓ History of substance use
- ✓ Tuberculosis (yes, no)
- ✓ Baseline drug Regimen type (AZT-based, D4T-based)
- ✓ Educational level
- ✓ Adherence
- ✓ CD4
- ✓ Drugs side effect
- ✓ Residence
- ✓ Occupation

3.7Methods of Data Analysis

In this study the data would be analysed using descriptive statistics and inferential statistics

3.7.1Descriptive Statistics

Descriptive statistics are brief describe that summarize a given data set, which can be either a representation of the entire population. Therefor descriptive statistics used for this study are pie chart, proportion, crosstabulationand frequency distribution.

3.7.2Inferential Statistics

Inferential statistics are type of statistics that deals with making inference or conclusion about the population based on sample taken from the population by considering their characteristics of the study.

3.7.2.1 Chi-square test of independence

The Chi-square test is intended to test how likely it is that an observed distribution is due to chance. It is also called a "goodness of fit" statistic, because it measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent

Chi-square test would be used to assess whether two variables are associated.

Here chi-square test use for the test of independency.

This is skewed to the right and random variable can never negative value.

Chi-square statistics is given by

$$\chi^2_{cal} = \sum_{i=1}^{i} \sum_{j=1}^{j} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Where O_{ij} = observed value and

e_{ij} =Expected value

χ^2_{cal}=Chi-square statistics

The Test statistics used for chi square is;

$$\chi^2_{cal} = \sum_{i=1}^{i} \sum_{j=1}^{j} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Null hypothesis: there is no association (independent) between mortality status outcome and independent variables of HIV/AIDS patient in Atat Hospital.

Alternative Hypothesis: there is association between mortality status outcome and independent variables of HIV/AIDS patient in Atat Hospital.

Assumption of Chi-square statistics

- ✓ The category should be mutually exclusive and independent.
- ✓ The data should be in certain category.
- ✓ Data(subject) must not be measured over time.

3.7.2.2BinaryLogistic regression analysis

Logistic regression is the appropriate regression analysis to conduct when the dependent variable is dichotomous (binary). Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

In this study the inferential statistics going to used logistic regression model. The dependent variable was mortality status and it is qualitative form which two possibilities; the patients those who have dead and the patients those who alive.

The model for p-explanatory variables (i.e, x_1, x_2… x_p) is given by

Where π(x) is the conditional probability of success and is given by

$$\pi_{(x)} = \frac{e^{(\alpha+\beta_1 X_1+\beta_2 X_2+\dots\beta_i X_i)}}{1+e^{(\alpha+\beta_1 X_1+\beta_2 X_2+\dots\beta_i X_i)}}$$

Which expressed by logit functions

Logit (π(x)) =log ($\frac{\pi(x)}{1-\pi(x)}$) = $\alpha+\beta 1 x_{1i}+\beta 2 x_{2i}+\ldots+\beta_k x_i$

Where, $\alpha, \beta_1 \ldots \beta_k$ are the model parameters

Suppose that the mortality status is denoted by "Y" which has binary values. When Y=1, it shows the patients dead and y=0, it shows the patients alive.

$$Y = \begin{cases} \mathbf{1}=\text{died} \\ \mathbf{0}=\text{alive} \end{cases}$$

If π(x) is the probability that the patients with dead.

1-π(x)Will be the probability that the patients alive.

This means, that $\frac{\pi(x)}{1-\pi(x)}$will be the odds that, the selection of patients with dead.

Odds Ratio (OR):is the measure of how much the greater or less the odds are to subjects possessing the risk factor to experience a particular outcome.

In terms of odd ratio, the logistic regression model can be written as

Which means that exp (β_i), i =1, 2... K is the factor by which the odd of occurrence of success change by a unit increases in the i^{th} independent variable.

Assumption of Logistic Regression

- ✓ Logistic regression is the appropriate regression analysis to conduct when the dependent variable is dichotomous (binary).

- ✓ Logistic regression model has linear form for the logit of probability of success. Which means linear in log transformation.
- ✓ In Logistic regression model can use both continues and categorical predictors variable
- ✓ In logistic regression residuals follow a binomial rather than a normal distribution.

