COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF STATISTICS

DETERMINANTS OF MALARIA DISEASE IN CASE OF ATAT HOSPITAL

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A RESEARCH SUBMITTED TO DEPARTMENT OF STATISTICS IN THE PARTAIL FULFLUMENT OF THE REQUIRMENT OF BSC DEGREE IN STATISTICS

JUNE,2019

WOLKITE, ETHIOPI

WOLKITE UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF STATISTICS

This is to certify that the paper prepared by Hemza Kedir and Abdulbasit Keru, entitled: **DETERMINANTS OF MALARIA DISEASE IN CASE OF ATAT HOSPITAL**and submitted in partial fulfillment of the requirements for the Degree of Bachelor ofScience complies with the regulations of the University and meets the accepted standards withrespect to originality and quality.

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We, the undersigned, declare that this paper is our original work and has not been presented for a degree in any other university, and that all sources of materials used for the paper have been appositely acknowledged.

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ABSTRACT

Malaria is the most deadly disease caused by Plasmodium parasites. The parasites are spread to people through the bites of infected Anopheles mosquitoes, called "malaria vectors". It remains to be a major challenge to public health and socio-economic development worldwide and in sub-Saharan Africa in particular. However, there is still a paucity of information on the occurrence of malaria at the study area. The objective of this study going to identify determinant of malaria disease and related risk factors in Atat Hospital.The datawere analyzed by statistical software packages such as SPSS.Both descriptive and inferential statistical methods were used to analyze the data (i.e. Chi- square and Logistic regression analysis).

As the result and discussion, 71.1% have malaria negative and the rest 28.9% have malaria positive. In chi square test of association some variables such as season and Types of species diagnosedhas association with Status of malaria. Also from the result of binary logistic regression model; explanatory variables such as: season, residence and Types of species diagnosed are significant variable.This were due to problem of their treatment seeking behavior, in that there is an extreme delay in early diagnoses which leads to the progress of severe and finally leads to high risk of malaria disease. So in order to address this problem, the governmental and non-governmental organizations those working in the areas should give due attention specially, on continuous awareness creation of early diagnoses and treatment to the health facility.

Keywords: Descriptive statistics, inferential statistics, Binary logestic regression.

ACKNOWLEDGEMENT

First of all, we would like to say thanks for our almighty God who gave our courage and patience for the completion of this research paper and for all our families for their continuous support morally and financially from the beginning until stage of our education level. We would like to express the most sincere thanks and profound sense of gratitude to our Advisor, Mr. AbebeYabeker (M.Sc) for his supportive and constructive advice, comments and efforts starting from title selection up to the end of this research paper.We have great appreciation and we would like to thanks Wolkite University, especially the department of statistics in providing computer services and other facilities for the accomplishment of our research report preparation work.

Finally, our great pleasure to thanks our entire friends for their important comment and suggestion on the research.

LIST OF TABLE

LIST OF ACRONYMS

EDHS: Ethiopia Demographic and Health Survey.

OR: Odd Ratio

RBM: Roll Back Malaria Programme.

S.E: Standard Error

SNNP: Southern Nations, Nationalities and peoples.

SPSS: Statistical Package for Social Science.

SSA: Sub-Saharan Africa.

TSPD: Types of Species Diagnosed

UNDP: United Nations Development Programme.

UNICEF: United Nations Children's Fund.

WB: World Bank.

WHO: World Health Organization.

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CHAPTER ONE

1 INTRODUCTION

1.1 Background of the study

Malaria is one of the world'smost deadly and life threatening parasitic diseases. One of the world's deadliest diseases affectingpeople particularly in tropical and subtropical regions of the world. Malaria is typically caused by single-celled obligate protozoan parasites of the genus Plasmodium. The genus of the Plasmodium that causes malaria has four major species including Plasmodium ovale, P.vivax, P.falciparuum, P.malaria and are mostly found in the sub-Saharan Africa. Majority of malaria infections in sub-Saharan Africa are caused by P.falciparum.(Abah and Temple, 2015)

The parasites are spread to people through the bites of infected Anopheles mosquitoes, called "malaria vectors". It remains to be a major challenge to public health and socio-economic development worldwide and in sub-Saharan Africa in particular. It causes an estimated 300 to 500 million cases and 1.5 to 2.7 million deaths worldwide each year, of which 80% of the cases and 90% of the deaths occur in Sub-Saharan Africa (WHO, malaria vectors, 2010).

There are four types of human malaria: plasmodium falciparum, plasmodium vivax, plasmodium malaria, and plasmodium ovule and its transmitted by the bite of female anopheles mosquitoes. Among the four species, Plasmodium falciparum is by far the most aggressive species, distributed globally especially common in Africa (WHO, 2009).

It is a threat to more than 40% of the world's population, and out of the more than 300 million acute cases each year between 1.1 and 2.7 million people die each year (RBM, 2002). The vast majority of malaria cases (90%) are in sub-Saharan Africa, where malaria constitutes 10% of the total disease burden. Children under five and pregnant women are most at risk, withPlasmodiumfalciparumbeing "the main cause of severe clinical malaria and death" (TDR, 2002).

According to the United Nations Children's Fund (UNICEF), "Malaria's cost to human and social well-being is enormous. It is a major cause of poverty and poverty exacerbates the malaria situation" (UNICEF, Malaria's cost to human,. 2000:1). So too is the economic loss, which in Africa aloneis estimated at more than $2 billion annually. According to the Roll Back Malaria

Programmer (RBM, 2002), "It has slowed economic growth in African countries by 1.3% per year, the compounded effects of which area gross domestic product level now up to 32% lower than it would have been had malaria been eradicated from Africa in 1960." Because of the seriousness of the problem, and the World Bank (WB) have joined forces in worldwide malaria control efforts, with the aim of reducing malaria mortality by 50% by the year 2010 (World Bank, 2001).

In Ethiopia, malaria is a leading public health problem, where 75 % of the country land surface is malaria and 68% of the populations are at risk of malaria infection (FMOH & ENMIS, 2011). Thus, malaria is a public health concern and all age groups of the population are vulnerable. Children under five years of age and pregnant women are generally considered to be at a higher risk. In 2009, malaria was still the first leading cause of health problem accounting for 48% of outpatient consultations, 25% admissions and 29.6% inpatient deaths (MOH, 2009). According to (MOH, 2009) reports, approximately 70,000 people die of malaria each year in Ethiopia.

