Hawassa University Vice President for Research and Technology Transfer

Research Programs Directorate

Proceedings of the 40th Annual Research Review Workshop: College Natural and Computational Sciences

April 2021

Hawassa, Ethiopia

Hawassa University

Office of the Vice President for Research and Technology Transfer

Research Programs Directorate

Proceedings of the 40th Annual Research Review Workshop:

College of Natural and Computational Sciences

Reviewed and Compiled by:

Berhanu Mekbib (Associate Prof)

Edited by: Berhan Demeke (Ph.D.)

Rahmeto Abebe (Associate Prof)

Mulye Girma (Ph.D.)

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Foreword

This year, Hawassa University is holding its 40th Annual Research Review Workshop since the University was founded as the Awassa College of Agriculture (ACA) in 1976. It is inspiring to see that the university, which started with a college when it was founded, now has eight colleges (i.e., College of Agriculture, College of Business and Economics; College of Education; College of Law and Governance; College of Social Sciences and Humanities; College of Natural and Computational Sciences; College of Medicine and Health Science; Wondo Genet College of Forestry and Natural Resources), 3 Institutes (i.e., the Institute of Technology; Institute of Policy and Development Research and Institute of Sidama Studies) and a campus (Daye campus).

Since the founding of Hawassa University, several types of research of national and international importance have been carried out by the university's academic staff with funds from the state budget and in collaboration with various international organizations/institutions. While research review workshops have been carried out at the university level for several years, review workshops are now being carried out at all colleges and institutes of the university due to the increased number of research projects associated with the growth and diversification of programs. The publication of Proceedings is one of the platforms that Hawassa University has long used to disseminate the research results of its staff to the scientific community inside and outside the university. I still believe that the current Proceedings consisting of the research findings of the academic staff at the respective college of the university, are public and provide scientific research material. The research papers included in the Proceedings of the 40th Annual Research Review Workshop will be an excellent resource for academic staff, postgraduate students, undergraduate students, and researchers working in government and non-governmental institutions. This year, six colleges have published proceedings, namely the College of Social Sciences and Humanities, Business and Economics, Education, Natural and Computational Sciences, Agriculture, and Medicine and Health Sciences. As I thank these colleges, I want to encourage the remaining colleges and the Institute of Technology to take a lesson from these colleges, work hard, and do the same for the next year.

As the proud Vice President for Research and Technology Transfer, thank all the academic staff at Hawassa University who presented their research results at the annual Research Review Workshop and who contributed to the publication of the proceedings and to the success of the university's research endeavors. I would also like to thank the Research Programs Directorate of Hawassa University for coordinating the Research Review Workshops conducted at six colleges and for editing, compiling, and publishing the proceedings. I would also like to thank everyone who has supported our work to improve the quality of education in Ethiopia.

Once again, I really appreciate the hard work of the Hawassa University staff this year, and I am eternally grateful for your ongoing scientific contribution. Together we are securing our vision of being one of the best research universities in Africa and moving away from teaching towards a stronger research orientation.

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Tafesse Matewos (Ph.D.)

Vice President for Research and Technology Transfer, Hawassa University

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Survival Analysis of Risk Factors for the Death of Patients with Cardiovascular Diseases under Follow-up: A Case Study at Hawassa University Comprehensive Specialized Hospital, Hawassa - Ethiopia

AshefetAgete* and Girma Altaye

Corresponding author: E-mail address: ashuagete2010@gmail. Com; Department of Statistics

ABSTRACT

Cardiovascular diseases (CVDs) are group of disorders of heart and blood vessels. It is a major health problem across the world; 80% of CVD death is contributed by countries with low and middle income. The study aimed to determine the prognostic factors/variables that affect the survival of cardiovascular patients. Source of the data was Hawassa University Comprehensive Specialized Hospital, located in Hawassa. A retrospective data was collected from September 2012 to April 2016. Out of 2, 500 total patients, a sample size of 410 were selected for this research by using simple random sampling technique. Survival models were used to analyze the data. The results of the study revealed that 48.8% were alive during the follow-up whereas the rest 51.2% of the patients died. The scaled Schoenfeld residual shows the non-proportionality for variable Education Level. Types of CVD and Blood Pressure and this variable needed to be stratified Cox regression model. The Cox-Snell residual showed the Cox PH model that does not fit these data adequately. So, compare the models Cox PH and Stratified cox regression models by AIC and BIC which gives, stratified Cox regression with No-interaction model use Types of CVD as strata was best fit to the data for the current study. Stratified Cox regression with No-interaction model showed that the variables; Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking and Pulse Rate are statistically significant and selected as significant factors for risk of death of patients with cardiovascular diseases at 0.05 level of significance. Thus, raising awareness among policy makers and the public at large, on the current magnitude of cardiovascular disease associated deaths and related risk factors can improve the survival time of cardiovascular diseases patients.

Keywords: Cardiovascular diseases, Cox proportional hazard model, Non-communicable disease, Stratified Cox regression model, Survival analysis.

INTRODUCTION

Background of the Problem

Cardiovascular disease is the disorders related to the heart and blood vessels. It is a major health problem across the world, accounting for 30% of all deaths. According to 2014 World Health Organization (WHO), heart diseases especially coronary heart disease is the leading cause of death globally and one of the major health burdens worldwide (WHO, 2013). The burden of cardiovascular disease is increasing rapidly in Africa, and it is now a public health problem throughout the African Region. Cardiovascular disease has a major socio-economic impact on individuals, families and societies in terms of health-care costs, absenteeism and national productivity. The most important cardiovascular diseases in the African Region are those related

to atherosclerosis, cardiomyopathies and rheumatic heart disease (Organization of African Unity, 2012). WHO noted that CVD has no geographic, socio economic or sex boundaries.

It is estimated that far from being confined to the most developed countries; cardiovascular disease is the leading cause of death in developing countries as well. About 80% of CVD death is recorded in countries with low and middle income. The combined burden of these diseases is rising fastest among the lower-income countries, populations, and communities (Alwan *et al*., 2010). Approximately 34% of Ethiopian population is dying from non-communicable diseases, with a national cardiovascular disease prevalence of 15%, cancer and chronic obstructive pulmonary disease prevalence of 4% each, and diabetes mellitus prevalence of 2% (WHO, 2011). The prevalence of cardiovascular diseases in Ethiopia appears to have increased over time among hospitalized patients, with studies in the 1970s reporting prevalence of 4.4% while studies in the 2000s reporting 12.6% and studies in the 2011s reporting 24.0%.

Cardiovascular diseases were mainly considered as the problem of the developed world just a few decades back. However, currently, reports suggest that it is becoming a primary health concern for middle and low income countries. The reports show that the proportion for the epidemic in developing countries already accounts for almost 10% of the cases and it is likely to become the developing world's leading cause of death.

Unbalanced nutrition reduced physical activities and tobacco and alcohol consumption are among the behaviors most commonly associated with the increased risk of cardiovascular disease. In Ethiopia, health complications related to cardiovascular, especially for the urban communities are becoming the major health threat. This threat is mostly manifested with obesity, high blood pressure, dyslipidemia, heart diseases and diabetes. A study in Ethiopia among adults in Addis Ababa also reported a prevalence of hypertension, an important CVD risk factor, of 31.5% among males and 28.9% among females (Tesfaye *et al*., 2009).

Epidemiologic transition which is taking place in every part of the world, among all races, ethnic groups, and cultures has resulted in the global rise in cardiovascular disorders (CVD). Today CVD became the most common cause of death accounting for 30% of deaths worldwide, with 80% of the burden now occurring in developing countries. Although human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) is the leading overall cause of death in the sub-Saharan region. CVD is the second leading killer and is the leading among those over the age of 30 (Gaziano *et al.*, 2007).

Mortality rates generally appear to be most closely linked to a country's stage of epidemiological transition. In underdeveloped countries at the early stages of epidemiological transition, infectious diseases predominate, but as the economy, development status, and health systems of these countries improve, the population moves to a later stage of epidemiological transition, and chronic non communicable diseases become the predominant causes of death and disease (Gaziano *et al*., 2006).

Statement of the Problem

We know the fact that cardiovascular diseases are one of the leading causes of mortality in the world, especially in low and middle income country. Therefore, this study measured the risk factors for the death of cardiovascular patients under follow-up at Hawassa Referral Hospital. To this end the research considered the following research question:

➢ What are the significant factors that affect the survival time of cardiovascular patients?
➢ How is the survival probability of the cardiovascular Patients who were under treatment estimated?
➢ How to investigate relationship between covariates and survival time of cardiovascular patients?

Objectives

General Objective

The general objective of this study was to identify the prognostic factors for the death of cardiovascular patients who were under follow-up at Hawassa University Comprehensive Specialized Hospital, Ethiopia.

The Specific Objectives were

➢ to identify significant factors that affect the survival time of cardiovascular patients.
➢ to estimate the survival probability of the cardiovascular patients who were under treatment.
➢ to assess relationship between covariates and survival time of patients with cardiovascular diseases.

Significance of the Study

The finding of this study is valuable for raising awareness among policy makers and the public at large, on the current magnitude of cardiovascular disease risk factors. Also, the outcomes of this study help health care workers to anticipate and inform patients about the possible related risk factors of death they might encounter. In addition to this, clinicians can decrease mortality among cardiovascular patients by early diagnosis and appropriate intervention. Furthermore, the result of this study can also be used as a source of information for other researchers.

Scope of the Study

The study mainly focused on Hawassa University Comprehensive Specialized Hospital with the objective of to assess the risk factors of mortality of cardiovascular patients under follow-up at Hawassa University Comprehensive Specialized Hospital, Hawassa Ethiopia.

Limitation of the Study

Some of limitations of the study are: the study is conducted based on secondary data gathered from the treatment card of patients, which might have incomplete and biased information, otherwise, the data gathering process becomes rigorous. As different literature pointed out, there are different factors that are assumed to have impacts on the survival time of cardiovascular

patients such as physically inactiveness, family history related to cardiovascular diseases, dietary pattern and socio-economic factors. However, data on these variables could not be available in hospital records, so these variables were not included in the study.

DATA AND METHODOLOGY

Study Area

The study is conducted at Hawassa University Comprehensive *Specialized* Hospital, which is located at Hawassa university medical campus. Hawassa is the capital city of Sidama regional state, Ethiopia. It is located at about $275km$ SouthWest from Addis Ababa. Geographically it is located between 07^005'latitude North and 38^029'longitude East. The altitude of the city is 1697m above sea level (Berhanu, 1999 E.C).

Description of Data

This study incorporates secondary data which reviews the patient's card and information sheet. The hospital's registration was used to retrieve data on cardiovascular diseases and patients initial dates of entry to follow-up. This data is survival data since the data is collected for investigation of time to event. Usually a set of individuals or patients are observed and then the time of death or lifetime of that individual or patients is record. The event can be death, otherwise censored. Though, the information for the censored or truncated subjects is not completely known. Cardiovascular patients, who stayed alive during the study time, lost and dropped before death, are considered as censored.

Study Population

The target population for this study is cardiovascular patients under follow-up at Hawassa Referral Hospital, from September 2012 up to April 2016. The data was secondary as recorded at the hospital from admission to the end of the study period.

Inclusion and Exclusion Criteria:

The study has considered cardiovascular patients whose age is greater than or equals to 13years and who were under follow-up during the study period in Hawassa City at Hawassa Referral Hospital. However, the study excluded those patients whose age was less than 13 years and also those who were not under follow-up.

Sampling Techniques

Sampling technique is a system of taking small ratio of observation from a large population with the aim of getting information of those large populations from the sampled observation by using some statistical techniques. In this study simple Random sampling technique was used as an appropriate sampling technique for selecting a representative sample of the patients by using lottery method.

Sample Size Determination

An appropriate sample size is a means of gaining optimal precision of estimation with minimum cost. The appropriate formula for determination of sample size using simple random sampling was adopted from (Cochran, 1977; Ali, 2003) as:

$$n = \frac{z_{\alpha/2}^2 * p * (1 - p)}{d^2}.$$

Where, $z_{\alpha/2}$ = 1.96 is the upper $\alpha/2$ point of standard normal distribution with α = 0.05 significance level. The parameter p represents the proportion of death due to cardiovascular diseases. A few studies describe the proportion of death due to cardiac diseases (rheumatic heart diseases) in rural Ethiopia, in this study the estimated of the death due to cardiac diseases has been taken to be 12.5% (based on estimates by Jilalu*et al*., 2006) and the degree of precision has been set as d = 0.032. Accordingly, the sample size using the given formula became; n = 410 patients for the current study.

Study Variables

In this study, several variables that are supposed to be associated with mortality of cardiovascular patients were considered. The variables considered in the study were selected based on the findings of previous study and those are expected to be determining factors for cardiovascular diseases.

Dependent Variable

The response (dependent) variable is the survival time of cardiovascular patients, the length of time from the start date of treatment until the event of death in months during the study period from September 2012 to April 2016. Cardiovascular patients, who stayed alive during the study time or lost or dropped before death, are considered as censored.

Independent Variables

In this study the explanatory variables expected to be the risk factors of cardiovascular diseases related mortality were categorical and continuous. The risk factors for the death of cardiovascular patients are several, but in this study only some variables as risk factors as all risk factors did not exist in the patient's card. The variables included in the study: Age at the start of treatment, Sex, Place of residence, Education Level, Types of cardiovascular disease, Smoking use, Alcohol use, Blood pressure at start of treatment, Pulse rate at start of treatment, Cholesterol level

Survival Analysis

Survival analysis is a collection of statistical procedures for data analysis where the outcome of interest is time until an event occurs. By time, years, months, weeks, or days from the beginning of follow-up of an individual until an event occur; alternatively, time can refer to the age of an individual when an event occurs. Survival analysis is an important statistical technique used to describe and model time-to-event data. The use of survival analysis, as opposed to the use of other statistical methods, is most important when some subjects are lost to follow up or when the

period of observation is finite and certain patients may not experience the event of interest over the study period. In this latter case one cannot have complete information for such individuals. These incomplete observations are referred to as being censored. Most survival analysis considers a key analytical problem of censoring. In essence, censoring occurs when we have some information about individual survival time, but we do not know the survival time exactly. There are generally three reasons why censoring may occur: a person does not experience the event before the study ends; a person is lost to follow-up during the study period and a person withdraws from the study because of death (if death is not the event of interest) or some other reason. According on Klein (1992), there are three categories of censoring,

1. Right censoring: occurs to the right of the last known survival time. Survival time is said to be right censored when it is recorded from its beginning to a defined time before its end time. This type of censoring is commonly recognized survival analysis and also considered in this study.