3.7.3Estimation of Parameter

3.7.3.1 Maximum likely hood ratio estimation

The goal of logistic regression is to estimate unknown parameters; this parameter estimation involves maximum likelihood estimation. The logistic regression uses maximum likely-hood estimation after transforming the dependent in to a logic variable. The parametric approach to statistical modeling of family of probability distribution is the binomial for the response variable. For the binomial outcome of y success in n trial the maximum likely hood estimation equals $P=\frac{y}{n}$ this is the sample proportion success for the n trial (Agrestic, A1996).

The likelihood-ratio test statistic is given by: -

$G^2=-2\log(L_0/L_1)=-2[\log(L_0)-\log(L_1)]$

Where, L_0 is the log likelihood value of the model which has the intercept term only and $L_1$is the log likelihood value of the full model.

3.7.4Model Adequacy Checking

3.9.4.1 Wald Test

The Wald test is a parametric statistical test named after the statistician Abraham Wald. Whenever a relationship within or between data items can be expressed as a statistical model with parameters to be estimated from a sample, the Wald test can be used to test the true value of the parameter based on the sample estimate.

Testing hypotheses

H_o: $B_j=0$

H_a: $B_j\neq0$

Wald Test

$$t = \frac{\beta_{j-\beta_0}}{\sqrt{var(\beta_j)}}$$

3.9.4.2 Likelihood Ratio Test

Is a statistical used for comparing the goodness of fit of two statistical models a null model against an alternative model? The test is based on the likelihood ratio, which expresses how many times more likely the data are under one model than the other. This likelihood ratio, or equivalently its logarithm can then be used to compute a *p*-value or compared to a critical value to decide whether to reject the null model.

The likelihood ratio test is used to test the null hypothesis that any subset of the betas is equal to 0. The number of betas in the full model is *p*, while the number of betas in the reduced model is *r*. (Remember the reduced model is the model that results when the betas in the null hypothesis are set to 0.) Thus, the number of betas being tested in the null hypothesis is \(p-r\). Then the likelihood ratio test statistic is given by

$$-2\log\frac{L_0}{L_1}$$

3.7.5Goodness of Fit of the Model

3.7.5.1 Deviance test

This model has a separate parameter for each observation, and it provides a perfect fit to the data. The model is said to be saturated.

Assessing goodness of fit involves investigating how close values predicted by the model with that of observed values (Be wick and Jonathan, 2005). The comparison of observed to predicted values using the likelihood function is based on the statistic called deviance.

Let LM denote the maximized log-likelihood value for a model M of interest.

Let LS denote the maximized log-likelihood value for the most complex model possible.

The deviance of a GLM is defined as

$$\text{Deviance} = -2[LM - LS]$$

Its maximized log likelihood LS is at least as large as the maximized log likelihood LM for a simpler model M.

3.7.5.2 Hosmer-Lemeshow test

The Hosmer-Lemeshow test is a statistical test for goodness of fit for the logistic regression model. The data are divided into approximately ten groups defined by increasing order of estimated risk. The observed and expected number of cases in each group is calculated and a Chi-squared statistic is calculated as follows:

$$x^2{}_{HL=}\sum_{g=1}^{G}\frac{(O_g - E_g)}{E_{g(1-E_{g/n_g})}}$$

With O_g, E_g and n_g the observed events, expected events and number of observations for the g^{th} risk decile group, and G the number of groups. The test statistic follows a Chi-squared distribution with $G-2$ degrees of freedom.

A large value of Chi-squared (with small p-value < 0.05) indicates poor fit and small Chi-squared values (with larger p-value closer to 1) indicate a good logistic regression model fit).

An alternative statistic for measuring overall goodness-of-fit is Hosmer-Lemeshow statistic.

Note: we use one predictor model here, that is, at least one parent smokes.

This is a Pearson-like χ^2 that is computed after data are grouped by having similar predicted probabilities. It is more useful when there is more than one predictor and/or continuous predictors in the model too. We will see more on this later, and in your homework.