Using the base line household cluster malaria survey, which was conducted, by the carter center SNNP regions, a number of research papers have been published. Graves *et al*.,(2008) studied individual, household and environmental risk factor of malaria in SNNP regions of Ethiopia.

To assess malaria infections in relation to socio-economic, demographic and environmental factors, they used univariate analysis. From the result it can be seen that overall prevalence of malaria was found to be low. The detailed report for this survey is presented by the carter center. The other research paper, which was conducted using this population-based survey, is evaluation of light microscopy and rapid diagnosis test. This was done by Endeshaw *et al*., (2008). The finding of this study suggested that blood slide microscopy found to be the best option for population-based prevalence survey of malaria paresthesia.

Similarly, in SNNP, the high transmission season of malaria cases usually goes from August to December Shargie et al.,(2010). Even though, there is a little reduction of death cases, the result of survey as well as the Routine surveillance data demonstrated that malaria continues to be a significant a public health challenge and a major public health problem in SNNP Shargie et al.,(2010). That blood slide microscopy found to be the best option for population-based prevalence survey of malaria parasitemia. However measuring malaria burden in a population is a challenge in most developing countries, because most disease incidences and deaths occur outside of the formal health care, particularly at home and the complexity of the disease control process, expensiveness of the control program, to evaluate the strengths and weakness of methods in estimating malaria disease and time trends resistance of the parasite to anti-malarial drugs and vectors to in pesticides are some of the challenges (MOH, 2008).

In Gurage zone 18% of the zone is exposed to malaria, and it is one of the leading public health problems in this zone. But, little published reports are available on recent malaria impact among the various age groups and their seasonal patterns in this zone. Depend up on this we going to motivate to contribute in identifying those important factors which play role to incidence of malaria using appropriate statistical method particularly, using binary logistic regression model Yimer *et al*., (2015).

1.2 Statement of the problem

Malaria disease is the major global health problem and causes the most serious form of the disease, and it's a common in developing countries, particularly in Sub-Saharan Africa like Ethiopia. There are many factors that contribute to Malaria disease like seasonal variability, residents of patients,types of species diagnosed, marital status,age and sex distribution due to parasite is change to complicated problems of society awareness and etc. However, the factors themselves and the health care way to manage the effect of these factors are not well known by the community. Similarly there is gap in health service and people face lack of health insurance and skilled medical care in the Atat hospital. In addition, there is no clear statistical methodology and quantitative research applied using modern and appropriate statistical models this factor in the Atat hospital considering the above listed and other problems, this study is motivated to contribute in identifying those important factors which play role to incidence of malaria using appropriate statistical method particularly, binary logistic regression model.

Research tries to answering the following question.

1.What factors enhance the Malaria disease in the Atat hospital?

2.What factors are related to the Malaria disease in the Atat hospital?

3.In which residents the malaria disease high; rural or urban residents?

1.3 Objective of the study

1.3.1 General objective of the Study

The general objective of this study is to identify the determinants of malaria disease in the case of Atat hospital.

1.3.2 Specific objectives of the study

1.To identify the factor that is significantly contribute to malaria disease.
2.To find out the relationship between malaria disease and demographic factors, season in months, residence of patients, and types of malaria species diagnosed.

1.4 Significance of the study

The findings of the study can be help peoples to better understand risk factors for incidence of malaria, to review the malaria related deaths, provide to society the demographic factors,season in months, residence of patients, and types of malaria species diagnosed which malaria highly occurred, to understand method used to resist the malaria disease, to identify gaps in health service and to make recommendation, to prevent future death and to take appropriate actions. It was to also serve as a guide for those who are interested to make further studies on the area and problems to acquire which factor have major effect on the death, solving the problems in the area by this study.

1.5 Scope of the study

The scope of the study was focused on Atat Hospital, to identify the determinants of malaria disease.

1.6 Limitation of the study

The study focused on identifying some of the factors that were expected to be associated factors of malaria disease in Atat hospital based on available data on patient cards. So the data were obtaind from some variable only; seasonal variability, residents of patients,types of species diagnosed, marital status,age and sex. However, the study could not incorporate some other important risk factors that may difficult to malaria disease due to lack of data, such as net usage, stagnant water, vaccination status, socio economic status of patients, awareness of patients about the disease, proper utilization of different malaria treatments and other related issues. Despite these limitations, the model derived in this paper may give a more accurate prediction of risk factors of malaria disease status by taking into account available proxy data of patient card of laboratory confirmed malaria positive.

CHAPTER TWO

2 LITERATURE RIVIEW

2.1 General concepts of malaria disease

Malaria is a major life-threatening vector-borne disease transmitted through a bite of female Anopheles mosquitoes and it is not only just a disease but an economic and social disease that burdens many nations globally (Sachs and Malaney, 2006).

The disease got its name from bad air (malaria) as it was thought that the disease came from fetid marshes. Later in 1880, it was discovered that the real cause of malaria was Plasmodium a single cell parasite which can only be transmitted from one person to another by the bite of female Anopheles mosquito. The male Anopheles mosquitoes are not involved in disease transmission, as they don't require blood to nurture eggs as their female counterparts do (Ribeiro, 2006).

According to World Malaria Report (2009), Geneva by World Health Organization 90% of deaths caused by malaria takes place in Africa, primarily among young children, pregnant women and their unborn children. A child in Africa dies every 30 seconds because of malaria and those who survive the severe episode of malaria might suffer from learning impairments or brain damage (Geneva by World Health Organization , 2008).

In the present study, a proportional raise in the prevalence of P.vivax was recorded from the year (2009 to 2012). An increased rate of drug resistance has been reported in the study region. Therefore, chloroquine resistant P.vivax malaria may be responsible for the observed slight increment in the proportion of P.vivax in the last few years. This was in agreement with a similar study conducted in Southern Ethiopia (J Inf Dis Immu., 2015).