2. Left censoring: Survival time is said to be left censored if an individual develops an event of interest prior to the beginning of the study; this is not common in survival studies.

3. Interval censoring: Survival time is said to be interval censored when it is only known that the event of interest occurs within an interval of time but the exact time of its occurrence is not known.

Descriptive Methods for Survival Data

An initial step in the analysis of a set of survival data is to present numerical or graphical summaries of the survival times in a particular group. In summarizing survival data, the two common functions applied are the survivor function and the hazard function (Hosmer and Lemeshow, 1999).

Survival Function

The basic quantity employed to describe time-to-event phenomena is the survival function, the probability of an individual surviving or being event-free beyond time t (experiencing the event after time t). Moreover, the distribution of survival time is characterized by three functions: survivorship function, probability density function, and hazard function. Let T be a random variable associated with the survival times, t be the realization of the random variable T and $f(t)$ be the underlying probability density function of the survival time t. The cumulative hazard function $\Lambda(t)$, which represents the probability that a subject selected at random will have a survival time less than some stated value t, is given by:

$$\Lambda_T(t) = P_T(T \leq t) = \int_0^t \lambda(u)du, t>0$$

The survival function is defined as the probability that the survival time is greater or equal to t.

$$S(t) = P\ (T > t), t>0,\ S(t) = 1 - \Lambda(t).$$

And density function is given by: $\text{f(t)} = \frac{-dS(t)}{dt}, 档 > 0$

Theoretically, as t rangesfrom 0 to infinity, the survivor function can be graphed as a smooth curve. This survival function gives the probability of surviving or being event free beyond time t.

Because Survival functions ($S(t)$) is probability, it is characterized by:
1.   They are non-increasing function.
2.   At time, $t = 0$, $S(t) = S(0) = 1$. That is, at the start of the study, no one has experienced the event yet, the probability of surviving past time 0 is one.
3.   As time $t \to \infty$, $S(t) \to 0$. That is, theoretically, if the study period increased without limit, eventually nobody would survive, so the survivor curve must eventually converge to zero.

Hazard Function

The hazard function is a measure of the probability of failure during a very small interval, assuming that the individual has survived at the beginning of the interval.The hazard function describes the concept of the risk of an outcome (e.g., death, failure, hospitalization) in an interval after time t, conditional on the subject having survived t otime t. It is the probability that an individual dies somewhere between t and $t + \Delta t$, divided by the probability that the individual survived beyond time t. The hazard function λ (t) can be formulated as:

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{P\{t \leq T < (t + \Delta t | T \geq t)\}}{\Delta t}$$

$$\lambda(t) = \frac{\mathcal{E}(t)}{S(t)}$$

The survival and cumulative hazard functions can be given in terms of the hazard function as:

$$\Lambda(t) = \int_0^t \lambda(u)du \text{ and } S(t) = exp(-\Lambda(t))$$

Using the above expressions the hazard function $\lambda(t)$ can also be given as:

$$\lambda(t) = -\frac{d \log S(t)}{dt} = \frac{d\Lambda(t)}{dt}$$

3.8.3 Estimation of survivorship function

In survival analys is, it is always a good idea to present numerical or graphical summaries of the survival times for the individuals. In general, survival data are conveniently summarized through estimates of the survival function and hazard function. This method is non-parametric or distribution-free, since they require no specific assumptions to be made about the underlying distribution of the survival times (Hosmer and Lemeshow, 1999).

Among the other estimators of the survivor function the Kaplan-Meier estimator is the most common one. The Kaplan-Meier estimator of the survivorship function (Kaplanand Meier (1958) also called product limit estimator, is the estimator used by most software packages. This estimator incorporates information from all of the observations available, both uncensored and censored, by considering survival to any point in time as a series of steps defined by the observed survival and censored times.

Suppose we have a sample of independent observations, their survival times denoted by t_1, t_2, ..., t_n and indicators of censoring denoting by δ_1, δ_2, ..., δ_n where

$$\delta_i = \begin{cases} 1, \text{ifeventofdeathoccurs} \\ 0, \text{otherwise} \end{cases}$$

Thus, the survival data are denoted by (t_i, δ_i), $i = 1, 2, ..., n$. The first step to obtain the Kaplan-Meierestimatorofthesurvivalfunctionistoorderthesurvivaltimesas$t_1, t_2, ..., t_n$. Assume that among

the *n* observations *m* ≤*n* death occurred at distinct *m* times. The main quantity of interest is the probability that an event will not occur by time *t*: $S(t) = P\ (T > t)$. Kaplan and Meier (1958) develop an estimator for the survival function.

$$\widehat{S_{KM}}(t) = \prod_{t_i \leq t} (\frac{n_i - d_i}{n_i})^{\delta_i} = \prod_{t_i \leq t} (1 - \frac{n_i}{d_i})^{\delta_i} \qquad =$$

Where, d_i is number of patients died at t_i and n_i is number of patients at risk before t_i. The variance of the Kaplan-Meier estimators which is referred to as Greenwood's formula is given as:

$$V(\widehat{S_{KM}}) = (\widehat{S_{KM}}(t))^2 \sum_{t_i \leq t} \frac{d_i}{n_i(n_i - d_i)}$$

Log-Rank Test

The log-rank test can be extended for comparing three or more groups of survival experience. The logranktest, developed by Mantel and Haenszel, is a non-parametric test for comparing two or more independent survival curves. Since it is a non-parametric test, no assumption about the distributional form of the data is required. This test is however most powerful whenusedfornon-overlappingsurvivalcurves.Thistestcanbegeneralizedtoaccommodate other tests that are equally used sometime in practice such as Generalized Wilcoxon test, Tarone-Waretest, and Peto-Peto-Prenticetest. Each of these tests uses different weights to adjust for censoring that is often encountered in survival data.

Modeling Survival Data

Through a modeling approach to the analysis of survival data, we can explore how the survival experience of a group of individuals depends on the values of one or more explanatory variables, whose values have been recorded for each individual at the time origin. A variety of models and methods have been developed for doing this sort of survival analysis using either parametric or semi-parametric.

Cox Proportional Hazard Model

A popular regression model for the analysis of survival data is the Cox Regression model. The strength of this model is that $h_0\ (t)$ or baseline hazard is left unspecified (unknown function). It represents the hazard of an individual with covariates equal to zero. We call this a Semi-parametric Regression model, this model is often also called Cox Proportional Hazard model. In the other way, Cox Proportional Hazard model is a semi-parametric model, which contains two parts, non-parametrically estimated baseline hazard $h_0(t)$ and parametrically estimated set of covariates (Gill,1984)).The distinguishing feature of Cox PH model is its ability to estimate the relationship between the hazard rate and explanatory variables without having to make any assumptions about the shape of the baseline hazard function. The Cox proportional hazards regression model relates covariates to the hazard function as follows:

$$h(t|x){=}h_0(t)c(\beta^l x)$$

Where $h_0(t)$ is called the baseline hazard function, which is the hazard function for an individual for whom all the variables included in the model are zero, $\beta^l = (\beta_1, \beta_2, ..., \beta_p)$ is a parameter vector of regression coefficients, $x=(x_1,x_2,...,x_p)^l$ is the value of the vector of explanatory variables for a particular individual, and $c(.)$ is a fixed, known scalar function (HosmerandLemeshow,1999). This is a semi-parametric model where the baseline hazard $h_0(t)$ is estimated non-parametrically, while the covariate effect is constrained by the parametric representation $c(\beta^l x)$ where, $c(.)$ take an exponential form

$$c(\beta^l x)=e^{\beta^l x}=e^{\sum_{i=1}^{p} \beta_i x_i}$$

which assures that the hazard is non-negative and assumes that covariate effects on the hazard are multiplicative. So,

$$h(t|x)=h_0(t)e^{\beta' x}= h_0(t)e^{\sum_{i=1}^{p} \beta_i x_i}.$$

Proportional Hazards (PH)

A key assumption of the Cox regression model is proportional hazards. The proportional hazards assumption means that the hazard ratio is constant over time, or that the hazard for an individual is proportional to the hazard for any other individual.

Let $x^*=(x_1^*,x_2^*,...,x_p^*)$ and $x=(x_1,x_2,...,x_p)$ be the covariates of two individuals. The hazard ratio is given as follows:

$$\frac{h_0(t)e^{\sum_{i=1}^{p} \beta_i x^*_i}}{h_0(t)e^{\sum_{i=1}^{p} \beta_i x_i}} = h_0(t)e^{\sum_{i=1}^{p} \beta_i (x^*_i - x_i)}$$

Likelihood Estimation for the Cox PH Model

Derivation of an estimator of β cannot be based on an ordinary likelihood functions in ce$h_0(t)$ is not specified parametrically in the Coxmodel. Instead, partial likelihood function has been proposed by Cox for the estimation of regression parameters which is a function depending on β only.

Cox Partial Likelihood

The partial likelihood method proposed by Coxin1975 gives essentially the same results as the last section for the model. Let $t_1, ..., t_n$ be the observed survival time for n individuals, and the ordered death time of r individuals be $t_{(1)}, ..., t_{(r)}$ The set of individuals who are at risk at t_j is denoted by $R(t_j)$. So that $R(t_j)$ is the group of individuals who are alive and uncensoredatatimejustpriortot_j. The conditional probability that the ith individual dies at t_j given that one individual from the risk set on $R(t_j)$ dies at t_j is:

$$\frac{h_i(t_j)}{\sum_{k \in R(tj)} h_k(t_j)} = \frac{h_0(t_j)e^{\beta^l x_j}}{\sum_{k \in R(tj)} h_0(t_j)e^{\beta^l x_k}} = \frac{e^{\beta^l x_j}}{\sum_{k \in R(tj)} e^{\beta^l x_k}}.$$

By taking the product of these conditional probabilities over r death times gives:

$$L(\beta) = \prod_{j=1}^{r} \frac{e^{\hat{\beta}^x x_{j_1}}}{\sum_{k \in R(t_j)} e^{\beta^x x_k}}.$$

Then the partial likelihood function for the Cox PH model is given by:

$$L(\beta) = \prod_{j=1}^{r} \left(\frac{e^{\beta^x x_{j_1}}}{\sum_{k \in R(t_j)} e^{\beta^x x_k}} \right)^{\delta_j}.$$

Where $R(t_j)$ is the risk set at time t_j and δ_j is the event indicator which is zero if the ith survival time is right censored and unity otherwise. This is the partial likelihood defined by Cox. The Cox methodology uses the partial likelihood to yield estimates of β that are consistent and efficient regardless of the form of $h_0(t)$. The partial likelihood is valid when there are no ties in the data set.

Model Building for CoxPH

In any applied setting performing a proportional hazard regression analysis of survival data requires a number of critical decisions. It is likely that we will have data on more covariates than we can reasonably expect to include in the model, so we must decide on a method to select a subset of the total number of covariates. When selecting a subset of covariates, we must consider such issues as clinical importance and statistical significance (Hosmer and Lemeshow, 1999). In statistics one of the method of selection of influential covariates is stepwise (forward selection and backward elimination) selection.

Model building starts from single covariate analysis as suggested by Collet (1994). Collet recommended the approach of first doing a single covariate analysis to "screen" out potentially significant variables for consideration in the multivariable model in order to identify the importance of each predictor. The purely statistical method is to use an automatic process 'step wise' regression. Finally, the importance of each variables included in the multivariable model should be verified by different model assessment techniques (Hosmer and Lemeshow, 1998).

Model Assumption

The key assumption of cox proportional hazard model is proportional hazard. The proportional hazards assumption means that the hazard ratio is constant over time, or that the hazard for an individual is proportional to the hazard for any other individual. When there are covariates in the analysis, which are not satisfy proportionality assumption since we have covariates information only at the time of the survey.

Model Adequacy Checking After the model has been fitted, the adequacy of the fitted model needs to be assessed which is usually performed using model residuals.

Cox-Snell Residuals

The Cox-Snell residual is given by Cox and Snell, which is used for assessing the fitness of PH model (Coxand Oakes,1984). The Cox-Snell residual for the ith individual is defined as:

$r_{ci} = exp(\hat{\beta}^l x_i)\hat{H}_0(t_i).$

Where $\hat{H}_0(t_i)$ is an estimate of the baseline cumulative hazard function at time ti. In practice, the Nelson Aalen estimate is generally used. If the final PH model is correct and the $\hat{\beta}$ are close to the true values of the β, then rci should resemble a censored sample from a unit exponential distribution. Therefore, a plot of the Nelson-Aalen cumulative hazard estimate of residuals $H\acute{}(rci)$ versus residuals rci should be a straight line through the origin with a slope of 1, if the fitted model is correct.

Proportional Hazard Assumption Checking

The main assumption of the Cox proportional hazards model is proportional hazards, which mean that the hazard ratio is constant over time. There are several methods for verifying that a model satisfies the assumption of proportionality (Graphical method, Scaled Schoenfeld residuals, Adding time dependent covariate) (Collett, 1994).

Scaled Schoenfeld Residuals

Scaled Schoenfeld residuals are defined as the product of the inverse of the estimated variance covariance matrix of the k^{th}Schoenfeld residual (LucyCheng, 2010). The scaled Schoenfeld residual can be used to assess time trends and lack of proportionality.

$r^*_{pji} = (V^{-1})r_{pji}.$

Where r^*_{pji} the Scaled Schoenfeld residual and r_{pji} is the Schoenfeld residual.

Under the null hypothesis, we expect to see a constant function over time. When the proportional hazards assumption holds, straight horizontal line with zero slopes is expected.

If this assumption is violated, the simple Cox PH model is invalid and more complicated analysis such as the stratified Cox regression model or the extended Cox regression model is required.

Stratified Cox Regression Model

The stratified Cox regression model is a modification of the Cox regression model that allows for control by stratification of a covariate that does not satisfy the proportional hazards assumption. Covariates that are assumed to satisfy the proportional hazards assumption are included in the model, however the predictors being stratified is not included. There are interaction and no-interaction models defined in the stratified Cox regression model (Therneau and Grambsch, 2000).