H_0: the current model fits well vs

H_A: the current model does not fit well

To calculate this statistic:

1. Group the observations according to model-predicted probabilities (πi).
2. The number of groups is typically determined such that there is roughly an equal number of an observation per group.
3. Hosmer-Lemeshow (HL) statistic, a Pearson-like chi-square statistic, is computed on the grouped data, but does NOT have a limiting chi-square distribution because the observations in groups are not from identical trials. Simulations have shown, that this statistic can be approximated by chi-squared distribution with df = g − 2 where *g* is the number of groups

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Descriptive Statistics Analyses

We used descriptive statistics such as frequency distribution to explain the general characteristics of some attribute in the study. After all the necessary data is gathered from Atat Hospital. The descriptive result of the study can be simply seen from the following tables.

Table4.1 Summary of descriptive statistics of mortality of HIV infected patients

Variable	Categories	Mortality status			
		death	alive	total	Percentage of death
Tuberculosis	yes	33	23	56	58.9%
	no	33	153	186	17.7%
Residence	rural	55	132	187	28.4%
	urban	11	44	55	20%
base line functional status	working	32	95	127	25.2%
	ambulatory	24	69	93	25.8%
	bedridden	10	12	22	45.5%
drug side effect	yes	26	38	64	40.6%
	no	40	138	178	22.5%
CD4	<=200	28	64	92	30.4%
	>200	38	112	150	25.3%
Sex	male	27	74	101	26.7%
	female	39	102	141	27.7%
AGG	15-24	12	20	32	37.5%
	25-34	16	63	79	20.3%
	35-44	15	57	72	20.8
	45-54	16	31	47	34%

	55-64	5	2	7	71.4%
	>=65	2	3	5	40%
occupational respondent	Merchant	15	42	57	26.3%
	NGO employ	8	7	15	53.8%
	Government employ	7	18	25	28%
	Jobless	19	41	60	31.7%
	Daily labor	6	16	22	27.7%
	farmer	9	32	41	22%
	House wife	2	20	22	9.1%
marital status	Single	22	28	50	44%
	Married	26	99	125	20.8%
	Divorced	10	97	37	27%
	Windowed	8	22	30	26.7%
educational status	No education	30	58	88	34.1%
	primary	21	70	91	23.1%
	secondary	13	42	55	23.6%
	Above secondary	2	6	8	25%
Who clinical stage	Stage I	20	61	81	24.7%
	Stage II	20	70	90	22.2%
	Stage III	24	41	65	36.9%
	Stage IV	2	4	6	33.3%
BMI	<20	32	84	116	27.6%
	>=20	34	92	126	27%

A total of 242 are eligible for this study. Among the patients, 66 (27.3%) of them died while 176 (72.7%) were alive. As it is shown in Table1, the proportion of mortality of patients was higher for patients who were TB positives (58.9%) than for patients who were TB negatives (17.7%). The proportion of mortality of patients was higher for those who live rural areas 29.4 than the urban areas (20%). Similarly, the proportion mortality of female patients is higher (27.7%) than male patients (26.7%). With regard to their age, the proportion of mortality of patients was higher for patients aged higher than 65 years (40%) than other age interval.

The highest proportion of mortality of patients was observed for patients who were single (44.0%) while it was lowest for patients who were married (20.8%). Similarly, the proportion of mortality of patients was highest for patients who have no education (34.1%) as opposed to the lowest proportion of mortality of patients for those patients whose level of education was primary (26.1%).

The proportion of mortality of HIV infected patients who were bedridden (45.5%) is higher than for the patients who were for other base line functional status and as opposed to the lowest proportion of mortality of patients for those patients are working (25.2%).

The proportion of mortality of patients was higher for those whose BMI 20 or less than (27.6%) than the patients whose BMI was above 20(27%). Similarly, the proportion of mortality of the patients was higher for those patients whose baselineCD4 count was 200 or less than (30.4%) than the patients whose baselineCD4 count was above 200 (25.3%). And the highest proportion of mortality of patients was observed for patients who were who clinical stage III (36.9%) while it was lowest for patients who clinical stage II (22.2%). The occupational respondent of NGO employs also higher proportion of mortality of patients