Malaria is a major public health problem in Ethiopia; it contributes up to 20% of fewer than five deaths. In this case many studies indicates that the people living close approximates to ponds in Ethiopia are at high risk of malaria compared to those living are not uncommon. Tragically, in epidemic in 2003, there were up to 16 million case of malaria. It is prevalent in 75% of the country. Puttingover50 million people at risks (out of country wide population of 77%). The diseases account for 7% of outpatient visits and represent the largest single cases of morbidity. Large scale epidemic tends of occur every 5-8 years in certain areas due to climate fluctuations and drought related to nutritional emergencies (UNICEF, 2007).

2.2 Factors that effects the risk of malaria disease

Malaria affects the lives of almost all people living in the area of Africa defined by the southern fringes of the Sahara Desert in the north, and altitude of about 28° in the south. Most people at risk of the disease live in areas of relatively stable malaria transmission-infection is common and occurs with sufficient frequency that some level of immunity develops. A smaller proportion of people live in areas where risk of malaria is more seasonal and less predictable, because of either altitude or rainfall patterns. People living in the peripheral areas north or south of the main endemic area or bordering highland areas are vulnerable to highly seasonal transmission and to malaria epidemics(MARA/ARMA collaboration, July 2002).

Similarly, Shargie *et al*. studied net coverage in Oromiya and SNNP regions of Ethiopia and ownership and use of long lasting insecticidal nets in 2008 and 2010. The result from these studies implies that malaria continues to be a significant public health problem in the surveyed regions of Ethiopia. The use of mosquito nets resulted in the decline of the malaria disease in Amhara, Oromiya and SNNP regions of Ethiopia (Shargie *et al*, 2008)..

A house hold cluster survey was conducted in Amhara, Oromia and Southern Nations, Nationalities and peoples' (SNNP) regions of Ethiopia during December 2006 to January 2007, during the end of the malaria season. A total of 224 clusters of average 25 households each (total 5,708 households) were selected and 28,994 individuals participated in at least one part of the survey. Variables (predictors) considered in the study were; age distribution, sex,pregnant women, main sources of drinking water, time to collect water, sanitation facility, main material of wall, and altitude were observed in detail. The questionnaire was developed as a modification of the Malaria indicator survey household questionnaire (WHO, 2009). By using multinomial logistic regression model the study were found the result that Oromia had a significantly lower prevalence than the other two regions, which are not significantly different from each other. Plasmodium falciparum prevalence was higher than Plasmodium vivax in all regions (Carter center report, August 2007).

The transmission of malaria in Ethiopia depends on attitude and rainfall with a lag time varying from a few weeks before the beginning of the rainy season to more than a month after the end of rainy season (WHO Ethiopia depends on attitude and rainfall, 2009). Epidemics from malaria are relatively frequent involving highlands or high and fringe areas of Ethiopia mainly areas (1000-2000) meters above sea level (Gething, 2015).

2.2.1 Age

Age is another important factor that determines prevalence of malaria. Several studies in different location have reported the prevalence of malaria based on locations. In children, reported that in the 1-3 year old children, low prevalence of malaria could be associated maternally derived antibodies,social life style, awareness, prevention, early report of cases etc by parents; 2-3 years old could be due to loss of immunity derived from the mother, social status, irregular immunization; 4 years old children could be associated to social status and life style, poor prevention, late report of cases etc by parents (Nwakaku, 2017).

School-aged children (age 5–15) bear the most significant burden of malaria in terms of having the highest prevalence rate. Although a number of studies have been conducted on malaria among children and young adults, most of them are clinical, treatment, and prevention-based studies. The ages of the children, and mosquito net use behavior for sleeping were found as significant determinants for malaria in children by multivariate model, and the effects of these variables were directly predicted using the odds ratio. From variable included in the multivariate model, the child's age was one of the most significant factors for malaria among children aged 6 months to 14 years. The odds ratio of children aged 5–9 years (OR = 2.29, 95% CI = 2.23, 3.82) and 10–14 years (OR = 4.47, CI = 3.33, 6.02) demonstrated that these two age groups were more vulnerable to malaria than children under 5 years (Malar J.,2012).

2.2.2 Gender

Gender which could either be male or female is another important that determines the prevalence of malaria is a population. As such the prevalence of malaria based on gender is compounding to determine. Other predisposing factor could cause high prevalence rate at particular gender in a given locality. (Oladeinde et al., 2014).

2.2.3 Residence of patient

Mboumb *et al* (2011)investigates study in different area of Gabon. During the study, cross-sectional surveys were carried out in health care facilities at four locations: two urban areas (Libreville and Port-Gentil), one semi-urban area (Melen) and one rural area (Oyem), between 2005 and 2011. Similar to other studies, this study also revealed that rural children experienced more malaria cases than urban children, which might be due to less availability of health care facilities and lack of proper social mobilization concerning malaria prevention. The result of Binary Logistic Regression model shows that increased risk of malaria infection in different areas of Gabon with over-five year-old children tending to become the most at-risk population, suggesting a changing epidemiology. Moreover, the heterogeneity of the malaria burden in the country highlights the importance of maintaining various malaria control strategies and redefining their implementation(BMC Infect Dis., 2009).

2.2.4 Seasons in Months

Season affect a wide range of things including living and non-living things. Typically two predominant season including raining (wet) and dry season(IzahS.C., 2017).

The wet season start from April to October, while the dry season begins from November to March of the following year. In recent times the seasonal pattern appears to be drifting. This is because is some years past rainfall in February is as highas rainfall in early rainy season month e.g April and May. Authors have also reported that season also affect water quality parameters (Bariwari, 2001). The occurrence of mosquito the vector for malaria appears to be higher during the wet season. This could be due to presence of breeding ground of mosquito. Garba et al. (2016) reported higher prevalence during wet season (9.2%) compared to dry season (4.9) among blood donors.

Malaria transmission peaks biannually from September to December and April to May, coinciding with the major harvesting seasons. This has series consequences for Ethiopia's subsistence economy and for the nation in general. Major epidemics occur every five to eight years with focal epidemics as the commonest form. By used Binary Logistic Regression model to identify the seasons in month's malaria highly occurred risk factors of malaria (Getachew *et al*., 2007).