No-Interaction Model

In the stratified model with no interaction, the strata divide the individuals into K disjoint groups, each having a distinct baseline hazard h_{0k} (t) but a common value for the regression parameter which means that the coefficients β_1, ..., β_p are the same for each stratum. The hazard function for the failure time of an individual in stratum k takes the form:

$$h_k(t|x)=h_{0k}(t)exp(\beta^1 x)$$

Where K denotes the particular stratum (k=1, 2,...,K), β is a vector of unknown regression parameters, and $h_{0k}(t)$ are K unknown baseline hazard functions. The subscript k in the equation indicates that each stratum has its own baseline hazard function while the β' are the same across strata. Under the stratified model, it can be seen that individuals within the Kth stratum share the same baseline hazard function $h_{ok}(t)$ which implies that the proportional hazards for two individuals in the same stratum still holds:

$$\frac{h_k(t/x_1)}{h_k(t/x_1)} = exp(x_1 - x_1)\beta'.$$

On the other hand, individuals from different groups can have non-proportional hazards as their baseline hazards functions may differ. $\frac{h_{0k}(t)}{h_{0k'}(t)}$ Comparing strata k to k'.

Since these functions are unrestricted, any relationship of this hazard ratio over time is possible. The partial likelihood for the stratified Cox model is the product of partial likelihoods in each stratum:

$$L(\beta) = \prod_{k=1}^{K} L_k(\beta).$$

Interaction Model

The data set can be stratified in to k strata according to the variable that does not satisfy the proportional hazards assumption; in this case, the interaction model is defined as follows:

$$h_k(t|x)=h_{0k}exp[\beta_{1k}x_1,\beta_{2k}x_2,...,\beta_{pk}x_p]$$

In this interaction model, each regression coefficient has the subscript k, which denotes the kth stratum and indicates that the regression coefficients are different for different strata. So if there is no interaction the stratified Cox regression model will contains regression coefficients that do not vary over the strata. If interaction is allowed for, different coefficients for each of the stratum are obtained. Likelihood ratio test statistics is used to examine the no-interaction assumption;

$$LR = -2logL_{no\text{-}interaction} - [-2logL_{interaction}]$$

The likelihood ratio (LR) test compares log likelihood statistics for the interaction model and the no-interaction model.

Comparison of Models

Model comparison and selection are among the most common problems of statistical practice, with numerous procedures for choosing among a set of models (Kadane and Lazar, 2004). There are several methods of model selection. The most commonly used methods include Akaike information and likelihood based criteria. A data-driven model selection method such as an adapted version of Akaike's information criterion AIC is used to find the truncation point of a series of models (Akaike, 1974). In some circumstances, it might be useful to easily obtain AIC

value for a series of candidate models (Munda *et al.*, 2012). In this study, we used the AIC criterion and log likelihood to compare Cox PH and Stratified Cox regression models, and also compare semi-parametric with parametric model. AIC is defined as:

$$AIC = -2l + 2(k + c).$$

Where l is the log-likelihood, k is the number of covariates in the model and c is the number of model specific ancillary parameters. The addition of 2(k+c) can be thought of as a penalty if non predictive parameters are added to the model. Small values of AIC suggest a better model.

RESULT AND DISCUSSION

This chapter presents the analysis of data collected results and discussion of Risk Factors for death of patients with cardiovascular diseases.

at Hawassa Referral Hospital, Ethiopia. The study included 410 patients out of 3, 300 patients 13 years and above from patient cards, who had been on follow-up during the study period at Hawassa Referral Hospital. Summary of results for demographic, socio-economic and environmental covariates included in this study are presented in Table 1.

The result displayed in frequency table (Table 1) shows the major characteristics of the cardiovascular patients obtained in the study area patients' card. In this study, a total of 410 patients were considered for the analysis of the functional status of patient is recorded in two categories: Alive (censored) and Not alive (event). According to descriptive output among 410 patients, 48.8% are Alive during the study and 51.2% of patients are died or not alive.

Descriptive Statistics

The descriptive statistics was presented in the Table 1. In this study, a total of 410 patients with cardiovascular diseases were considered for the analysis.

Table 1: Summary of Covariates

Covariates	Categories	Event (%)	Censored (%)	Total
Sex	Female	108(46.6%)	124(53.4%)	232(56.6%)
	Male	102(57.3%)	76(42.7%)	178(43.4%)
Place of residence	Rural	121(53.1%)	107(46.9%)	228(55.6%)
	Urban	89(48.9%)	93(51.1%)	182(44.4%)
Education level	No education	62(44.9%)	76(55.1%)	138(33.7%)
	Primary	66(65.3%)	35(34.7%)	101(24.6%)
	Secondary	51(49.5%)	52(50.5%)	103(25.1%)
	Collage or above	31(45.6%)	37(54.4%)	68(16.6%)
Smoking use	No	126(40.9%)	182(59.1%)	308(75.1%)
	Yes	84(82.4%)	18(17.6%)	102(24.9%)

Alcoholic use	No	98(39.7%)	149(60.3%)	247(60.2%)
	Yes	112(68.7%)	51(31.3%)	163(39.8%)
Types of CVD	Coronary (IHD)	55(71.4%)	22(28.6%)	77(18.8%)
	CHD	11(50.0%)	11(50.0%)	22(5.4%)
	RHD	75(54.3%)	63(45.7%)	138(33.7%)
	Stroke	40(41.7%)	56(58.3%)	96(23.4%)
	HHD	10(30.3)	23(69.7%)	33(8.0%)
	Others	19(43.2%)	25(56.8%)	44(10.7%)
Blood pressure	Normal	42(31.6%)	91(68.4%)	133(32.4%)
	High	154(61.6%)	96(38.4%)	250(61.0%)
	Uncontrollable	14(51.9%)	13(48.1%)	27(6.6%)
Cholesterol level	Normal	83(36.9%)	142(63.1%)	25(54.9%)
	High	127(68.6%)	58(31.4%)	185(45.1%)
Pulse rate	Regular	142(47.5%)	157(52.5%)	299(72.9%)
	Irregular	68(61.3%)	43(38.7%)	111(27.1%)
Continuous Variables	Age at start of treatment	Mean	Standard deviation	Sample size
		40.65	19.135	410

From Table1, we observe that, out of the total of 410 patients of cardiovascular included in the study, 56.6% of the patients were female and 43.4% male. Among those patients, by considering sex, the death proportion for female is 46.6% which is lower than that of male patients which is 57.3%. About 55.6% of patients were from rural area and 44.4% from urban area. From the total sample, the death proportion for rural resident which is 53.1% seems larger than urban resident which is 48.9%.

Regarding to education level, which measure 33.7% had no education, 24.6% had primary, 25.1% had secondary and 16.6% were college or above. From this, the death proportion were highest for those patients who had Primary which is 65.3%, followed by those who had secondary education which is 49.5%, while the lowest proportion of death 45.6% and 44.9% were patients who had college or above and no education respectively.

Out of the total cardiovascular patients included in this study, 75.1% of patients were non smokers and 24.9% were smokers. The death proportion was highest for those patients who smoker which is 82.4% compared to non-smokers with 40.9%. 60.2% of patients were not alcohol users and 39.8% were alcoholic users. The death proportion for alcohol user patients is 68.7%, greater than that of patients who were not alcohol users which is39.7%.

Regarding types of cardiovascular diseases, 18.8% were Coronary (IHD), 5.4% were CHD, 33.7% were RHD, 23.4% were Stroke, 8.0% were HHD and 10.7% were Others CVD. From this, the death proportion were highest for those patients who had Coronary (IHD) which is 71.4%, followed by those who had RHD which is 54.3%, CHD which is 50.0%, Others which is

43.2%, Stroke which is 41.7%, while the lowest proportion of death 30.3% was among who had HHD.

Regarding blood pressure, 32.4% were normal, 61.0% were high and 6.6% were uncontrollable. From this, the death proportion were highest for those patients who had high blood pressure which is 61.6%, followed by those who had uncontrollable which is 51.9%, while patients who had normal the lowest proportion of death 31.6%.

Regarding cholesterol level, which measure 54.9% was normal and 45.1% were high. From this, the death proportion was highest for those patients who had high which are 68.6% and lowest 36.9% for patients who had normal cholesterol level. Regarding to pulse rate, 27.1% were irregular and 72.9% were regular. From this, the death proportion was highest for those patients who had irregular which is 61.3% and lowest 47.5% for patients who had regular pulse rate.

Survival Analysis

Descriptive survival analysis was employed to compare the survival times in different groups. We use log-rank test and Kaplan-Meier survival estimates to look in to the significance of the difference in survival experience among different factors. The results of the log-rank test for the equality of survivor functions are presented in Table2. The null hypotheses to be tested have been no difference between the probabilities of an event occurring at any time point for each population.

Table2: Log-rank test for equality of Survival function among the different groups of covariates for the Death of Cardiovascular Patients.

Covariates	Chi-square value	DF	P-value
Sex	5.5	1	0.019
Place of residence	2.2	1	0.137
Education level	14.4	3	0.002
Smoking use	32.2	1	0.000
Alcoholic use	27.5	1	0.000
Types of CVD	20.9	5	0.001
Blood pressure	21.5	2	0.000
Cholesterol level	27.3	1	0.000
Pulse rate	3.5	1	0.062

The log-rank test results in Table 2 show that Sex, Education level, Smoking use, Alcoholic use, Types of CVD, Blood pressure and Cholesterol level are a significant covariate at 5% level of significance, whose different levels have an impact in the survival time of cardiovascular patients, whereas Place of residence and Pulse rate do not have significance impact at 5% level of significance.

The Kaplan-Meier estimator survival curve can be used to estimate survivor function among different covariates so that one can make comparison. Separate graphs of the estimates of the Kaplan-Meier survivor functions are constructed for different categorical covariates. In general, the survivorship pattern of one is lying above another means the group defined by the upper curve has a better survival than the group defined by the lower curve.

On the figure 1, 2, 3 and 4 the Kaplan-Meier survival curve revealed that patients who drink alcohol and smoking cigarettes had less survival time as compared to the other groups which do not drink alcohol and non-smoker patients. Similarly, male patients, abnormal blood pressure and high level of cholesterol survived poorly as compared to female patients, patients with normal blood pressure and normal cholesterol level patients respectively. Patients that are affected by different types of CVD which is; Coronary (Ischemic) heart diseases had less survival time as compared to patients that are affected by Rheumatic heart diseases, Congenital heart diseases, Stroke, Others CVD and Hypertensive heart diseases; Rheumatic heart diseases had less survival time as compared to patients that are affected by Congenital heart diseases, Stroke, Others CVD and Hypertensive heart diseases; Congenital heart diseases had less survival time as compared to patients that are affected by Stroke, Others CVD and Hypertensive heart diseases; Stroke had less survival time as compared to patients that are affected by Others CVD and Hypertensive heart diseases; Others CVD had less survival time as compared to patients that are affected by Hypertensive heart diseases.
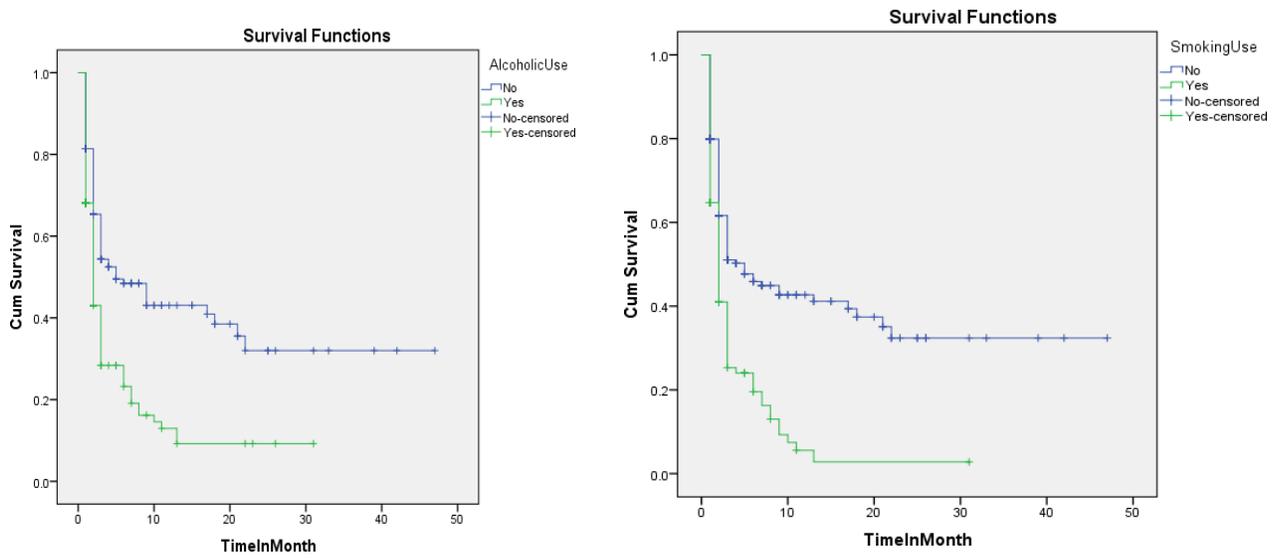
Figure 1: Survival Curves by Alcoholic Use and Smoking
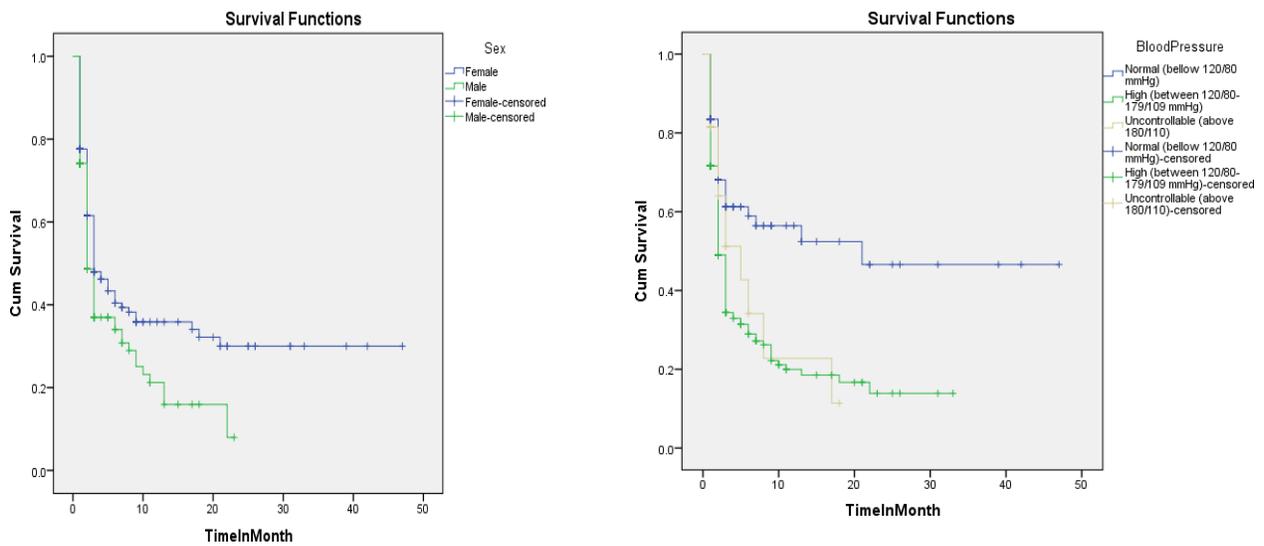
Figure 2: Survival Curves by Sex and Blood Pressure
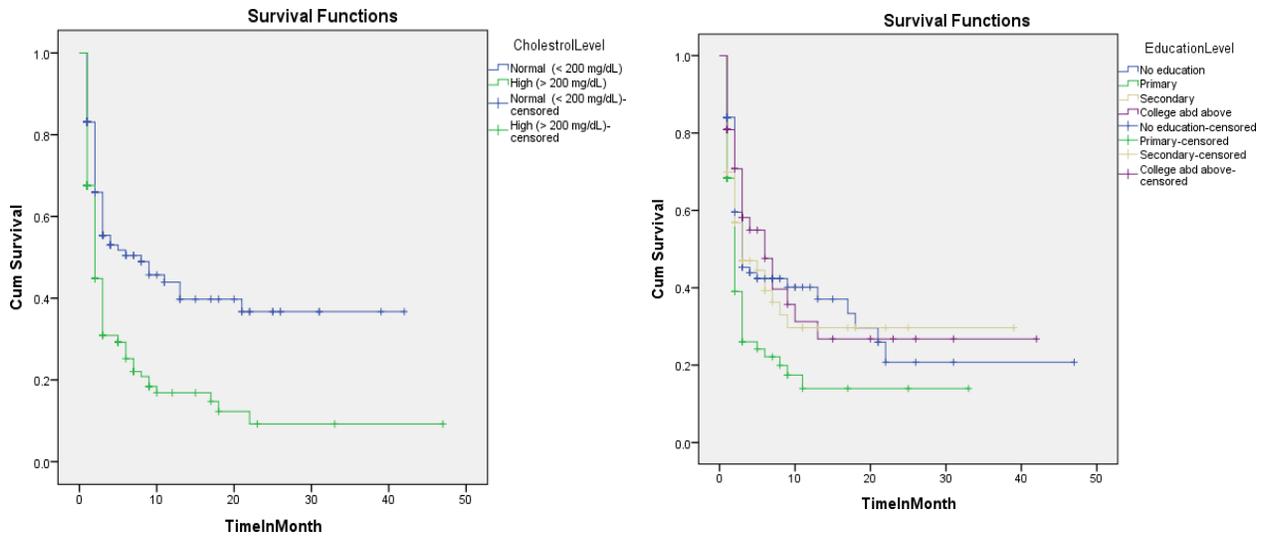
Figure 3: Survival Curves by Cholesterol Level and Education Level
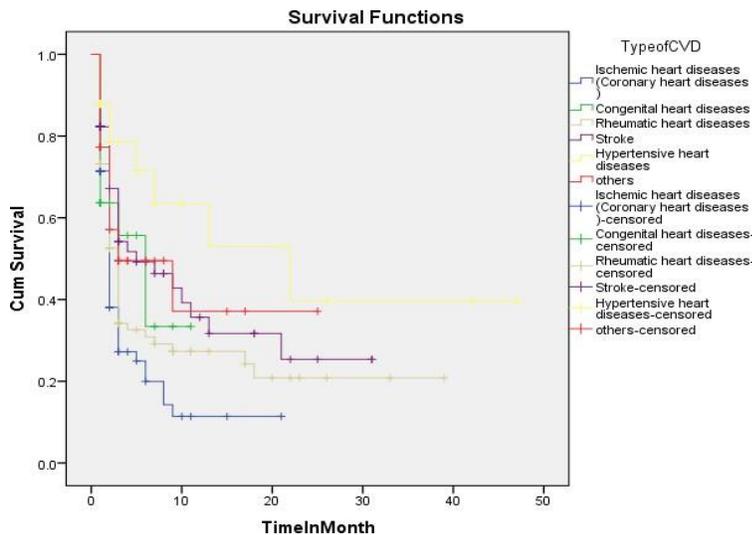
Figure 4: Survival Curves by Types of CVD