4.2 Descriptive Statistics Analyses using frequency distribution char

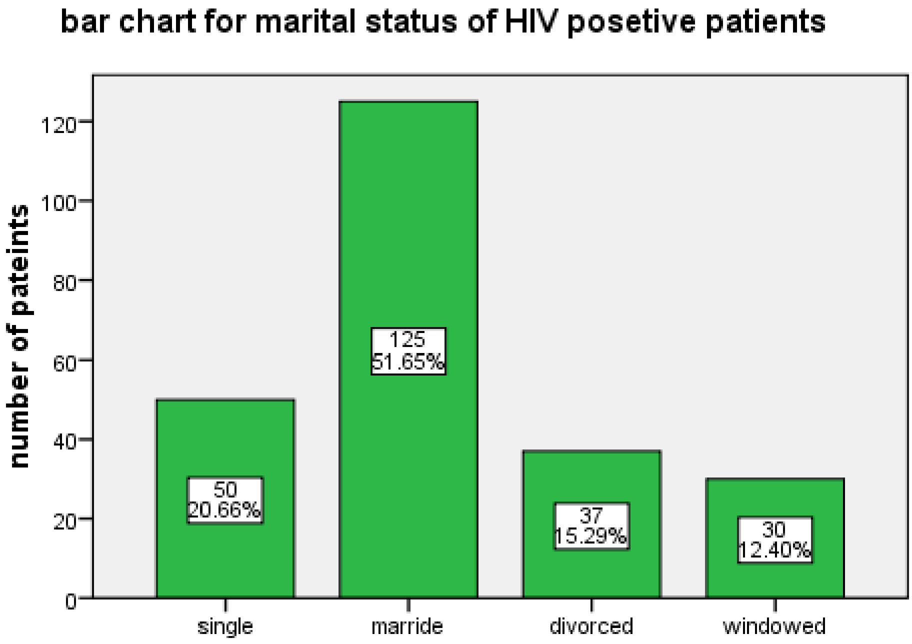


fig1 marital status of patients with HIV AIDS

From the given information of the above bar chart, out of 242 HIV positive patient about 125(51.65%) have marital status have married and it is the lowest proportion of mortality of patients was observed (20.8%). as opposed to the highest proportion of mortality of patients for those patients are single and the number of patients of marital status single is 50(20.66%). the smallest number of patients are recorded in marital status windowed

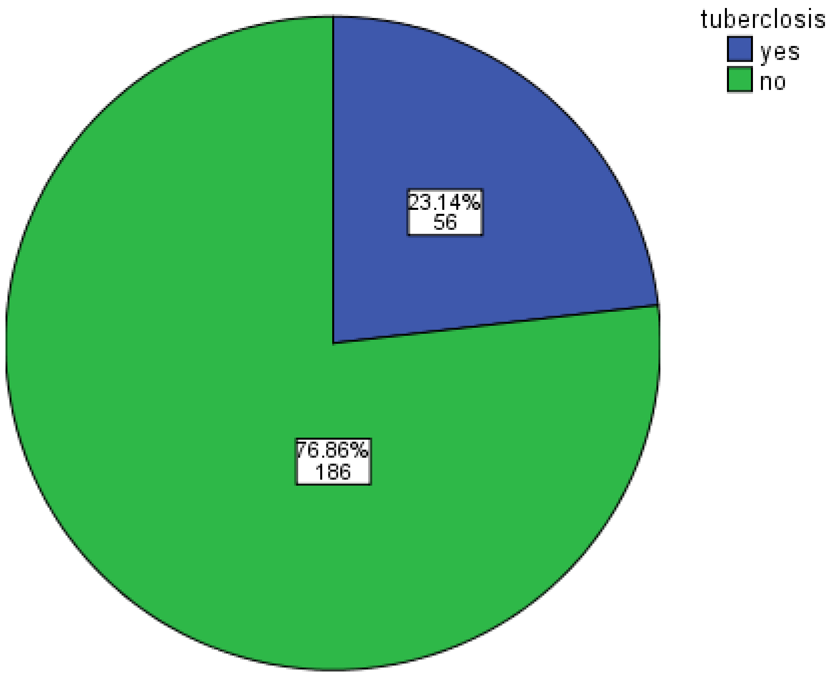
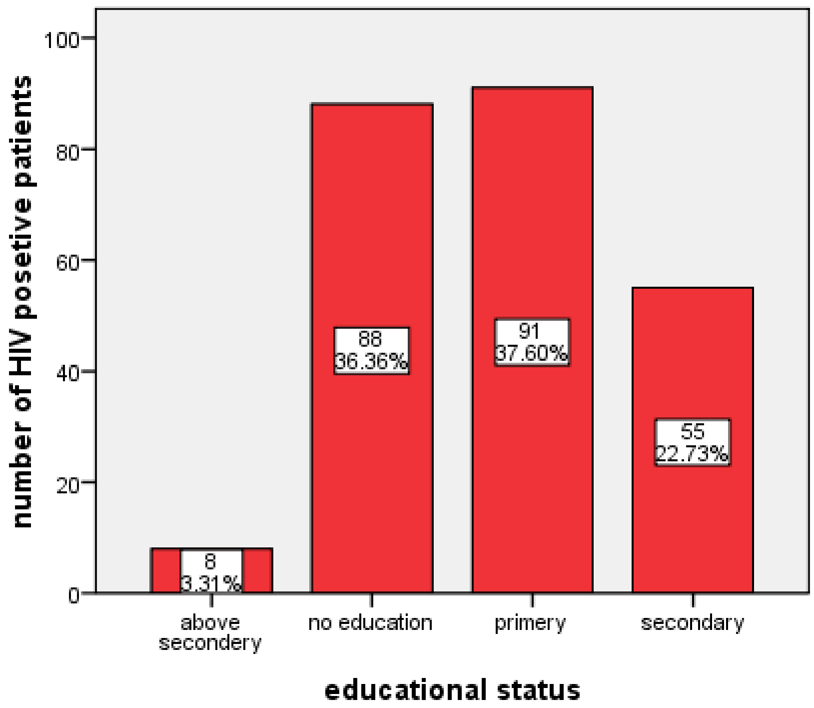