2.2.5 Types of Species Diagnosed

Woyessa *et al* (2012) studied in the malaria disease in Butajira area, south-central Ethiopia. The method used in this study were a multi-stage sampling technique, 750 households were selected. All consenting family members were examined for malaria parasites in thick and thin blood smears. In this study variables used as predictor (independent) were age group, sex, survey period types of malaria species diagnosed and Season in months. Finally the result obtained by the study were, in total 19,207 persons were examined in the six surveys. From those tested, 178 slides were positive for malaria, of which 154 (86.5%) were positive for Plasmodium vivax and 22 (12.4%) for Plasmodium falciparum; the remaining two (1.1%) showed mixed infections of Plasmodium falciparum and Plasmodium vivax.

Alemu et al (2012) have done a research on trend analysis of malaria prevalence in Kola Diba, North Gondar, North west Ethiopia. A retrospective study was conducted to determine the prevalence of malaria from peripheral blood smear examinations from the Kola Diba Health Center of Ethiopia. The case notes of all malaria cases reported between (2002–2011) were carefully reviewed and analyzed. The result obtained during investigation were within the last decade (2002–2011) a total of 59, 208 blood films were requested for malaria diagnosis in Kola Diba health center and 23,473 (39.6%) microscopically confirmed malaria cases were reported in the town with a fluctuating trend. Regarding the identified plasmodium species, Plasmodium falciparum and Plasmodium vivax accounted for 75% and 25% of malaria morbidity, respectively. As researcher concluded that, the study after the introduction of the current malaria control strategies, the morbidity and mortality by malaria is decreasing but malaria is still a major health problem and the deadly species Plasmodium falciparum is predominant.

Alexander et al. 2011 studied prevalence of malaria among patients attending public health facilities in Maputo city, Mozambique. The predictor included in the study were age group- (>=5 vs. <5), residence in Maputo city, house close to water bed net at household, bed net hung the previous night and documented fever enrolment. By using logistic regression model this study were published the result, among the 706 enrolled patients, 11 (15.7%) cases were identified; 105 of Plasmodium falciparum only, two of Plasmodium ovaleonly, and four of both Plasmodium Falciparum and Plasmodium ovale. No cases of Plasmodium vivax or Plasmodium malaria were identified. The RDTs were positive in 99 of the 111 patients, yielding a sensitivity of 89.2% (95% confidence interval [CI]:82.2-96.2%).The specificity was 97.0% (95% CI: 95.3–98.7%), because RDTs were negative in 577 of the 595 non-cases.

CHAPTER THEREE

3 METHODOLOGY

3.1Study Area

The study was conducted at Atat Hospital. Atat Hospital is located 175km south west of Addis Ababa, 17km off the town of Wolkite on the road to Hosanna in ChehaWoreda of Guraghe Zone, SNNPRs and managed and run by Medical Mission Sisters under the Eparchy of Emdibir since its establishment back in 1969 G.C. It renders service to more than 300,000 peoples with in and out of the operational area with an average daily load of 272 with only five working days in a week(Dagim T, 2014).

3.1.1Data source

The data used in the study were obtained from Atat hospital; patient's card and log book.

3.2 Variables consider in the study

3.2.1 Dependent Variable

The response or dependent variable in this study is the binary response variable, which is named as presence or not presence. This status of malaria presence is coded as (1= if the patient have malaria or positive and 0 = if the patient have no malaria or negative).

Status of Malaria	Y	0= negative
		1= positive

3.2.2 Independent Variables

The independent variables that are expected to cause the malaria disease and their classification or category are presented with their detail codes and descriptions in below.

	Representation of Variable	Category
Sex	X_1	0=Female 1=Male
Age	X_2	Continues
Marital status	X_3	0= Unmarried 1= Married
Season in year	X_4	0= winter 1= summer 2= spring 3= autumn
Types of malaria species diagnosed	X_5	0= Plasmodium Falciparum 1= Plasmodium vivex 2=No TMSD
Residence of patients	X_6	0= Urban 1=Rural

3. 3 Statistical Method of Analysis

This study was anayze the data by useddescriptive statistics and inferential statistics. From descriptive statistics tables, charts and graphs was used for the organization, summarization and presentation of data in meaningful forms and for measure of variation (range, variance, maximum, minimum, etc) is used. From inferential statistics, chi-square test and logistic regression is used, and also the statistical software's was used for this studys is SPSS.

3.3.1 Descriptive statistics

Descriptive statistics is to provide an over view of the information collected and it consists of method for organization. Descriptive statistics is used during the calculation of the frequency, percentage, cumulative percentage. This describe by tables and cumulative percentage. It is also very help full in drawing conclusion or decision making.

3.3.2 Inferential statistics

Inferential statistics is the statistical method deals with making inference or conclusion about population based on data obtained from limited number of observations that came from the population. Inferential statistics consist of estimation and hypothesis testing; we used in this study chi-square test for the purpose of association checking between variables and logistic regression model under consideration.

3.3.3 Chi-square test

Chi-square(X^2) is a statistical measure with the help of which it is possible to access of the significance of the different between the observed frequencies and expected frequencies obtained from some hypothetical universe. It is a measure of the different between the observed and expected counts.

In addition it helps us to determine whether two variables are associated or not. In order to that chi-square test may be applicable both the frequencies must be grouped in the same way and theoretical distribution must adjust to give the same total frequency, which is equal to that of observed frequency. Chi-square test enables us to test whether more than two population proportion, we considered equal.

Chi-square test of independence:- enables us to explain whether or not two attributes are associated or simply it is a technique of judging significance of the two associations or relationship between two attributes. The chi-square test for independency use when we have two descriptive variables is associated. The objective of chi-square test of independency is to test whether there is association between two categorical variables.

From these our study we was used the chi-square test of independence.

Test of hypothesis

H0: There is no association between dependent and independent variable.

H_1: There is association between dependent and independent variable.

The test statistics is given by:

$$X^2{}_{cal} = \sum_{i=1}^{r}\sum_{j=1}^{c}[\frac{(O_{ij} - E_{ij})^2}{E_{ij}}]\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.1)$$

Where: Oij is observed frequency of i^{th} row and j^{th} column, and E_{ij-} expected frequency of i^{th} row and j^{th} column.

The test statistics is distributed approximately as chi-square with (r-1) (c-1) degree of freedom.

Note that: c is number of the columns on the data sand r is number of rows on the data.
Expected frequency = (row total * column total)/Grand total.
P-value is the smallest level of the test for which the null hypothesis (Ho) is rejected.
That is when p-value greater than the significance level, Ho is not rejected.
Decision Rule: - Reject the null hypothesis and do not reject the alternative hypothesis.
Conclusion: Based on the decision.