Single Covariate Cox PH Regression Analysis

To determine the variables to be included in the final model, the single covariate Cox PH regression analysis is applied first to identify the impact of individual variable on time to event beforeproceedingmorecomplicatedmodelselection.Variablesareidentifiedassignificant using a 0.25 significance level in the single covariate analysis.

Table 3: Results of Single Covariate Cox PH Analysis

| Covariates	Categories	Coef	SE(coef)	p-value	exp(coe)	95% CI
Age		0.008548	0.003636	0.0187	1.008584	1.001 , 1.016
Sex	sex0(ref.)				1	
	sex1	0.3218	0.1389	0.0205	1.3796	1.051 , 1.811
Types of CVD	TypofCVD0(ref.)				1	
	TypofCVD1	-0.4040	0.3307	0.221832	0.6676	0.3491, 1.2766
	TypofCVD2	-0.3022	0.1781	0.089777	0.7392	0.5213, 1.0480
	TypofCVD3	-0.7005	0.2086	0.000784	0.4963	0.3298, 0.7470
	TypofCVD4	-1.2074	0.3456	0.000477	0.2990	0.1519 , 0.5886
	TypofCVD5	-0.6164	0.2664	0.020649	0.5399	0.3203, 0.9099
Place of Residence	PlaceResid.0(ref.)				1	
	PlaceResid.1	-0.2111	0.1401	0.312	0.8097	0.6153, 1.066
Education level	Educ.Level0(ref.)				1	
	Educ.Level1	0.58981	0.17740	0.000885	1.8036	1.2739, 2.554
	Educ.Level2	0.20503	0.18916	0.278418	1.2276	0.8473, 1.779
	Educ.Level3	-0.08527	0.22015	0.698530	0.9183	0.5965, 1.414
Blood pressure	BloodPress.0(ref.)				1	
	BloodPress.1	0.7725	0.1744	9.48e-06	2.165	1.5382, 3.047
	BloodPress.2	0.5239	0.3090	0.09	1.689	0.9214, 3.094
Cholesterol level	Chole.Level0(ref.)				1	
	Chole.Level1	0.7217	0.1416	3.42e-07	2.058	1.559, 2.716
Alcohol use	AlcoholUse0(ref.)				1	
	AlcoholUse1	0.7154	0.1391	2.71e-07	2.045	1.557, 2.686
Smoking use	SmokUse0(ref.)				1	
	SmokUse1	0.7854	0.1420	3.21e-08	2.193	1.66, 2.897
Pulse rate	PulRate0(ref.)				1	
	PulRate1	0.2788	0.1475	0.0588	1.3215	0.5667, 1.5621

According to the single covariate Cox PH analysis (Table 3), that the covariates Age, Sex, Types of CVD, Education Level, Blood Pressure, Cholesterol Level, Alcoholic Use, Smoking Use and Pulse Rate are statistically significant at 0.25 level of significance and selected as significant risk factors for the death of cardiovascular patients from single covariate analysis.

Multivariable Cox PH Regression Analysis

Full multivariable Cox PH analysis (by using step wise selection process) including all the potential risk factors that had a P-value of less than or equal 0.05 in single covariate Cox PH analysis was conducted. To select the best subgroup of variables in our model, the approach of stepwise was applied. The step wise selection process consists of a series of alternating forward selection and backward elimination steps. It means only variables with P-value less than or equal to 0.05 will be tested in the model, and to keep it in the model, its P-value should be less than or equal to 0.05. The results from the step wise proportional hazard regression are displayed as Table 4.

Table 4: Results of the Multivariable Cox PH Analysis

| Covariates	Categories	Coef	se(coef)	p-value	exp(coef)	95% CI
Age		0.00528	0.0038	0.1678	1.0053	0.9978, 1.0129
Sex	sex0(ref.)				1	
	sex1	-0.100028	0.1605	0.5332	0.9048	0.6605, 1.2394
Types of CVD	TypofCVD0(ref.)				1	
	TypofCVD1	-0.349352	0.3430	0.3085	0.7051	0.3600, 1.3813
	TypofCVD2	-0.052369	0.1852	0.7774	0.9490	0.6600, 1.3644
	TypofCVD3	-0.487447	0.2119	0.0214	0.6142	0.4055, 0.9304
	TypofCVD4	-0.660886	0.3600	0.0664	0.5164	0.2550, 1.0457
	TypofCVD5	-0.251803	0.2777	0.3646	0.7774	0.4511, 1.3398
Education level	Educ.Level0(ref.)				1	
	Educ.Level1	0.447070	0.1850	0.0157	1.5637	1.0882, 2.2470
	Educ.Level2	0.154412	0.2029	0.4466	1.1670	0.7841, 1.7368
	Educ.Level3	-0.385917	0.2360	0.1021	0.6798	0.4280, 1.0797
Blood pressure	BloodPress.0(ref.)				1	
	BloodPress.1	0.644993	0.1820	0.0004	1.9060	1.3342, 2.7228
	BloodPress.2	0.044743	0.3270	0.8912	1.0458	0.5509, 1.9851
Cholesterol level	Chole.Level0(ref.)				1	
	Chole.Level1	0.492644	0.1492	0.0010	1.6366	1.2217, 2.1925
Alcohol use	AlcoholUse0(ref.)				1	
	AlcoholUse1	0.432842	0.1813	0.0170	1.5416	1.0805, 2.1996
Smoking use	SmokUse0(ref.)				1	
	SmokUse1	0.403784	0.1682	0.0164	1.4975	1.0770, 2.0822
Pulse rate	PulRate0(ref.)				1	
	PulRate1	0.381823	0.1549	0.0137	1.4649	0.5039, 1.9248

To further optimize the Cox model, the variable with the highest P-value and over threshold of significance are removed from the predictive model one by one until all the rest variables are shown significant impact on the prediction of hazard rate. From Table 4 the variables Age and sex are the variables with highest p-value, so it is removed. The result is shown as Table 5.

Table 5: Elimination of Variables with High p-value by Stepwise Selection Process

Covariates	Categories	Coef	se(coef)	p-value	exp(coef)	95% CI
Types of CVD	TypofCVD0(ref.)				1	
	TypofCVD1	-0.377	0.337	0.2648	0.686	0.3540 , 1.3287
	TypofCVD2	-0.069	0.184	0.7066	0.9336	0.6511, 1.3376
	TypofCVD3	-0.481	0.212	0.0232	0.6186	0.4080, 0.9363
	TypofCVD4	-0.640	0.359	0.0744	0.5276	0.2611, 1.0652
	TypofCVD5	-0.308	0.274	0.2614	0.735	0.4291, 1.2582
Education level	Educ.Level0(ref.)				1	
	Educ.Level1	0.413	0.183	0.0239	1.512	1.0561, 2.1635
	Educ.Level2	0.114	0.199	0.5649	1.121	0.7594, 1.6555
	Educ.Level3	-0.419	0.235	0.0741	0.658	0.4152 , 1.0417
Blood pressure	BloodPress.0(ref.)				1	
	BloodPress.1	0.621	0.181	0.0006	1.861	1.3050, 2.6539
	BloodPress.2	0.091	0.324	0.7778	1.096	0.5808, 2.0673
Cholesterol level	Chole.Level0(ref.)				1	
	Chole.Level1	0.504	0.149	0.0007	1.656	1.2374, 2.2151
Alcoholic use	AlcoholUse0(ref.)				1	
	AlcoholUse1	0.422	0.171	0.0136	1.525	1.0906, 2.1335
Smoking use	SmokUse0(ref.)				1	
	SmokUse1	0.416	0.166	0.0125	1.515	1.0938 , 2.0993
Pulse rate	PulRate0(ref.)				1	
	PulRate1	0.396	0.153	0.0094	1.486	0.4989, 1.9072

The final model is presented in Table 5; the data showed that most of the predictors are significant in the model with their p-value less than 0.05. After we built a multivariable model of main effects, we then check all the interactions between predictors. To test the interaction among variables, the list of all raw variables and all possible combinations of interactions are included for proportional hazard regression analysis however none of the interactions are significant. Eventually, the final model is generated including the variable Types of CVD, Education Level, Blood Pressure, Cholesterol Level, Alcoholic Use, Smoking Use and Pulse Rate.

The final multivariable Cox PH model concluded that: The variable Types of CVD, Education level, Blood pressure, Cholesterol level, Alcohol use, Smoking use, and Pulse rate are the more risk factor for the death of cardiovascular patients, those variables significantly affects the survival of cardiovascular patients. After fitting Cox PH model, we can plot the survivor and cumulative hazard, as shown in figure5
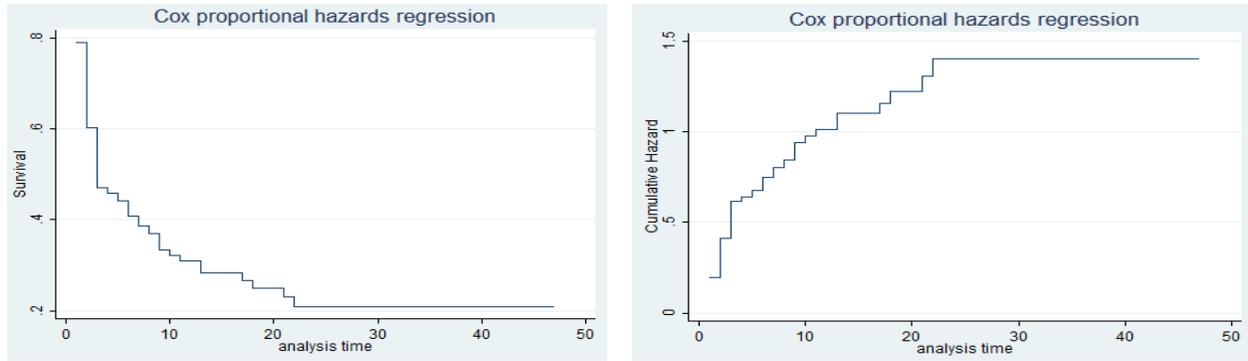
a. Overall Kaplan-Meier Survivor function   b. cumulative hazard function plot

Figure 5: Cox PH model: Survivorship Function and Cumulative Hazard Function Plot

Figure 5 of the first plot shows the estimate of the overall Kaplan-Meier Survivor function revealed that most of the deaths occurred in the earlier months of time and it declined in the later months of follow-up. Similarly, the second plot is cumulative hazard function plot implies that the hazard increases when the month of follow-up increases.