fig2 pie chart sex of patient

The above pie chart indicates that about 186(76.68%) HIV positive patient have no TB disease and 56(23.13%) have TB infection.



The largest bar indicates that the highest number of patients are recorded in educational level primary and the shorter bar indicate that patients that educational level above secondary was smallest frequency.

4.3 Inferential Statistics Analysis

4.3.1Bivariate analysis

This analysis was done to determine association between the survival status as the main predictor and other various independent variables as the outcome variable. The categorical variables were analyzed using Chi square test. P value< 0.25 was considered significant.

Table 0-1 Individual Chi-Square Test for Independent Variable

Association variables		Pearson chi-square		
		Chi-Square	Df	significance
Mortality status	Sex	0.025	1	0.873
Mortality status	Age	13.531	5	0.019
Mortality status	Functional status	4.043	2	0.132
Mortality status	WHO clinical stage	4.593	3	0.204
Mortality status	CD4count cell	0.748	1	0.387
Mortality status	Active TB	36.811	1	0.000
Mortality status	marital status	9.700	3	0.021
Mortality status	Educational status	3.258	3	0.354
Mortality status	BMI	0.011	1	0.916
Mortality status	Occupation of patients	10.005	6	0.124
Mortality status	Residence	2.686	1	0.101
Mortality status	adrerance	0.108	2	0.947
Mortality status	Drugs side effect	7.821	1	0.005
Mortality status	History of substance use	11.132	1	0.001

For bivariate analysis Chi-square test will be used to assess two categorical variables are associated or not at 25% for selected variables in order to use multivariable binary logistic regression for our data.

Hypothesis tests

Null hypothesis: there is no association between the outcome of mortality status and its covariates.

Alternative Hypothesis: there is association between the outcome of mortality status and its covariates.

Based on the table 4.2, the bivariate analysis used chi-square test of association results the independent variables of HIV/AIDS patients of age, Functional status, WHO clinical stage, Active TB, marital status, Occupation of patients, Residence, Drugs side effect andHistory of substance useare significant at 25%. Means there is significance association with the outcome of mortality status of patients and these variables are included in binary logistic regression model. But the independent variable sex, CD4count cell, educational status, BMI and adrerance are not significant at 25%.