Assumption of Chi-square

- ✓ Each cell and every individual object is independent of each other
- ✓ All individuals' observation in the sample should be independent.
- ✓ The populations must be normally distributed for the variable under the study.
- ✓ The sample must be randomly selected from population.
- ✓ The expected frequency of each category must be at least 5.
- ✓ The sample size is large.

3.4 Logistic Regression Model

One of the statistical techniques for this study was used to the logistic regression model. Logistic regression is a variation of ordinary regression which is used when the dependent (response) variable is dichotomous variable (i.e. it takes only two values, which usually represent the occurrence and non-occurrence, or success or failure, or satisfy or not satisfy of some outcome events usually coded as 0 or 1) and the independent (input) variables are continuous, categorical or both.

Logistic regression also produces odds ratio (O.R) associated with each predictor values of a variable. The odds of an event are defined as the probability of an outcome event occurring divide by the probability of the event not occurring. In general the odds ratio is one set of odds divide by another.

If the hypothesis testing and confidence interval become inaccurate and the probability value lies outside (0-1) interval, it violating the basic assumption of the probability and creates the problem of non-normality. To overcome this problem, we used logit model. Therefore, logit is fitted to explain (model) the relationship between each factor with the malaria disease. Accordingly, in our model the dependent variable take 1 if the malaria is prevalent with probability “1+” otherwise value of “0” that is, if not prevalent “1-”.

Assumption of logistic regression model

- ✓ Normally distributed errors terms are not assumed.
- ✓ Logistic regression does not assume a linear relationship between the dependent and the independent variables.
- ✓ The dependent variable must be categorical.
- ✓ Linearity in the logit regression equation should have a linear relationship with the logit form of be the dependent variable.
- ✓ Absence of multicollinearity.
- ✓ The dependent variables need not be homoscedasticity for each level of independent variables; that is there is no homogeneity of variance assumption.

3.5 Binary logistic regression model

Binary logistic regression is the form of regression which was used to solve with the dependent variable is dichotomous and the independent variables are of any type (continuous or categorical). It was used to predict a dependent variable on the basis of continuous and (categorical independent variables) and to determine the percent of variance in the dependent variable explained by the independents; to rank the relative importance of independent variables; to assess the interaction effect and to understand the impact of covariate control variables. But in logistic regression our objective is to find the probability of something happening (probability of success)

By inverting the definition of the logistic function, we obtained as:

$$P = p(y_i = 1|x_i) = \frac{e^{\beta_0+\beta_1 x_{i1}+\cdots+\beta_k x_{ik}}}{1+e^{\beta_0+\beta_1 x_{i1}+\cdots+\beta_k x_{ik}}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Suppose that malaria disease denoted by “Y” which has binary values. When Y=1, it shows malaria presence and Y=0, it shows not malaria presence

The logistic regression model is give as follows:

- ✓ $\text{Logit}(p)=\log(\frac{p}{1-p}) = \text{ex}[\beta_0 + \beta_1 X_1 + \beta_2 X_2 +...+ \beta_k X_k]$……………………(3.3)

  1-p: is the probability of failure

β_0: constant $X_1, X_2, X_3 \ldots X_k$ are independent variables.

$\beta_1, \beta_2, \beta_3 \ldots \beta_k$ are coefficients of independent variables.

The ratio of probability of success to probability of failure is $\frac{p}{1-p}$ is odd ratio.

If L= $\ln \frac{p}{1-p}$ is positive,the odds that it means that regresses and equals one decreases the value of X increases.

If L= $\ln \frac{p}{1-p}$ is negative, the odds that regresses and equals one decreases the value ofXincreases(Agresti, 2002).

3.5.1 Odds Ratio

This is a cumulative logit model that assumes the odds of response below a given response level are constant regardless of which level we pick. This model allows separate intercepts for the cumulative logit, but restricts the parameter sets for the predictors to be the same across all logits. A proportional odds model that constrains some predictors to have common parameters and leaves other predictors free to have separate parameters is called a HYPERLINK "http://support.sas.com/kb/22954.html" partial proportional odds model.

Logistic regressions work with odds so it is necessary to define both odds and odds ratio. The odds are simply the ratio of the probabilities for the two possible outcomes. If p is the probability that the event is occurring, then 1 –p is the probability that the event is not occurring

$$\text{Odd} = \frac{p}{1-p} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.4)$$

In 2 × 2 contingency tables:

Within row 1 the odds of success are

$$Odds1 = \left(\frac{p_1}{1-p_1}\right)$$

Within row 2 the odds of success equal

$$Odds2 = \left(\frac{p_2}{1 - p_2}\right)$$

The ratio of the odds from the two rows,

$Odds\ ratio = \left(\frac{p_1}{1-p_1}\right) / \left(\frac{p_2}{1-p_2}\right)$……………………………………………….(3.5),

Iscalled odds ratio (Agresti, 2002).

Whereas the relative risk is a ratio of two probabilities, the odds ratio pi is a ratio of two odds.

Note: When a logistic regression is calculated, the regression coefficient (b1) is the estimated increase in the log odds of the outcome per unit increase in the value of the exposure. In other words, the exponential function of the regression coefficient (e^{b1}) is the odds ratio associated with a one-unit increase in the exposure.

When is it used?

Odds ratios was used to compare the relative odds of the occurrence of the outcome of interest (e.g. disease or disorder), given exposure to the variable of interest (e.g. health characteristic, aspect of medical history). The odds ratio is also used to determine whether a particular exposure is a risk factor for a particular outcome, and to compare the magnitude of various risk factors for that outcome.

OR=1 Exposure does not affect odds of outcome.

OR>1 Exposure associated with higher odds of outcome.

OR<1 Exposure associated with lower odds of outcome.

3.6 Parameter Estimation for Logistic Regression

The maximum likelihood and non-iterative weighted least square the two meet computing. Estimation methods was used in fitting logistic regression model (Hosmer & Lemeshow, 1989)

When the assumption of normality of the predictors does not hold, the non- iterative weighted least square method is less efficient. In contrast the maximum likelihood estimation method is appropriate for estimating the logistic model parameters due to this less restrictive nature of underlying assumption (Hosmer & Lemeshow, 1989) hence in this study the maximum likelihood estimation technique was used to estimate parameters of the model consider the logistic model.