Model checking

Adequacy of a fitted model needs to be assessed after a model has been constructed. It is desirable to determine whether a fitted Cox PH regression model adequately describes the dataornot.Thisincludesatestforviolationoftheassumptionofproportionalhazardsand   measuring the overall goodness of fit of the model.

Assessing the goodness of fit of the model

The goodness of fit of the proportional hazards model need to be checked based on the empirical data. The statistic used to determine the overall significance of a Cox model is called the likelihood ratio test. The likelihood ratio test compares the likelihood of the full model (the model with covariates) with the likelihood of the null model (a model which contains only the intercept or empty model) . Then, the fitness of the model can assess by testing the hypothesis that all the parameters of the final model are zero or not.

Therefore, the model fitted in this study the Likelihood Ratio, score and Wald tests are used to compare (at 5% significance level) the goodness of fit of the model. The output inTable6 reveal that the log partial likelihood function (-2LL) and AIC without covariate was 2218.007 and 2218.007, while the function with covariates was 2189.77 and 2217.776 respectively. This means the likelihood ratio test of the model chi-square of 77.5 with 14 degrees of freedom and p-value $7.997e-11$, and also Wald of test the model is chi-square of 75.29 with DF 14 and p-value $2.09e-10$ and Score test of the model chi-square of 79.11 with DF 14 and p-value $4.14e-11$, which is the p-value in all tests <0.0001 shows that the model is appropriate. The test of hypothesis that all coefficients in the model are zero, that is, an overall test of whether the model as a whole can predict changes in the hazard rate. Here the tests agree, and it appears that at least

one of our regression coefficients is significantly different from zero. Thus the model fits the data very well.

Table 6: Results of the Model Fit

Model	Model fitting Criterion		Likelihood ratio test		
	-2 LogLikelihood	AIC	Chi-square	Df	Sig.
Empty	2218.007	2218.007			
Final	2189.776	2217.776	77.56	14	7.997e-11

The PH Assumption Checking

The final model is based on a major assumption that the hazards between groups are proportional. To test the assumption of proportionality, the scaled Schoenfeld residuals have been used.

Scaled Schoenfeld residuals

Table 7: Results of Scaled Schoenfeld Residuals for All Fitted Covariates of Cox PH Model

Cavariates	rho	Chisq	P
Type of CVD	-0.00524	0.00665	0.035
Education Level	-0.09905	1.96551	0.051
Cholesterol Level	-0.00937	0.02019	0.887
Alcoholic Use	0.03608	0.34200	0.559
Blood Pressure	0.09545	1.61336	0.024
Smoking Use	0.08095	1.65246	0.199
Pulse Rate	-0.01128	0.02701	0.869

The results in Table 7 shows that the p-value corresponding to covariates Education Level, Types of CVD and Blood Pressure are less than 0.05 indicating that p-value of rho statistic is less than 5% for a given covariates indicates the rejection of null hypothesis of the proportionality of Cox proportional hazard model, the assumption of proportional hazard is not satisfied for those variables. Conversely, the p-values were greater than 0.05 for all the remaining covariates like Cholesterol Level, Alcoholic Use, Smoking Use, and Pulse Rate. Therefore, there is not enough evidence to reject the null hypothesis that the covariates Cholesterol Level, Alcoholic Use, Smoking Use and Pulse Rate satisfy the assumption of proportional hazard.

Cox-Snell Residuals

We assess the adequacy of the fitted by using Cox-Snell residual plot. The plot of the cumulative hazard function of the Cox-Snell residuals against the Cox-Snell residuals is presented in Figure6 below. In Figure6, the black line is the estimation of Cox-Snell residuals while the red line is the origin with a slope equals to 1. The plot suggests that the Cox PH model does not fit the straight line adequately. There is some evidence of a systematic deviation from the straight line which gives us some concern about the adequacy of the fitted model. As the scaled Schoenfeld residuals showed that the Cox PH model displayed non-proportionality for variable Education Level, Types of CVD and Blood Pressure and also the Cox-Snell residuals suggests that the Cox PH model does not fit the data adequately, so the Stratified Cox regression model is more adequate to be used.
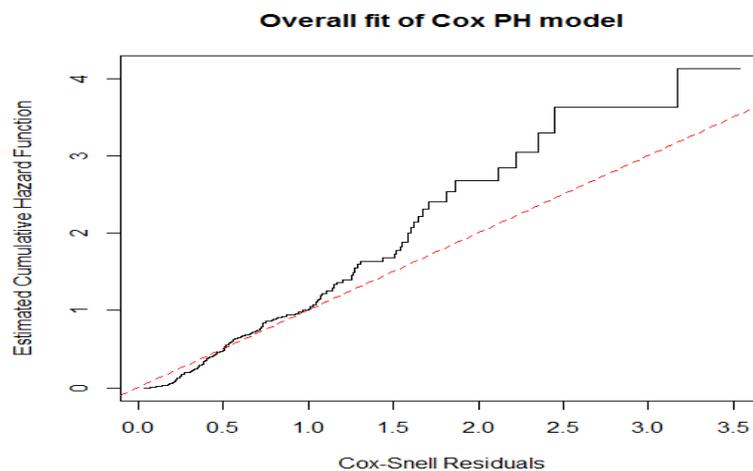

Figure 6: The Cox-Snell Residual Plot for Cox PH Model.

The Stratified Cox Regression Model

One way of accommodating non-proportional hazards in model is to use the Stratified Cox regression model. Stratification entails fitting separate baseline hazard functions across strata (in this study Education level, blood pressure and Types of CVD category). A baseline hazard function represents the hazard rate over time for an individual with all modeled covariates set to zero. With a Stratified Cox model, a proportional hazards structure does not necessarily hold for the combined data, but is assumed to hold within each Education level, Blood pressure and Types of CVD. There are Interaction and No-interaction models defined in the stratified Cox regression model. The stratified Cox regression with No-interaction model, the coefficients on the included covariates are common across Education level, Blood pressure and Types of CVD categories in the No-interaction model so that the relative effect of each predictor is the same across Education level, Blood pressure and Types of CVD. But, in the Interaction model the coefficients on the included covariates are different across (strata) Education level, Blood pressure and Types of CVD categories. As we have attempted to show in the previous section, the proportional hazards assumption is not satisfied for the covariate Education level, Blood pressure and Types of CVD. Hence, the Stratified Cox regression model is used to obtain the estimated coefficients of the remaining covariates after stratification by Education level, Blood pressure and Types of CVD.

No-Interaction Model

The stratified Cox regression with No-interaction model, the coefficients on the included covariates are common across Education level, Blood pressure and Types of CVD categories in the No-interaction model so that the relative effect of each predictor is the same across Education level, Blood pressure and Types of CVD. The coefficients on the included covariates are different across (strata) Education level, Blood pressure and Types of CVD categories. The results in Table10 show the final fitted Stratified Cox regression model, Education level as strata. In this model, from p-values Types of CVD, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are found to be important risk factors which affect the survival time of patients with cardiovascular diseases. TypofCVD3, TypofCVD4, BloodPress.1, Chole.Level1, AlcoholUse1, SmokUse1 and PulRate1 are the important level that statistically significant contribution for mortality of cardiovascular patients at 5% level of significance. The results in Table 11 show the final fitted Stratified Cox regression model, Blood pressure as strata. In this model, from p-values types of CVD, Education level, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are found to be important risk factors which affect the survival of patients with cardiovascular diseases. TypofCVD3, Educ.Level.1, Chole.Level1, AlcoholUse1, SmokUse1 and PulRate1 are the important level that statistically significant contribution for mortality of cardiovascular patients at 5% level of significance. The results in Table 12 show the final fitted Stratified Cox regression model, Types of CVD as strata. In this model, from p-values Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are found to be important risk factors which affect the survival time of patients with cardiovascular diseases. Educ.Level1, BloodPress.1, Chole.Level1, AlcoholUse1, SmokUse1 and PulRate1 are the important level that statistically significant contribution for mortality of cardiovascular patients at 5% level of significance.

In survival analysis, comparisons between a number of possible models can also be made based on the Akaike Information criterion (AIC) and Bayesian Information Criterion (BIC). The guiding principle is that the smaller value of AIC and BIC is better the fit of the model to the data. The values of AIC and BIC can be compared across different models, from the Stratified Cox Regression with No-interaction model Education level, Blood pressure and Types of CVD as strata, the AIC and BIC of those models are shown in Table 12; 1580.161, 1839.775 and 1500.89 the BIC of the models are also 1624.338, 1887.969 and 1537.035 respectively. In addition to this, the log partial likelihood function (-2LL) of those models are 1558.161 with Df 11, 1815.775 with Df 12 and 1482.89 with Df 9 respectively. This implies that model information criteria (AIC and BIC) and log partial likelihood function (-2LL) values for the Stratified Cox regression with No-interaction models Types of CVD as strata is small as compared to other two Stratified Cox regression with No-interaction models use Education level and Blood pressure as strata revealed that, the No-interaction model Types of CVD use as strata is more adequate than that of the Stratified Cox regression with No-interaction models uses other covariates as strata. This model, Stratified Cox regression with No-interaction model Types of CVD as strata is a better fitting and appropriate model.

Interaction Model

The data set can be stratified in to different strata according to the variables Education level, Blood pressure and Types of CVD that does not satisfy the proportional hazards assumption. The Interaction model the coefficients on the included covariates are different across (strata) Education level, Blood pressure and Types of CVD categories.

In those models, Stratified Cox regression with Interaction models the covariates Education level, Blood pressure and Types of CVD uses as strata. For the three Interaction models, the data set is divided in to three, two and five strata according to the covariates Education level, Blood pressure and Types of CVD respectively. These three Interaction models are shown in Table 13, 14 and 15. From Table 14, we observe that model information criteria (AIC and BIC) and log partial likelihood function (-2LL) values for the Stratified Cox regression with Interaction models that use Types of CVD as strata is small as compared to other two Stratified Cox regression with Interaction models that use Education level and Blood pressure The strata revealed that the Interaction model using Types of CVD as strata is more adequate than that of the Stratified Cox regression with Interaction models that use other covariates as strata. This model, Stratified Cox regression with Interaction model using Types of CVD as strata is a better fitting and appropriate model. In survival analysis, comparisons between a number of possible models can also be made on the AIC, BIC or -2log likelihood function (-2LL). The values of AIC, BIC and -2LL for the stratified Cox regression with No-interaction and with Interaction model are given inTable 8.

Table 8: Results of Comparison of Stratified Cox Regression with Interaction and with No-interaction Models

Criterion	Stratified Cox Regression models					
	No-interaction model			**Interaction model**		
	Education level as strata	**Blood pressure as strata**	**Types of CVD as strata**	**Education level as strata**	**Blood pressure as strata**	**Types of CVD as strata**
AIC	1580.161	1839.775	1500.89	1606.504	1847.063	1526.074
BIC	1624.338	1887.969	1537.035	1783.215	1991.645	1742.947
-2 LogLikelihood	1558.161	1815.775	1482.89	1518.504	1775.063	1418.074

Our study shows that, according to the AIC, BIC and -2LL, using the stratified Cox regression with No-interaction model use Types of CVD as strata gives more suitable results for survival data in the presence of non-proportional hazards.

Table 9: Results of Stratified Cox Regression with No-Interaction Model, Types of CVD as Strata

Covariates	Categories	Coef	exp(coef)	se(coef)	P-value	95% CI
Education level	Educ.Level0(ref.)					
	Educ.Level1	0.3847	1.469	0.184	0.03600	1.0248 , 2.1061
	Educ.Level2	0.1003	1.106	0.200	0.62000	0.7470 , 1.6362
	Educ.Level3	-0.4192	0.658	0.236	0.07600	0.4139 , 1.0446
Blood pressure	BloodPress.0(ref.)					
	BloodPress.1	0.6162	1.852	0.183	0.00075	1.2942 , 2.6496
	BloodPress.2	0.0839	1.088	0.327	0.80000	0.5732 , 2.0632
Cholesterol level	Chole.Level0(ref.)					
	Chole.Level1	0.5217	1.685	0.150	0.00049	1.2566 , 2.2594
Alcoholic use	AlcoholUse0(ref.)					
	AlcoholUse1	0.4218	1.525	0.172	0.01400	1.0894 , 2.1340
Smoking use	SmokUse0(ref.)					
	SmokUse1	0.3731	1.452	0.167	0.02600	1.0459 , 2.0164
Pulse rate	PulRate0(ref.)					
	PulRate1	0.3763	1.4568	0.153	0.01400	0.5085 , 1.9266

Models Comparison

In survival analysis, comparisons between a number of possible models can also be made based on the AIC and BIC. The guiding principle is that the smaller value of AIC and BIC is better the fit of the model to the data. The values of AIC and BIC can be compared across different models. The values of AIC and BIC for the Cox PH model and stratified regression model Table 9.

Table 10: Results for Model Information Criterion

Model	AIC	BIC
Cox PH model	2217.776	2274.002
Stratified Cox regression	1500.89	1537.035

Table 9 provides the model information criteria values for Cox PH model and Stratified Cox regression with No-interaction model use Types of CVD as strata. Thus, Stratified Cox regression model with smaller AIC and BIC values is a better fitting and appropriate model. This shows that using Stratified Cox regression model gives more suitable results for survival data in the presence of non-proportional hazards. Stratified Cox regression model showed that the variables; Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are statistically significant and selected as significant factors for risk of death of patients with cardiovascular diseases at 0.05 level of significance.

DISCUSSION

This study was aimed to determine the prognostic factors that affect the survival of cardiovascular patients who are under treatment follow-up at Hawassa University Comprehensive Specialized Hospital, Ethiopia. For these purpose, survival analyses are used. The results obtained are discussed as follows:

In the survival analysis, Cox PH model and Stratified Cox regression models are used. Assuming the value of AIC and BIC presented in Table 9. This leads us with the choice between the models Cox PH and Stratified Cox regression due to small values in AIC and BIC, we choose the best model fit the data adequately, which is Stratified Cox regression has small values of AIC and BIC.