4.3.2 Binary Logistic Regression Analysis

Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

4.3.2.1Model Adequacy checking

4.3.2.1.1Wald test

Hypothesis

$H_{O:}$ β_k =0 VS $H_{1:}$ not H_O α=0.05

Test statistic: $$t = \frac{\beta_{j-\beta_0}}{\sqrt{var(\beta_j)}}$$

Since Wald test is used to test the statistical significance of individual coefficient (β) in the model and the test statistic is a chi-square statistic.

The hypothesis to be tested is:

To conclude that the given coefficient is significant to model based on the P- Values of coefficients are less than the level of significance, $\alpha=0.05$.

From the parameter estimation below Table 0.3;

For the coefficients of marital status single $\beta1$: - From the parameter estimation above; the chi-square statistics (Wald) =7.407 is greater than the tableted value 3.84 the p-values for the $\beta1$ =0.006 is less than 0.05 level of significance. Thus, based on this result we see that the coefficient of marital status of single patients are significant to the model.

For $\beta2$ coefficients of marital status married: the chi-square statistics (Wald) =3.936 is greater than the tableted value 3.84 the p-values for the $\beta2$ =0.047 is less than 0.05 level of significance. Thus, based on this result we see that the coefficient of coefficients of marital status married is significant to the model. Similarly, $\beta3$ coefficients of is Marital status divorced: the chi-square statistics (Wald) =6.042 is greater than the tableted value 3.84 the p-values for the $\beta3$=0.014 is less than 0.05 level of significance. Thus, based on this result we see that the coefficient of coefficients of marital status divorced is significant to the model.

For $\beta4$ coefficients of TB: the chi-square statistics (Wald) = 28.367 is greater than the tableted value 3.84 the p-values for the $\beta3$ =0.000 is less than 0.05 level of significance. Thus, based on this result we see that the coefficient of TB status of is significant to the model.

4.3.2.1.2Likelihood Ratio Test

Table 4.3 Model summery

Step	-2 Log likelihood	Nagelkerke R Square
1	196.841	.437

The logistic regression table 4.3 provides or to test using log-likelihood test. In the table 4.4 output Log-Likelihood from the maximum likelihood iterations is displayed along with the statistic G. This statistic tests the null hypothesis that all the coefficients associated with predictors equal zero versus these coefficients not all being equal to zero. In this output, G = 196.841 indicating that there is sufficient evidence that at least one of the coefficients is different from zero. The model summary of and Nagelkerke's R2 below the table 4.3 provide some approximations of R2 statistic in logistic regression. Nagelkerke's R2 equals 0.437, which indicates that 43.7% of the variability in the overall HIV/AIDS patient mortality status was explained by the explanatory variable.

Table 4.4Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.067	8	.851

Hosmer and Lemeshow Test above the table 4.4: -

Ho: the model is good fit.

H1: the model is not good fit.

Decision rule: we do not reject Ho, since p-value >α-value that means 0.851>0.05.

Interpretation: according to Hosmer and Lemeshow Test table, we conclude the goodness of fit test has a p-value greater than α-value (0.05) that means p-value =0. 851.We do not reject Ho that there is no difference between observed and model predicted values. The test indicates sufficient evidence the model fit the data adequately

Table 4.5 Classification Table

Classification Table					
Observed			Predicted		
			mortality status		Percentage Correct
			dead	alive	
Step 1	mortality status	Dead	33	33	50.0
		Alive	11	165	93.8
	Overall Percentage				81.8
a. The cut value is .500					

The classification Table 4.7 shows us that this rule allows us to correctly classify 33 / 66 = 50.0% of the subjects where the predicted event (survival status to dead the research) was observed. This is known as the sensitivity of prediction, the P(correct | event did occur), that is, the percentage of occurrences correctly predicted. We also see that this rule allows us to correctly classify 165 / 176 = 93.8% of the subjects where the predicted event was not observed. This is known as the specificity of prediction, the P(correct | event did not occur), that is, the percentage of non-occurrences correctly predicted

Table 4.3 Contingency table for Hosmer and Lemeshow test

		mortality status = death		mortality status = alive		Total
		Observed	Expected	Observed	Expected	
Step 1	1	20	20.916	4	3.084	24
	2	16	14.828	8	9.172	24
	3	9	9.018	15	14.982	24
	4	7	6.378	17	17.622	24
	5	3	4.997	21	19.003	24
	6	4	3.652	20	20.348	24
	7	4	2.691	20	21.309	24
	8	2	1.874	22	22.126	24
	9	0	1.132	24	22.868	24
	10	1	.514	25	25.486	26

As shown above the table 4.5 indicates that the Observed and Expected Frequencies allows you to see how well the model fits the data by comparing the observed and expected frequencies. There is sufficient evidence that the model fit the data well, since there is no great difference between observed and expected frequencies.