For estimation of coefficient in logistic we was used to (MLE) maximum Likelihood estimation.

$L(\beta) = \Pi^{n}_{i=1} p(x)^{y}(1-p(x))^{1-y})$.

Where $p(x)^y$= probability of success for the different value of x.
y-is the response variable.
To estimate the parameter we differentiate the likelihood function with respect to each parameters and equation to zero as follows.

For constant we find $\frac{\partial L(\beta)}{\partial(\beta 0)} = 0$ and

For the slopes we find the partial derivative of the likelihood function with respect to the parameters and equal to zero $\frac{\partial L(\beta)}{\partial(\beta j)} = 0$

3.7 Goodness of Fit of the model

The goodness of fit of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model are to the observed values. The appropriateness of the fitted logistic regression model needs to be examined before it is accepted for use as in the case of all regression models.
In practice, several different measures exist for determining the significance or goodness of fit of a logistic regression model. These are Pearson, Hosmer & Lemeshow, Deviance goodness of fit, likelihood ratio test and the classification table. In theoretical sense, all measures are equivalent. To be more precise, as the number of observation goes to infinity, all measures converge to the same estimate of the model significances. The test can detect major departures from a logistic response function (Alan, 1990).

3.8.1 Test of overall model fit

Likelihood-Ratio Test

The likelihood ratio test statistic (G^2) is the test statistic commonly used for assessing the overall fit of the logistic regression model. Agresti (1990) argues that the likelihood ratio test is better, particularly if the sample size is small or the parameters are large. The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L1) over the maximized value of the likelihood function for the simpler model (L0).
The likelihood-ratio test statistic is given by:

G^2=-2log (Lo/L1) = -2[log (Lo)-(L1)] = -2log (Lo-L1) (3.5)

Where: - L1 is the likelihood of the full model andL_0 is the likelihood of the null model.

The likelihood ratio test statistic has an approximate distribution with k degrees of freedom. (Where, k is the number of predictors in the full model). If significant, it suggests that, taken together, the predictors contribute significantly to the prediction of the outcome.

It tests the null hypothesis that all population in logistic regression coefficients is zero except the constant one. And a small p-value, for example, $p < 0.05$ leads to rejection of the null hypotheses that all of the predictor effects are zero. Thus when likelihood test is significant, at least one of the predictors is significantly related to the response variable.

Hosmer and Lemeshow (H-L) Test

The final measure of model fit is the Hosmer & Lemeshow goodness of fit statistics, which measurethe correspondence between the actual and the predicted value of the dependent variables. The Hosmer & Lemeshow test is commonly used test for assessing the goodness of fit model and allows for any number of explanatory variables, which may be continuous or categorical. In this casebetter model fit is indicated by smaller difference in observed and predicted statistic. The Hosmer & Lemeshow test uses a test statistic that asymptotically follows an x^2 distribution to assess whetheror not the observed event rates match expected event rates in subgroups of the model population.

The test statistic is constructed by grouping the data set into groups (of ten g=10). The groups are formed by ordering the existing data by the level of their predicted probabilities. So the data are first ordered from least likely to have the event to most likely for the event. Then g roughly equalsized groups are formed. The observed and expected numbers of events are computed for eachgroup.

The test statistic is: $$G^2{}_{HL} = \sum\left(\frac{O_j - E_j}{E_j(1 - E_j / nj)}\right) \approx X^2 \quad \text{.........(3.6)}$$

Where, OJ and EJ are the observed and expected number of events in the jth group respectively, and j is avariance correction factor for the jth group. If the observed number of events differs from what isexpected by the model, the statistic $G^2{}_{HL}$ was large and there was evidence against the null hypothesis. This statistic has an approximate chi-squared distribution with (g – 2) degrees offreedom. The advantage of a summary goodness-of-fit statistic like $G^2{}_{HL}$ is that it provides a singleasily interpretable value that can be used to assess fit (Hosmer and Lemeshow, 2000).

3.8.2 Test of individual predictor

The Wald test statistic

The Wald test is a way of testing the significance of particular explanatory variables in a statistical model. In logistic regression we have a binary outcome variable and one or more explanatory variables. For each explanatory variable in the model there associated parameters. If for a particular explanatory variable, or group of explanatory variables, the Wald test is significant, then we was conclude that the parameters associated with these variables are not zero, so that the variables should be included in the model. If the Wald test is not significant then the explanatory variables would omitted from the model.

To test staticallysignificance of each coefficient (β) in the model:

- $Z = \frac{\beta}{Se(\beta)}$

  Where β= coefficient of regression.

  Se(β)= standard error of the coefficient.

  Z= normal distribution.

  This z value is the squared yielding Wald statistics with a chi-square distribution of 95% CI

Omnibus Test

The omnibus test is the method of testing the coefficients and the significance of the model. Which means the overall model is significant if all variables are included in the model.

R^2 Statistic

The Cox and Snell measure is based on log-likelihood and considers sample size. The maximum value that the Cox & Snell R^2 attains is less than 1. The Nagelkerke R^2 is an adjusted version of the Cox & Snell R^2 and covers the full range from 0 to 1. The Cox & Snell R^2 is given by

$$R^2{}_{cs} = 1 - \left(\frac{L(\beta(0))}{L(\hat{\beta})}\right)^{\frac{2}{n}} \quad \text{…………………………………………..………..(3.7)}$$

The Nagelkerke measure is as follows: $R_N^2 = \frac{R_{CS}^2}{1 - L(B(O))^{\frac{2}{n}}}$

Where, $L(\beta^{(0)})$ is the log likelihood function for model without explanatory variables and $L(\hat{\beta})$ is the log likelihood function for model with estimated parameters.

CHAPTER FOUR

4 RESULTS AND DISCUSSION

4.1 Results of descriptive analysis

For this study, the data was obtained from Atat Hospital from tests card registry and log book, at time interval from September 2010-August 2010 of total sample size are 544.