Although as elsewhere, cardiovascular disease is a multifactor in Ethiopia, the several risk factors have been identified, the intervention against any one of them in selected high risk individuals is unlikely to influence the overall mortality in cardiovascular diseases. It is unethical not to treat high risk individuals but for maximal public health benefit, a population perspective must be considered. The main aim of this study was to identify factors for the death of patients with cardiovascular diseases in Hawassa University Comprehensive Specialized Hospital, Ethiopia. Both single covariate and multivariable statistical analysis were employed to examine associated factors affecting cardiovascular patient's death. Our analysis revealed that some demographic, socio economic and environmental factors had statistically significant effect on the death of patients with cardiovascular diseases. The variables influencing cardiovascular patient's death identified in this study are; Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate. Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are the important level that statistically significant contribution for mortality of cardiovascular patients at 5% level of significance.

Results obtained from this study were found to be comparable with some studies found in earlier studies in the literature. According to this study Sex of patients with cardiovascular diseases is

not significant effect on the survival of cardiovascular patients. The present finding also contradict with earlier results by (Alwan *et al*., 2010), the risk of death of male patients is higher as compare to that of female.

The present study reveals that Education level of the patients significantly affects the survival of patients with cardiovascular diseases. The finding of a study by Kilander *et al*. (2001) shows thatlow education was associated with a higher rate of mortality from cardiovascular disease (crude relative risk compared to high educational attainment).

The major behavioral risk factors for cardiovascular diseases are: tobacco use and excessive alcohol consumption. The risk of death of smoker and alcoholic user patients with cardiovascular diseases is higher as compare to non-smoker and not alcoholic user patients. Those risk factors are associated with other rather than cardiovascular diseases that account for about 80% of deaths from those diseases (Lozano *et al*., 2012). Use of Alcohols also found to be predictive factors that significantly affect the survival of patients with cardiovascular diseases.

This study revealed that cardiovascular patients with access to normal blood pressure had less risk of death as compared to those from patients having abnormal blood pressure. This result is similar to the findings of the study in Ethiopia, by (Muluneh *et al*., 2012) which agrees with other studies showing the occurrence of a "silent epidemic" of high blood pressure in developing countries, particularly in Ethiopia (Awoke *et al*., 2012). The result also revealed that blood pressure is associated with the risk of patients with cardiovascular diseases mortality. A study in Ethiopia among adults in Addis Ababa also reported a prevalence of hypertension (blood pressure), an important CVD risk factor for the death of cardiovascular patients (Tesfaye *et al*., 2009).

A pulse rate has a significant effect on the death of patients with cardiovascular diseases. The finding reveals that the risk of death of cardiovascular patients that have irregular pulse rate is higher relative to those patients having regular pulse rate. The findings of the study by Johannes (2012) who investigated the risk factors that determine the patients with cardiovascular diseases in Ethiopia suggested that the patients having irregular pulse rate were much more likely to die than the patients having regular (normal) pulse rate.

The result shows that the patients that have high cholesterol level are higher at risk as compared to the other who has a normal cholesterol level. The finding confirmed by previous study, a high cholesterol concentration was firmly established as a risk factor for patients with cardiovascular diseases mortality (Yuanxin, 2013).

According to this study the covariate, Age of patients at start of treatment and Sex are not significant effect on the death of cardiovascular patients, Alcoholic use and Smoking are significantly affect the survival of patients with cardiovascular diseases. The present finding is contradicted with the finding of a study by Yohhanes (2011) who investigated the risk factors that determine the patients with cardiovascular diseases mortality in Ethiopia. His results suggested that Age and Sex have significant effect on the death of cardiovascular patients, but Alcoholic use and smoking are not significantly that affect the survival of patients with cardiovascular diseases.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The study was aimed to identify prognostic factors for the death of patients with cardiovascular diseases who are under treatment follow-up at Hawassa University Comprehensive Specialized Hospital, Ethiopia.

In assessing the significance risk factors in the Log-Rank test showed that Sex, Education level, Smoking use, Alcoholic use, Types of CVD, Blood pressure and Cholesterol level were significant covariates whose different levels have an impact in the survival of cardiovascular patients. The result of this study also indicates that the survival probability of a patient's with cardiovascular diseases was statistically the same among groups classified by Place of residence and Pulse rate.

The scaled Schoenfeld residuals showed that the Cox PH model displayed non-proportionality for variables Education Level, Types of CVD and Blood Pressure. For this reason, Stratified Cox regression model were applied by using Education Level, Types of CVD and Blood Pressure as strata.

To analyze and model, the survival time of cardiovascular patients, Cox PH model and stratified Cox regression models were applied. The stratified Cox regression with no-interaction model use Types of CVD as strata is better fits to the data on the survival time of cardiovascular patients at Hawassa University Comprehensive Specialized Hospital. From the analysis of the stratified Cox regression model, the variables Education level, Blood pressure, Cholesterol level, Alcoholic use, Smoking Use and Pulse Rate are statistically significant risk factors for death of cardiovascular patients at 0.05 level of significance.

Recommendations

These recommendations are based on the findings of this analysis of the cardiovascular patient's data set taken from Hawassa University Comprehensive Specialized Hospital, Ethiopia. Based on the study prognostic factors were identified for time-to-death. We recommend the following:

➢   Awareness should be created by health professional on the identified factors in this study.
   ➢ Awareness should be raised among policy makers and the public at large, on the current magnitude of cardiovascular disease died related risk factors.
   ➢ The health care workers should work on interventions required to control the risk factors.
   ➢ The ministry of health also should create a great awareness about risk factors associated with cardiovascular diseases and survival of patients.
   ➢ Further studies should be conducted in the regions of Ethiopia and identify other prognostic factors that are not considered in this study.

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Determinants of Women Migration to Middle East Countries: The Case of Southern Ethiopia
Cheru Atsmegiorgis*

Department of Statistics, *E-mail: cherueden@yahoo.com,

ABSTRACT

Being one of the most populated countries in Sub Saharan Africa, three-quarters of the general population of Ethiopia consists of women and children that are exposed to widespread poverty. As gender attributes are usually assigned by cultures, the migration choices and constraints for females can vary vastly depending on their socio-cultural origins. This research aimed at investigating the main causes of very high migration of women to Arab countries from south Ethiopia. Moreover, pinpointing the decision maker for women to migrate to the Arab countries was the other concern of this research. The study population was women who were requesting visa from South branch immigration Bureau to move to these Arab countries. Primary data were collected using one of the instruments of data collection called interview guide. Pretesting was conducted using a pilot survey on ten percent of the sample women in order to check the adequacy of the interview guide. A cross-sectional study design was employed to conduct this study. Samples of three hundred thirty women were selected using systematic random sampling method after the sampling frame is secured from the immigration bureau. Among the descriptive measures, charts, graphs and measures of central tendencies were used to explain the variable of interest. Moreover, inferential statistics like Binary and Multinomial logistic regression analysis were employed to investigate the key factors that can explain the high level of movement of women to the Arab countries. From the result of binary logistic regression, it was found that the age of the women themselves and the number of siblings that the woman had significant influence on the woman plan to migrate to Arab countries. Moreover, the multinomial logistic regression pinpoint that the factors like number of sibling, age of the woman and having the family member who migrated to Arab countries have significant effect preferring the economic reason as reason of migration to family influence as reason of migration. Similarly the number of sibling that a woman had is found to be a significant factor for preferring the suitability of the system as reason of migration to family influence as reason of migration at 5% level of significance. The researcher recommends that organizing a discussion forum with fathers would be indispensable to make reasonable decision for the woman to migrate to Arab countries. The agencies which delivered the training for women should include a package that would enable the women to know better about their destination countries so that the challenges that they face would be minimized.

Keywords: *Women migration, Multinomial logistic regression, reasons of migration, Number of Siblings, System suitability, Arab Countries*

INTRODUCTION

Background of study

Ethiopia is one of the developing countries in the world undergoing its effort to improve the economy of the country. Although, the people of the country are struggling poverty, it is still under the poverty. The causes for this poverty may include social, political, economic and environmental factors. Thus, people opt to migrate to more developed countries in search of better opportunities to get education and employment, and access to better living facilities. During the Derg period, many Ethiopians left their country mainly due to absence of democracy and unrelenting political disruptions while those who were already abroad chose to stay away. Even after the fall of the Derg regime, people continued to migrate for different reasons: to pursue higher quality education, in search of employment and escaping unfavorable conditions in the country including political instability.

Migration refers to a change of usual place of dwelling where it can be across city, regional state or international boundary lines. Having this definition in mind, an important aspect of migration worth examining is whether it is voluntary or forced. In general voluntary migrants are those who change place within or beyond their country of origin at their own discretion rather than for other uncontrollable factor. Voluntary migrants mostly, though not always, are people seeking better social, economic or environmental conditions in other regions or countries.'

Migration is a multi-facetted and complex global issue which today involves every country in the world. All countries in the world or sovereign states of the world are now points of origins, transits or destinations for migrants; or all at once. The UN's current official estimate remains at hundred seventy five million migrants globally. By basing the growth of the known migrants stocks for the period 1990-2000, the UN population Division predicted a total of between hundred eighty five million and hundred ninety two million migrants by early 2005(IOM, 2006). Hence, it can be said that movement has increasingly become an integral part of human existence.

While talking about trans-border migration, the concept of migration can be divided in to three broad parts: 1) life before migration and the causes of migration; 2) migrants situation in the host country; and 3) coming back to the country of origin which includes reasons for their return, their situation in their country of origin and their contribution to their country's development. This study focuses on investigating the causes of migration of migrants from Southern Ethiopia.

Limited information is available regarding the migration pattern of Ethiopian migrants. Most migration studies in Ethiopia are concerned about internal migration and not much is done on international migration. Some of the studies available on international Ethiopian migration, among the few, include: An assessment of International Labor Migration by Emebet Kebede (2003), which concerns only female labor migrants who migrate to the Gulf States; Ethiopian Migration: Challenging Traditional Explanatory Theories , examining the causes of Ethiopian migration in terms of the universal theories; Reversing the trend of Brain Drain: the Case of Ethiopian Diasporas, which is restricted to the brain drain aspect of migration.

International migration from Ethiopia is an economic coping strategy and a societal issue. The migration of a family member generates resources, which support other family members and enables them to make investments in education, health and housing. The ability to invest in these resources reduces the vulnerability of family members, particularly women and children. Migration is also a means to improve the family's social status: providing their younger sibling with better education opportunities is a very strong incentive for Ethiopians to migrate abroad. Migration of the highly-skilled is considerable as qualified professionals increasingly leave the country seeking better opportunities for professional development and higher salaries.

International migration undeniably can have favorable features for the countries of destination and origin as well as for the migrants and their families. For the latter migration can generate remittances and hence contribute to a decline in poverty. Upon return, expatriates also take back vital skills and expertise and thus contribute positively to development in their home countries. The Ethiopian government has taken a number of initiatives to maximize the utilization of remittances and skills and experiences of returning migrants. Despite these efforts, the majority of remittance flows are channeled through informal channels and numbers of returnees remain low.

Official estimates suggest that Ethiopians working abroad (both permanent and temporary) number between eight hundred thousand and one million (National Bank of Ethiopia 2006). In 2008, the recorded inflow of remittances from migrants was worth over US eight hundred million Dollars (National Bank of Ethiopia 2008). Unofficial estimates suggest that the figures of unrecorded migrants and informal remittances are at least equivalent, if not higher.

According to the UN's estimate, there were hundred seventy five million international migrants in the world in 2000 that represented more than a double increase from 76 million in 1960. By comparison, the world population only doubled from three billion in 1960 to six billion in 2000. As a result, international migrants represented 2.5 per cent of the world population in 1960 and 2.9 per cent in 2000 (IOM, 2005).

Consequently, sixty per cent of the world's migrants currently reside in more developed regions. Most of the world's migrants live in Europe (sixty four million), followed by Asia (Fifty three million) and Northern America (forty five million) (Eshetu, 2006). Nearly half of all international migrants are female and female migrants outnumber male migrants in developed countries. Three-quarters of all international migrants are concentrated in just 28 countries and one in every five international migrants live in the United States of America (Eshetu, 2006).

In Africa, there were an estimated 16.3 million migrants and close to 13.5 million internally displaced persons (IDPs) in 2002. According to ILO estimates, the number of labor migrants in Africa today constitutes one fifth of the global total. Moreover, by 2025, one in ten Africans will live and work outside their countries of origin.

The Gulf States are characterized by great wealth, small populations and labour shortages, and, therefore, a permanent migration policy would have seemed to be fitting. However, to the small monarchies giving permanent residence and citizenship to migrants seems too risky. The contract

workers, therefore, are seen as solely economic migrants on a strictly temporary basis, with neither social nor political rights.

The objective of this study was to identify factors that increase women flow to Arab countries from Southern Ethiopia. It is well known that migration can result from poverty, but it is not always the poorest who migrate, because of the costs and opportunities involved (World Bank, 2005).The study totally relied on the primary data that were collected using well-structured questionnaire and employing well trained students on how to fill the questionnaire and approach the respondents. Moreover, the data collectors were postgraduate students of statistics department. This would have its own contribution for collecting quality data. For this particular survey, the target population was all those women who have an interest to migrate to Arab countries and are claiming to get visa.

Statement of the Problem

According to Kebede (2002), being one of the most populated countries in Sub Saharan Africa, three-quarters of the general population of Ethiopia consists of women and children that are exposed to widespread poverty. Due to existing cultural values that are common mainly in rural Ethiopia, women have limited access to education and training opportunities. Hence, as compared to men, women have lesser access to employment opportunities. Research findings show that women and children in Ethiopia experience serious challenges that affect their survival and development as a result of socio economic, political and cultural factors (Bezabih, 2008).

According to Tekle and Belayneh (2000) women have no right to negotiate on the condition of their employment, and in cases of such negotiation, it is often done between the agent of the women and the employer. The above study further indicate that where there is a contract, it is written in Arabic, a language which the Ethiopian migrants cannot understand a word of it. The women do not have any right to complain when conditions are breached by their employers as they are not cognizant of the terms agreed upon.