Table 0.5 Variables in the Equation

	B	S.E.	Wald	df	Sig.	Odds ratio	95.0% C.I.for EXP(B)	
							lower	upper
intercept	-3.571	1.055	11.459	1	.001	.028		
sex			2.289	1	0.03			
Female(ref)								
Male	-.665	.439	2.289	1	.030	.514	.217	1.217
Marital status			9.473	3	.024			
Windowed(ref)								

Marital status single	1.372	.504	7.407	1	.006	3.942	1.468	10.587
Marital status married	1.253	.632	3.936	1	.047	3.502	1.015	12.078
Marital status divorced	1.813	.738	6.042	1	.014	6.129	1.444	26.017
Educational level			4.499	3	.212			
Above secondary(ref)								
No education	.825	.456	3.273	1	.070	2.283	.934	5.582
Primary	.924	.547	2.847	1	.092	2.519	.861	7.365
secondary	1.082	1.265	.731	1	.393	2.950	.247	35.239
Occupation of respondent			7.284	6	.295			
House wife(ref)								
merchants	-1.342	.820	2.675	1	.102	.261	.052	1.305
NGO employs	.279	.797	.123	1	.726	1.322	.277	6.309
Government employs	.102	.578	.031	1	.860	1.107	.356	3.441
Jobless	-.095	.731	.017	1	.896	.909	.217	3.805
Daily labor	-.187	.640	.086	1	.770	.829	.237	2.906
Farmer	1.472	.917	2.578	1	.108	4.358	.723	26.281
residence			0.996	1	0.318			
Urban(ref)								
Rural	.485	.486	.996	1	.318	1.624	.627	4.205
TB status			29.128	1	0.000			
Negative(ref)								
positive	2.286	.424	29.128	1	.000	9.840	4.289	22.575
Functional status			.952	2	.621			
Bedridden(ref)								
working	.163	.444	.136	1	.713	1.178	.493	2.812
ambulatory	-.499	.734	.463	1	.496	.607	.144	2.557

WHO clinical stage			.973	3	.808			
Stage IV(REF)								
WHO stag I	.102	.496	.042	1	.838	1.107	.419	2.924
WHO stage II	-.115	.548	.044	1	.834	.892	.305	2.610
WHO stage III	-1.071	1.254	.729	1	.393	.343	.029	4.003
CD4 count			0.967	1	0.325			
Greater than 200(ref)								
200 and less than 200	.380	.386	.967	1	.325	1.462	.686	3.119
adrerance			2.082	2	.353			
Poor(ref)								
Good	.822	.657	1.564	1	.211	2.274	.628	8.241
Fair	-.349	.579	.364	1	.547	.706	.227	2.192
drug side effect			0..316	1	0.574			
No(ref)								
Yes	.257	.456	.316	1	.574	1.292	.529	3.159
Substance use			8.484	1	0.004			
No(ref)								
Yes	1.401	.481	8.484	1	.004	4.058	1.581	10.417
BMI			0.554	1	0.457			
Less than 20 (ref)								
20 and greater than 20	.295	.397	.554	1	.457	1.343	.617	2.923

As shown in the table 4.3 above, no need of saying anything about insignificant variable because they are not important to predict the model and we fit the Logistic model only for a significant variable.

Now the model becomes:

$$\frac{\pi(x)}{1-\pi(x)} = e^{(-3.571+1.372X1+1.253X2+1.813X3+2.286X4+1.401X5-0.665X6)}$$

Log($\frac{\pi(x)}{1-\pi(x)}$)= $(-3.571 + 1.372X1 + 1.253X2 + 1.813X3 + 2.286X4 + 1.401X5 - 0.665X6)$

Where, X1 is Marital status single, X2 is Marital status married, X3 is Marital status divorced, X4 is positive TB status, X5 Substance use X6 is sex of male.