Table 4.1: Summary of descriptive statistics for determinants of malaria disease

Variables	categories	status of malaria				Total	
		Yes		No			
		Count	Percent(%)	Count	Percent(%)	Count	Percent(%)
Sex	Female Male	90 67	16.5% 12.3%	225 162	41.4% 29.8%	315 229	57.9% 41.1%
Residence	urban Rural	29 128	5.3% 23.5%	94 293	17.3% 53.9%	123 421	22.6% 77.4%
TMSD	P.vivax P.falciparum	116 41	21.3% 7.5%	2 2	0.4% 0.4%	118 43	21.7% 7.9%
Marital status	married unmarried	96 61	17.6% 11.2%	219 168	40.3% 30.9%	315 229	57.9% 41.2%
Season	winter summer spring autumn	26 26 14 91	4.8% 4.8% 2.6% 16.7%	158 67 59 103	29.0% 12.3% 10.8% 18.9%	184 93 73 194	33.8% 17.1% 13.4% 35.7%

The results (Table 4.1) reveal that out of malariatestsconsidered in the analysis (71.1% have malaria negative and the rest 28.9% have malaria positive), 16.5% of females and 12.3% of males have a malariapositive,while 41.4% of females and 29.8% males were no malaria,and out of 157 malaria patients, 57.32% of females and 42.68% of males have a malaria positive, totally 57.9% of tests are female and 41.1% tests are male.

Similarly 5.3% of urban and 23.5% of rural have malaria positive, but 17.3% of urban and 53.9% of rural were malaria negative, andout of 157 malaria patients, 81.5% of rural and 18.5% of urban have a malaria positive, totally 22.6% of tests are urban and 77.4% of tests are rural.

On the other hand from TMSD 21.3% of malaria tests have plasmodium vivax and 7.5%of malaria tests have plasmodium falciparum, and out of 157 malaria patients, 73.89% of

plasmodium vivax and 26.11% of plasmodium falciparum have a malaria positive, totally21.7% of malaria tests have plasmodium vivax and 7.9% of malaria tests have plasmodium falciparum.
Similarly 17.6% of malaria positive are married and 11.2% of malaria positive are unmarried, but 40.3% of malaria negative are married and 30.9% of malaria negative are unmarried, and out of 157 malariapatients, 61.15% of malaria positive are married and 38.85% of malaria positive are unmarried, totally 57.9% of malaria tests are married and 42.1% of malaria tests are unmarried.
Also 4.8% of tests have malaria positive in winter season, 4.8% of tests have malaria positive in summer season, 2.6% of testshave malaria positive in spring season and 16.7% of tests have malaria positive in autumn season, but 29.0% of tests are no malaria in winter season, 12.3% of tests are no malaria in summer season, 10.8% of tests are no malaria in spring season and 18.9% of tests are no malaria in autumn season, andout of 157 malaria patients, 16.56% of patients have malaria positive in winter season, 16.56% of patients have malaria positive in summer season, 8.9% of patients have malaria positive in spring season and 57.98% of patients have malaria positive in autumn season, totally 33.8% tests are in winter season, 17.1% tests are malaria in summer season, 13.4% tests are malaria in spring season and 35.7% tests are malaria in autumn season.

Table 4.2: Descriptive statistics for age

Continuous Variable	Minimum	Maximum	Mean	Standard deviation
Age of patients	.00	74.00	27.8511	19.32931

The output of Table 4.2 shows that the minimum, maximum, mean and std. Deviation of the age of patients are .00, 74.00, 27.8511 and 19.32931 respectively.

4.2 Inferential statistics

4.2.1 Chi-square test of association

Table 4.3: Result of chi-square test association between dependent variable Vs independent variables.

Pearson chi-square tests			
malaria disease V_S	Chi-square value	d. f	p-value
Age	72.664	72	.456
Sex	.449	2	.799
Residence	2.161	1	0.142
TSMD	4.917E2	2	0.000
Marital status	0.952	1	0.329
Season	53.590	3	0.000

Depending on the above table we test if there is association or no association between dependent variable (malaria disease) and independent variables (age, sex, season, marital status, residence and TSMD).

Accordingly; age, sex, residence and marital status are greater than level of significance (P-value = .456, .799, 0.142and 0.329 > 0.05 respectively), therefore we conclude that there is no association between age, sex, season, residence and marital status of patients with malaria disease.

But the p-value of TSMD and Season of patients are less than level of significance (0.000< 0.05), therefore we conclude that there is association between TSMD and Season of patients with malaria disease.

4.3 Analysis of binary logistic regression model

4.3.2 Model adequacy checking

Table 4.4 Omnibus tests of model coefficients

Omnibus Tests of Model Coefficient				
		Chi-square	d. f	Sig.
Step1	Step	557.454	9	0.000
	Block	557.454	9	0.000
	Model	557.454	9	0.000

From the above table 4.4 the p-value (0.000) is less than α = 0.05 statistical level of significance and implies that to reject null hypothesis. Hence there is at least one parameter which differs from zero. This indicates that the overall model is significant we conclude that adding the explanatory variables to the model had significantly increased our ability to predict to have malaria patients.

Table 4.5 Model summary

Step	-2 log likelihood	Cox & Snell R square	Nagelkerke R square
1	96.288[a]	.641	.917

a. estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

From table 4.5 , the value of Cox and Snell R square .641 which is found between 0 and 0.75 this indicates that the logistic regression model fit the data And Nagelkerke R square is .917 which is found between 0 and 1 that indicates the logistic regression model fit the data.

Therefore Cox and Snell R square is .641(64.1%) of the variation in the dependent variable is explained by the predictor variables and Nagelkerke R-square shows that 91.7% of the dependent variable is explained by the predictor variables.

Table 4.6 Hosmer and Lemshow test.