A research finding indicate that women and young girls who migrate to Lebanon, Egypt, Yemen and Saudi Arabia has also revealed that these women experienced various types of human right abuses (Agrinet, 2004). Another research finding show that a large number of Ethiopian women and children who migrate to Middle East countries to work as housemaids are victims of trafficking and are exposed to different kinds of abuse and exploitation. The most common form of abuse and exploitation faced by women and young girls working as domestic workers in the Middle East are sexual abuse, overwork, confinement, physical abuse, insult, belittlement, and withholding of salary. Moreover, their movement is restricted by the employers and illegal agents, and they are also expected to work between nine and nineteen hours a day with limited hours for rest (Belayneh, 2003).

The trafficking of women and children from Ethiopia, especially to countries in the Middle East, is considered as a significant problem. According to Agrinet (2004), about eighty four percent of women who had migrated for employment in domestic work were trafficked and most of them do not envisage the prospect of leading a good life locally. Furthermore, International Organization for Migration/ Special Liaison Mission in Addis Ababa show that a little less than

Ninety one percent of the hotline counseling service beneficiaries was young women from Ethiopia looking for information on working in the Middle East (IOM/SLM Addis Ababa, 2004). The above report clearly shows that the majority of migrants are female. Hence, the reason why this issue has been chosen for study is to reveal the extent of the problem of trafficked female Ethiopian migrants are facing by bringing their personal experiences to be heard.

According to IOM (2004), the trafficking of women and children has developed into one of the most disastrous features of contemporary global migration in which as many as two million people are estimated to be trafficked every year, lured by promises of well-paying jobs. Many victims, willingly, but unknowingly, accept the services offered by traffickers without realizing the full implications of future employment or the conditions under which they will work.

According to Human Right Watch (2010), Lebanese families employ an estimated of 200,000 migrant domestic workers primarily from Ethiopia, Sri Lanka, the Philippines and Nepal, who are not protected by law. Furthermore, Sayah (2011) shows among 42,900 refugees, asylum seekers and migrant workers, over 36,000 were Ethiopian domestic workers seeking help as they were exposed to various abuse and exploitation. According to Human Right Watch report (2007) labor laws of Lebanon, Saudi Arabia, Kuwait, and the United Arab Emirates (UAE) give minimal legal protection to migrant domestic workers. The report further indicated that women domestic workers in an unregulated and undervalued job sector are at high risk and face abuse and various forms of

Significance of the study

In view of the above background, this study is expected to have the following contributions:

1. It may provide valuable information for concerned governmental and non-governmental bodies, as well as service providers, about the factors that motivates women to migrate to these Arab countries.

2. It may contribute to creating awareness and shed more light in identifying who is going to make decision about the migration of women in the family;

3. It may serve as an initial reference for researchers and stakeholders who might be interested in conducting research at a larger scale on the area of psycho-social wellbeing of trafficked women.

Objective of the Study

General objective

This study aimed at investigating the main causes of very high migration of women to Arab countries from south Ethiopia particularly Hawassa city and around.

Specific objectives

- ➢ To describe the Socio-demographic characteristics of respondents
- ➢ To identify the key factors that induces women to migrate to Arab countries
- ➢ To examine who is making the migration decision from family members for women to migrate to these countries.
- ➢ To investigate what roles do the networks (migrant, family, kinship) have for such movement?
- ➢ To provide valuable information for concerned governmental and non-governmental bodies, as well as service providers.

MATERIALS AND METHODS

Description of Study Area

The study was aimed at investigating the factors that motivate women in southern Ethiopia to migrate to Arab countries. It is expected that those women requesting passport from southern branch immigration bureau came from the southern parts of the country Ethiopia.

Study Subject

The subjects for this particular study were all women who planned to move to Arab countries and requesting passport from the southern branch immigration Bureau.

Study Design

A cross-sectional study design was employed to conduct this study. Regarding sampling technique, Systematic random sampling method will be employed to identify the sample respondents. Firstly, these women who were requesting visa to move to these Arab countries were identified with the support from the Immigration Bureau. Then, systematic random samples were taken from the sampling frame we get.

The minimum required sample size for this study was specified by using the following sample size determination formula:

$$n = \left(\frac{z_{\alpha/2}}{e} \right)^2 pq$$

Where

- o n is the minimum required sample size;; e is the desired level of precision; α is level of significance; and
- o According to Emebet Kebede (2003) study conducted on **"The assessment of the international labor migration situation: the case of female labor migrant"** in 2003, the proportion of women who migrate to these Arab countries due to the influence of others who already migrate constitute 21%. Therefore, the value of p is 0.21 and its complementary event which is the proportion of women were influenced by factors other than the above mentioned factor was 0.79.

Using the above formula the minimum required sample size with 90% confidence level, 6% margin of error, and 0.21 estimated proportions is $n = 307$. With 10% contingency, the total sample size required for this study is 330.

Study Methodology

Primary data were collected from the respondents. To improve the quality and accuracy of information postgraduate students of Statistics department were involved after an intensive training on how to approach and ask these women. It is assumed that data that are obtained from women are reliable. It is because of the fact that women do not have fear to provide information as they pass through the entire legal requirement for getting their passport. Moreover, postgraduate students who can speak the language that women speak were involved in data collection. This would improve the trust that women have on the provision of data so that data quality would be kept good. The quantitative data were collected by using well designed structured questionnaire. Pretesting was conducted using a pilot survey on 10% of the sample (18 women) in order to check the adequacy of the questionnaire. Moreover, professional from the immigration bureau was involved to get quality data from the respondents.

Data Management and Analysis

In statistics, there are descriptive and inferential statistics. For this particular study, charts, graphs, measures of central tendencies like mean, median and measures of variation like coefficient of variation and variance were used to explain the data. Moreover, inferential statistics like Chi-square analysis and Binary and Multinomial logistic regression analysis were employed to investigate the key factors that can explain the high level of movement of women to the Arab countries.

The various reasons for migrating to Arab countries are considered to be the dependent variable. It is believed that there are more than two reasons. Thus, a multinomial logistic regression model will be fitted on the reasons of migration. The potential explanatory variable that would affect the reasons of migration are place of residence, age, family size and income, peer influence and etc.

The other model planned to fit is the multinomial regression on the dependent variable "who decides the migration" having more than two categories. The possible explanatory variables listed above also works for this model.

RESULT AND DISCUSSION

Descriptive Statistics

The background characteristics of the women and their families are described below using the descriptive statistics. The educational level, marital status of the women and the educational level of their mother and father and the existence of sibling are described below using tables and charts.

Educational Level of Women

It is believed that the educational level of women have significant contribution on the decision of women to migrate to Arab countries. For this particular study, the distribution of women based on their educational level has been analyzed. The simple bar chart displayed below illustrates this distribution. As seen from the bar chart, about 90% of the women had a primary and secondary education and 6.37% of the women can't read and write and illiterate.

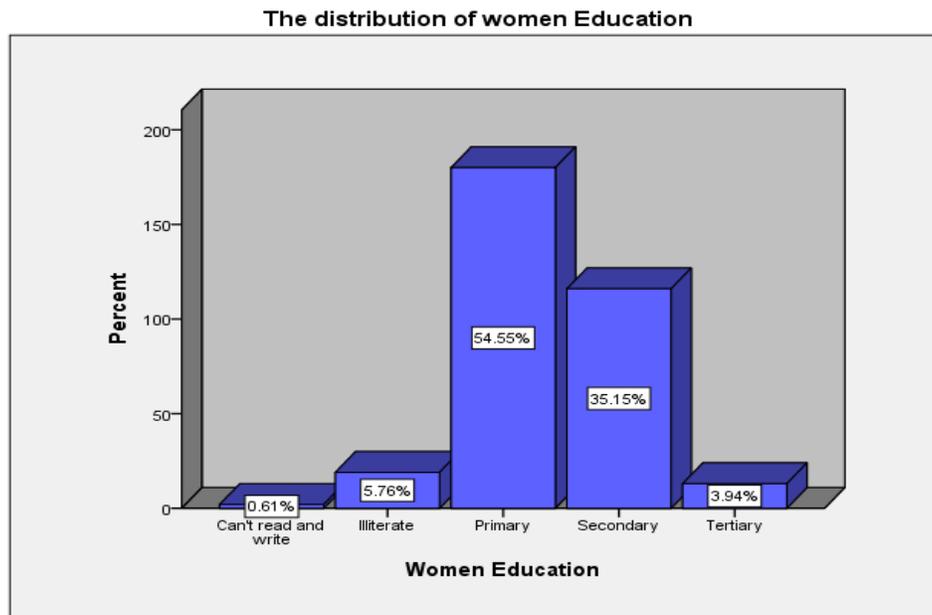**The distribution of women Education**

Figure 1. Percentage distribution of women education

The migration experience, number of months they stay in the Arab countries, which country they resided, their plan to go to Arab countries, statistics on who decides their migration, the country they plan to migrate and reasons of migration have been portrayed using the descriptive statistics displayed below.

Migration Experience of Women

Table 1. Migration Experience of Women to Arab countries

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	11.8	11.8	11.8
	No	291	88.2	88.2	100.0
	Total	330	100.0	100.0	

Among the 300 women, about 12% had the experience of travelling to Arab Countries. The remaining 88% of the women had no experience of moving to Arab countries in their life time. This indicates that majority of the respondents have no experience of travelling to Arab countries throughout their life time.

Number of months stayed in Arab Countries

Those women who had the experience of travelling to Arab countries were asked to respond on how long they stayed (in months) in their place of residence. Accordingly, they had stayed there from 1month to 96years (12years).

Who make the decision to migrate to Arab countries

Some research findings declared that there are people who make decisions for the migration of women to Arab countries other than herself. These people are father, mother and other family members.
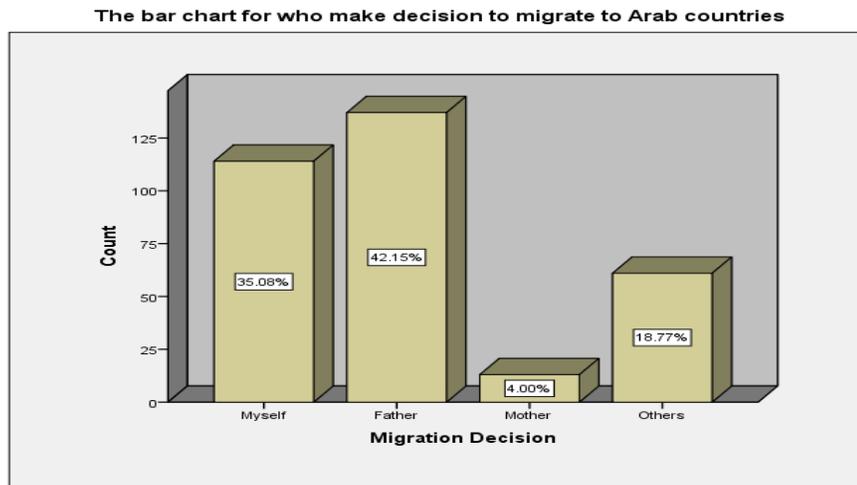

Figure 2. Simple bar chart for the question "who decide for women to migrate to Arab Countries?"

On the basis of the figure 2 output, majority of women (42.15%) are forced by their father to migrate to Arab countries. The father of these women is the one who decides for the women to

migrate to the Arab countries. Secondly, the women herself is the one who decides to migrate to Arab countries.

Country of Residence of women during their stay in Arab countries

As it is illustrated in the Figure 3 below, among the women who had an experience of migrating to Arab countries, majority (16) were living in Beirut followed by the countries Dubai and Saudi Arabia with 9 women in each country.
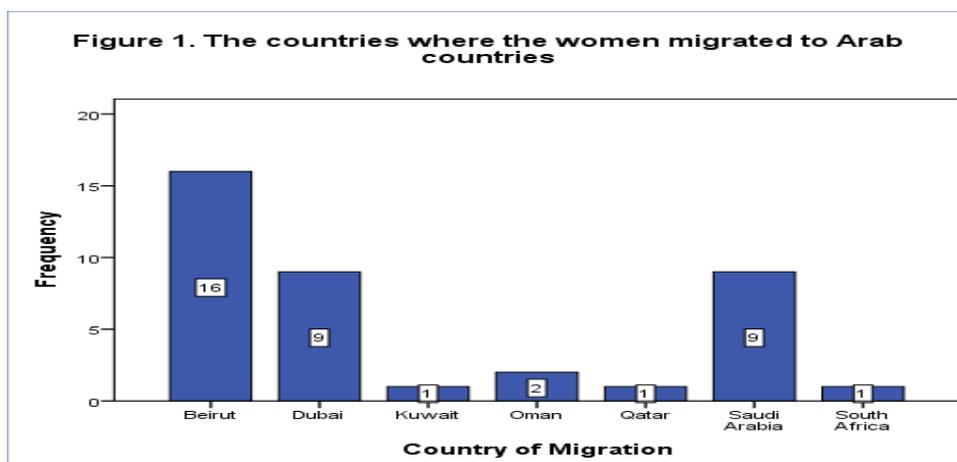
Figure 3: The distribution of Arab countries where the women migrated.

Women's plan to go to Arab Countries

The women were requested to respond on their plan to migrate to Arab countries. Accordingly the following results have been obtained.

Table 2. The women plan to migrate to Arab countries in the near future

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	325	98.5	98.5	98.5
No	5	1.5	1.5	100.0
Total	330	100.0	100.0	

Among the 330 women who responded for the study, the majority (98.5%) replied that they have a plan to migrate to Arab countries in near future. Only 1.5% of the total women have a plan to non-Arab countries.