In this study the inferential statistics going to used logistic regression model. By inverting the definition of the logistic function, we interpreting odd ratio of sex, marital status, Substance use and TB status. Those interpretations are: -

The coefficient of marital status single (β1=1.372), it is positive, this indicates that there is a positive relationship existed between mortality status and marital status when using single.

The odds of being died for HIV infected patients whose Marital status single was 3.942 times (OR=3.942, 95% CI: 1.468, 10.587) higher than those patients' Marital status windowed controlling other variables in the model. Similarly, the estimated odds of mortality of HIV-positive patients of married are 3.502 times higher than windowed patients controlling other variables in the model.

Also, the odds of being died for HIV patients who were TB positive were 2.286 times (OR=2.286, 95% CI: 4.289, 22.575) higher than patients who were TB negative controlling other variables in the model.

The coefficient of sex of male (β1=-0.665), it is negative; this indicates that there is a negative relationship existed between mortality status and sex when using male. The estimated odds of mortality of HIV-positive patients of male are 0.514 times less than male patients. Similarly, the odds of being died for HIV infected patients have drug side effect are 1.292 times higher than patient which cannot have drug side effect. The odds of being died for HIV infected patients whose level of education was no education was 2.283 times (OR=02.283, 95% CI: 0.934, 5.582) higher than HIV patients who had above secondary controlling other variables in the model while the odds of being died for patients whose level of education was primary was 2.519 times (OR=2.519, 95% CI: 0.861, 7.365) higher than those patients who had above secondary controlling other variables in the model.

Discussion

The study asses that factors sex, marital status, substance use, and TB status had significant effect on mortality of HIV infected patients at 5% level of significance. Study revealed that the marital status single, married and divorced HIV patients were more likely to die compared to the windowed patients. this study confirmed that HIV infected patients who were TB positives at ART initiation were more likely to die compared to those HIV infected patients who were TB negatives. This might be due to the fact that TB is the leading cause of death worldwide in HIV-infection.

Based on the descriptive frequency table 4.1 the proportion mortality of female patients is higher (27.7%) than male patients (26.7%). With regard to their age, the proportion of mortality of patients was higher for patients aged higher than 65 years (40%) than other age interval. The highest proportion of mortality of patients was observed for patients who were who clinical stage III (36.9%) while it was lowest for patients who clinical stage II (22.2%). The occupational respondent of NGO employs also higher proportion of mortality of patients. The study also asses that the HIV infected patients whose level of education was secondary or above were less likely to die compared to those patients with no education. Our study also revealed that patients with low BMI were more likely to die compared to those patients with high BMI.

CHAPTER FIVE

Conclusion and recommendation

5.1 Conclusion

This study was aimed to identify and describe factors associated with mortality among HIV infected patients who are taking ART in Atat Hospital. The results of the study revealed that, out of 242 HIV infected patients taking ART from March 2009 up to May 2015, Among the patients, 66 (27.3%) of them died while 176 (72.7%) were alive. The result of binary logistic regression asses that factors sex, marital status, substance use, and TB status had significant effect on mortality of HIV infected patients at 5% level of significance. There is significant improvement in our risk factors of mortality of HIV-positive patients when using sex, age, functional status, WHO clinical stage, CD4 count cell, active TB, educational level, weight in kg, residence, occupation of patients and BMI. And for bivariate analysis the independent variables of HIV/AIDS patients of age, Functional status, WHO clinical stage, Active TB, marital status, Occupation of patients, Residence, Drugs side effect and History of substance use are significant at 25%. The older HIV infected patients were more likely to die compared to the younger patients. Patients with no education were also more likely to die than those patients who attend at least primary school.

5.2 RECOMMENDATIONS

Based on the results of this study the following recommendations are suggested.

- Health workers should be cautious when a patient has lower baseline CD4 and lower BMI.
- Level of education of the patients has an important role in increasing their quality of life (reduction of mortality).
- Health workers need to support those patients with no or little education by continuous awareness creation of taking care of themselves and knowing what factors facilitate death.
- Patients who have drug side effect should be given a special care .
- Patients of female with HIV infection should be given a special care

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