Step	Chi-square	d. f	sig
1	11.443	8	.178

Interpretation: From Table 4.6 Hosmer and Lemeshow test shows a goodness of fit test of the null hypothesis is that the model adequately fits the data, since the value of the Hosmer-

Lemeshow goodness-of-fit test statistical significance value is greater than 0.05 (i.e. 0.178>0.05), we fail to reject the null hypothesis that there is no difference between observed data and model-predicted values, implying that the model fits the data at an acceptable level, this proves that the predicted data are not significantly different from the observed data.
Therefore, our fitted logistic regression model is good fit

Table 4.7 Classification of Table

Observed		predicted		
		Status of malaria		Percentage correct
Step 1		no	yes	
	No	383	4	99.0
	Yes	8	149	94.0
	Overall percentage			97.8

Table 4.7 shows that the number of 0 and 1 that are the observed values of the response variable. The predicted values of the response variable based on the full logistic regression model how many subjects are correctly predicted (383 subjects are observed to be 0 and are correctly predicted to be 0; 149 subjects are observed to be 1 and are correctly predicted to be 1), and how many subjects are not correctly predicted (4 subjects are observed to be 0 but are predicted to be 1; 8 subjects are observed to be 1 but are predicted to be 0). As can be seen from the classification table, the overall percentage of those correctly classified is equal to 97.8%, a big increase from the constant-only model correctly classifying 28.86%. We can inspect the table for some specifics now: of that tests have not malaria, the model correctly classifies 383 out of 387 subjects have no malaria. The model predicting of patients have a malaria has correctly classifies 149 out of 157 have a malaria. The "Overall Percentage" of 97.8% is calculated by summing up the diagonal values (383 and 149) and dividing over the total number of subjects (544). The "diagonal" consist of the sum of "have not malaria" and "have malaria" frequencies. Therefore, the resulting percentage correctly classified is 532/544 = 97.8%.

Table 4.8 Results of binary logistic regression model

Variables	Categories	B	S.E	Wald	df	Sig.	Exp(B)	95%C.I for EXP(B)	
								Lower	Upper
(Intercept)		-1.954	0.937	4.346	1	.037	.142		
Age	Continuous	.000	.022	.000	1	.991	1.000	.957	1.044
Sex	Female	Ref.							
	Male	1.152	.709	2.643	1	.104	3.166	.789	12.702
Residence	Urban	Ref.							
	Rural	-2.099	.944	4.940	1	.026	.123	.019	.780
Maritalstatus	Unmarried	Ref.							
	Married	.950	.977	.945	1	.331	2.585	.381	17.530
Season	Winter	Ref.		9.233	3	0.348			
	Summer	-1.899	.825	5.294	1	.021	.150	.030	.755
	Spring	-1.1456	.902	1.610	1	.204	.318	.054	1.865
	Autumn	-1.636	1.072	2.329	1	.127	.195	.024	1.592
TSPD	P.falcparm	Ref.		117.677	2	0.000			
	P.vivax	8.113	1.150	49.734	1	.000	3.339E3	350.173	3.183E4
	No TSPD	8.935	1.081	67.945	1	.000	7.590E3	907.011	6.351E4

The Odds Ratio Interpretation

A nice feature of logistic regression models with categorical explanatory variables is that the exponents of the parameter estimates are the odds ratios and an important interpretation of logistic regression model uses the odds ratio.

Column-6 of the table gives the odds ratios for each variable. The first categories of the explanatory variables (Sex, Residence, Maritalstatus, Season, TSPD) are used as reference. The odds ratio is the ratio of the odds of an event occurring in one group to the odds of it occurring in another group.

The odds ratio interpretation for this table follows as: The odds of being malaria positive for rural area was 87.7 less likely than urban area, keeping the other varaiblesas constant in the model.. This indicates that the malaria disease is less severe for rural areas than patient diagnosed from urban areas aroundAtat Hospital.

The odds of being malaria positive for P.vivax are 3.339E3 times more likely compared to P.falcparm; this indicates that the malaria disease is more severe for P.vivax than patient diagnosed from P.falcparm in Atat Hospital.

The odds of being malaria positive for summer was 85 less likely compared to winter; this indicates that the malaria disease is less severe for summerthan patient diagnosed from winter, around Atat Hospital.

4.4Discussion

This retrospective study was attempted to identify the factors of malaria disease related in Atat hospital using binary logistic regression model were computed and the results of the study show that from 544 tests, 157 patients have malaria and 387 have no malaria and malaria disease for the predictor variables like residence, TSPD and season has significant. While variables like age, sex and marital status are no significance to the malaria disease. Based on the findings in this chapter the results obtained are discussed as follows:

Then according to our study suggested that place of residence was significant to malaria disease around Atat hospital, and then patients who live in urban areas are affected by malaria disease than in rular areas. This result is similar with Mboumbet et al. (2011).

This study also shows that season of the year were significant to malaria disease in Atat Hospital and malaria was more effect on the season ofwintersummerthan summer, spring and autumn season, but according to Garba et al. (2016), reported higher prevalence during wet season compared to dry season.

This study also shows that TSPD was significant to malaria disease in Atat Hospital and malaria was more effect on the TSPD of P.vivax than P.falcparm. This result is consistent to Woyessa et al (2012), according to this study high malaria disease that varied with TSPD.

Generally several researchers have been done on this by the different authors. Variables like age, residence, stagnant water and season had significant contribution to the status of malaria in the study. Furthermore, variables like season, TSPD and residence of patients have significant impact on malaria disease in our study.

CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusions

The main objective of this study is to investigate the factors that affect malaria disease in Atat hospital using Binary logistic regression; at time interval from September 2010-August 2010 of total sample size are 544. Thus the following Conclusions are made.

Among 544 tests 157 have malaria positive and 387 have malaria negative. The result of chi-square test showed that there is an association between season and TSMD of patients with malaria disease, but the other is not associated.

The Binary logistic regression analysis revealed that out of six categorical predictor variables, three predictor variables, such as residence of patients, TSMD and season had significant effect on the status malaria patients at 0.05 level of significance.

5.2Recommendation

Based on the findings the following are recommended in order to identify the determinants of malaria disease in the case of Atat hospital.

- The health workers should give more attention to reduce malaria disease efforts to decrease mosquito larva in the exposed season around Atathospital .
- The health workers have to give priorities to P. vivax than P. falcparm in Atathospital reduce malaria disease.

This were due to problem of their treatment seeking behavior, in that there is an extreme delay in early diagnoses which leads to the progress of severe and finally leads to high risk of malaria disease. So in order to address this problem, the governmental and non-governmental organizations those working in the areas should give due attention specially, on continuous awareness creation of early diagnoses and treatment to the health facility.

Finally, the concerned body has to expand and maintain health promotions on designing appropriate interventions, clothes towards communities at high risk and effective treatment in home or community based care.

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