Women's plan of destination country

This study requested the respondents to provide information on the place of destination where the women plan to migrate. Accordingly, the following descriptive findings have been obtained. On the basis of the pie chart displayed below, the most preferred country of destination for women is Dubai with 58.77% and the least preferred countries of destinations are Qatar and

Kuwait with 3.69% and 4.92% preference respectively. During the interview, it was found that there were women who still did not decide their country of destination and they constitute 0.62% of the total population.
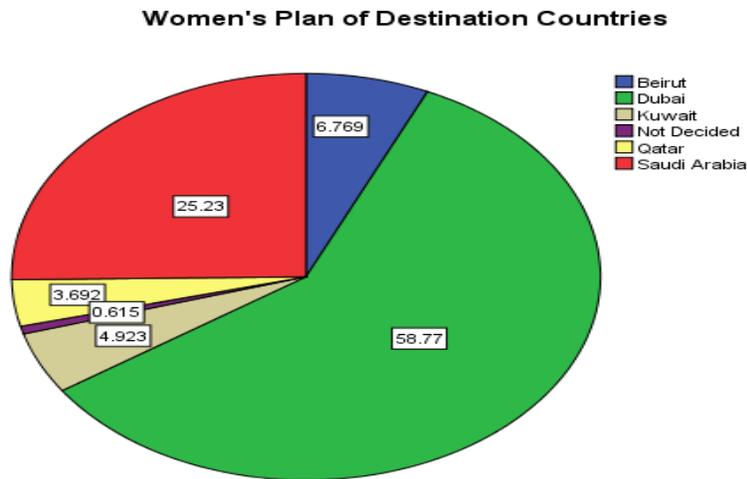
Figure 4. The major destination countries that the women plan to migrate to Arab countries

Women's reasons of migration

There are various reasons of migration of women from their place of origin to other countries. The major objective of this study was to examine these reasons of migration and design strategies to address issues related to it. Reasons like economic, peer pressure, system being legal, work load in house and family influence have been investigated in this study. Accordingly, the bar chart displayed below portrayed the result. On the basis of the bar chart, the dominant reasons for women to migrate to Arab countries are economic followed by the existence of system that facilitates their migration. It was depicted in the chart that 81.23% and 12% of the women mentioned that the reasons that motivate them to migrate to the Arab countries are economic and the existence good system respectively.
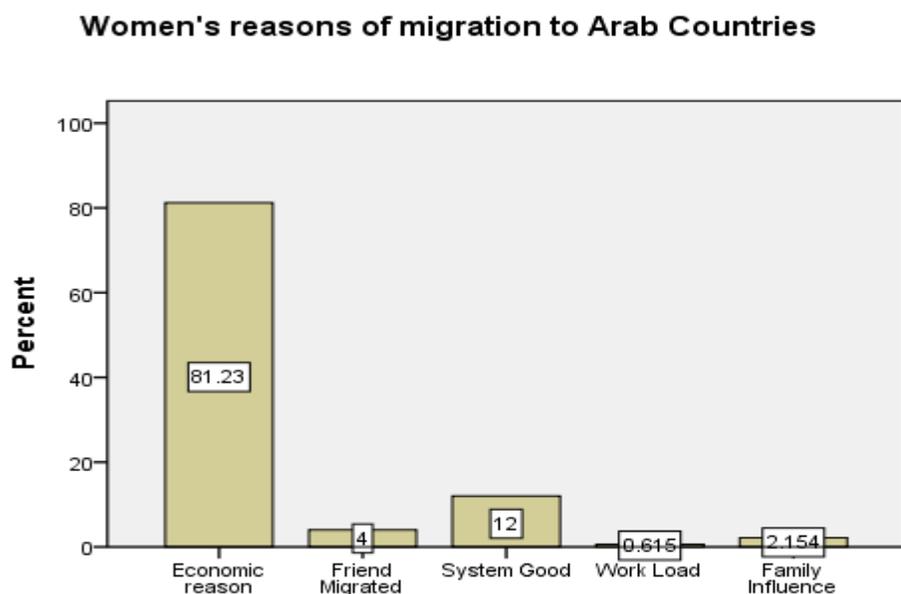
Figure 5: The major reasons of migration for female to migrate to Arab countries

Women's Information about the Destination Countries

Many researchers found out that one of the major reasons that the women faces physical and psychological problems in their work place is the lack of enough information about their destination countries and the nature of the work they planned to work on.

Table 3. Women's Information about their country of destination

| Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	129	39.1	39.1	39.1
No	201	60.9	60.9	100.0
Total	330	100.0	100.0	

As seen from the table 3, more than three fifth of the women do not have enough information about their place of destinations. Most of the problems that the women working in Arab countries face are highly related with the lack of information about their destination countries and work situation. This study confirms that majority of the women do not have information about their country of destination and work situation. Two fifth of the women only have information. This suggests that there is still a need to fill gap of women regarding their plan of destination countries and their work situation.

Satisfaction of women on training provided on cleaning and related activities

The new rules and regulation of the government on migration of women to Arab countries put a requirement that a women should complete the training on cleaning and cooking. Unless the women provide evidence that they took the training, they cannot proceed to passport claim.

In this regard, women were asked to provide information on their level of satisfaction on the training they took. Accordingly, the following output has been derived. On the basis of the output below, the women satisfaction have been categorized into five Likert scale but one of the scale do not get a hit. According to the chart displayed below, majority of the women responded neutral. Slightly higher that two third of the women do not want to express their feeling about their level of satisfaction on the quality of the training provided by the agents that the government has selected and gave licenses. Approximately equal proportion of women responded that they are very satisfied and satisfied. Collectively, more than 32% of the women have a good feeling about the quality of the trainings they took as a requirement for processing their visa to the Arab countries. In contrast to this, less than 1% of the respondents do not have a good feeling or they are dissatisfied about the quality or of the training provided.

Figure 6. The satisfaction of women on the quality of the training provided by agents

The background characteristics of the women and their families are described below using the descriptive statistics. The educational level, marital status of the women and the educational level of their mother and father and the existence of sibling are described below using tables and charts.

Marital Status of Women

The pie chart displaying the proportion of women with respect to their marital status is displayed below. The pie chart describes that majority of women have single marital status constituting 76.67%. The married category of the marital status constitutes 23.03%. Moreover, there are a negligible proportion of women who are in other category other than single and married.

The distribution of women on the basis of their marital status
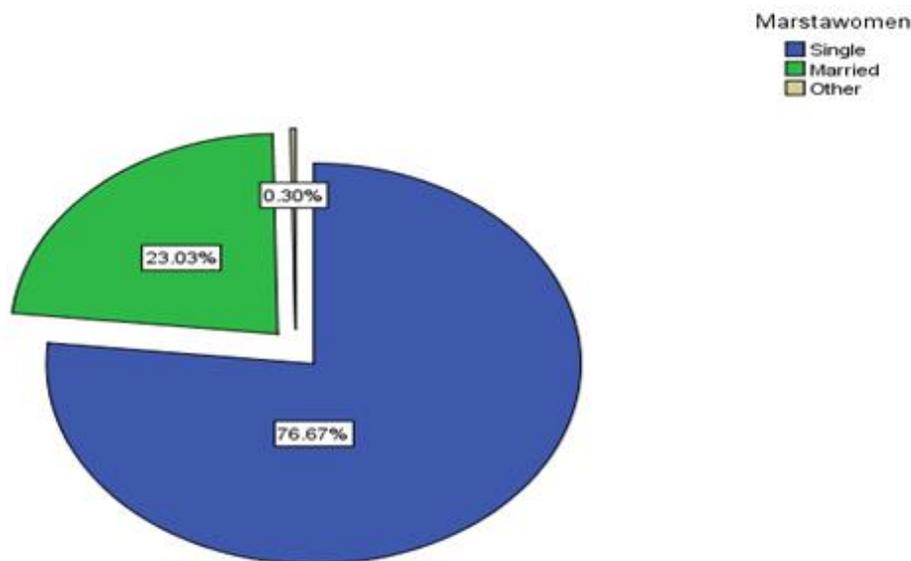
Figure 8. The percentage distribution of women based on their marital status

Educational level of Women's Mother and Father

Various literatures depicted that educational level of women's mother and fathers have significant effect on the decision of women to migrate. This study also aimed at investigating the status of women's mother educational level. On the basis of table 4 and table 5 outputs below, more than 92% of the women's mother has an illiterate and primary. There are very few proportion (1%) of the mother has a tertiary educational level. Collectively, the percentage of mother having secondary and above educational is 4.2%. Only 3.2% of the women's mothers cannot read and write.

Table 4. The frequency distribution of women's mother Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Can't read and write	10	3.0	3.2	3.2
	Illiterate	196	59.4	62.2	65.4
	Primary	96	29.1	30.5	95.9
	Secondary	10	3.0	3.2	99.0
	Tertiary	3	.9	1.0	100.0
	Total	315	95.5	100.0	
Missing	System	15	4.5		
Total		330	100.0		

Table 5. The frequency distribution of women's father Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Can't read and write	4	1.2	1.4	1.4
	Illiterate	122	37.0	43.7	45.2
	Primary	105	31.8	37.6	82.8
	Secondary	37	11.2	13.3	96.1
	Tertiary	11	3.3	3.9	100.0
	Total	279	84.5	100.0	
Missing	System	51	15.5		
Total		330	100.0		

The frequency distribution of women's father depicted that more than 80% of the women's fathers have an illiterate and primary educational levels. The secondary and above educational level of fathers of women constitute 17.2%. Fathers who cannot read and write make up 1.4%. The cumulative percentage of fathers of women having primary, secondary and tertiary education level is 84.6%. The women's fathers having illiterate and primary educational level constitute 43.7% and 37.6%.

Inferential Statistics

Binary Logistic Regression of the migration plan of women

One of the objectives of this study was to examine the factors affecting the migration plan of women to Arab countries. It is planned to examine the effect of whether father is alive or not, the number of sibling the woman has, age of the women and family size. To make the objective real, binary logistic regression has been fitted and the output has been displayed below.

Based on the output in table 6, the classification capability of the binary logistic regression model has been portrayed. On the basis of the output, the model has the overall percentage of 98.5%.It indicates that the model classifies the Yes to Yes and No to No is accurately and it is high. This means that 98.5% of the classification of the variable plan to migrate has been correctly classified by the predicted model. This is one of the good qualities of the better models.

Table 6. The prediction capacity of the binary logistic regression analysis

Observed			Predicted		
			Plan to Migrate		Percentage Correct
			Yes	No	
Step 1	Plan to Migrate	Yes	324	0	100.0
		No	5	0	.0
	Overall Percentage				98.5

a. The cut value is .500

The overall percentage of the classification capacity of the binary logistic regression model is 98.5% which indicates that 98.5% of the two responses "yes" and "no" of the dependent variable plan to migrate are correctly classified.

The effect of predictors like whether father is alive or not, the number of sibling the woman has, age of the women and family size on the women's plan to migrate to Arab countries has been fitted and displayed below.

On the basis of the output in table 7 with 5% level of significance, the Exp (B) for the variable age is 0.765 which indicate that as age increases by one year, the odds of having a plan to migrate to Arab countries deceases by 23.5%. Moreover, age is found to have a significant effect on the odds of having a plan to migrate to Arab countries.

Variables father alive, sibling size and family size are found to have no significant effect on the odds of having a plan to migrate to migrate to Arab countries.

Table 7. The Binary logistic regression model output of women's plan to migrate to Arab countries

	Variables in the Equation					
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Father alive(yes)	.094	1.250	.006	1	.940	1.098
	Sibling Size	.526	.543	.938	1	.030	1.692
	Age	-.268	.127	4.448	1	.035	.765
	Family Size	-.621	.532	1.361	1	.243	.537
	Constant	3.704	3.397	1.189	1	.276	40.615

Multinomial Logistic Regression of Reason for Migration to Arab Countries

Among the specific objectives of this research, discovering the effect of one or more factors on the reasons of migration to Arab countries was the one. The major factors that are assumed to influence the reasons of migrating and supported by literature are the number of siblings that the woman has, age of the woman, family size, existence of family members who migrate, existence of siblings and whether the father is alive or not. To examine the influence of these factors on the reasons of migration, the multinomial logistic regression model has been fitted. The output of this model is displayed below in table 8.

Table 8. The Multinomial logistic regression model output of women's reasons to migrate to Arab countries (Parameter Estimates)

Reason of Migration[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Economic reason	Intercept	4.365	3.623	1.451	1	.228			
	No of Sibling	-.736	.441	2.788	1	.009	.479	.202	1.137
	Age	-.065	.135	.233	1	.029	.937	.719	1.220
	Family Size	.662	.389	2.893	1	.089	1.939	.904	4.157
	Has family member migrated	.371	.825	.203	1	.006	1.450	.288	7.298
	No family member migrated	0[b]	.	.	0	.	.	.	.
	Father is Alive	-.727	1.147	.402	1	.526	.483	.051	4.574
	Father Died	0[b]	.	.	0	.	.	.	.
Friend Migrated	Intercept	1.046	4.416	.056	1	.813			
	No of Sibling	-.726	.551	1.738	1	.187	.484	.165	1.424
	Age	-.020	.164	.015	1	.049	.980	.711	1.352
	Family Size	.586	.507	1.339	1	.002	1.797	.666	4.850
	Has family member migrated	1.093	1.000	1.194	1	.275	2.983	.420	21.196
	No family member migrated	0b	.	.	0	.	.	.	.
	Father is Alive	-1.412	1.319	1.145	1	.025	.244	.018	3.235
	Father Died	0b	.	.	0	.	.	.	.
System Good	Intercept	.727	3.939	.034	1	.854			
	No of Sibling	-1.028	.485	4.484	1	.034	.358	.138	.926
	Age	-.047	.145	.106	1	.745	.954	.718	1.268
	Family Size	.863	.440	3.845	1	.050	2.371	1.000	5.621
	Has family member migrated	.680	.880	.598	1	.440	1.974	.352	11.078
	No family member migrated	0[b]	.	.	0	.	.	.	.
	Father is Alive	.522	1.360	.147	1	.701	1.686	.117	24.244
	Father Died	0[b]	.	.	0	.	.	.	.
Work Load	Intercept	-10.510	7.382	2.027	1	.155			
	No of Sibling	-1.420	1.281	1.229	1	.268	.242	.020	2.976
	Age	-.249	.267	.872	1	.350	.780	.462	1.315
	Family Size	.528	1.243	.181	1	.671	1.696	.148	19.377
	Has family member migrated	1.142	1.719	.441	1	.507	3.132	.108	90.976
	No family member migrated	0[b]	.	.	0	.	.	.	.
	Father is Alive	17.267	.000	.	1	.	31535020.665	31535020.665	31535020.665
	Father Died	0[b]	.	.	0	.	.	.	.

a. The reference category is: Family Influence.

The multinomial logistic regression needs to set the reference category for the dependent category and each independent variable included in the model. Based on the preference of the researcher and the rule to set the reference category, the level of the dependent variable "family influence" is set to be the reference category. The categorical independent variable Sibling has the reference category "no sibling", the woman who has no family member migrated is the reference for the second categorical variable and the last categorical variable has Whether the father is alive or not set the reference category to be "father died". The other quantitative variables that would influence the reasons of migrating to Arab countries are number of siblings, family size and age of the woman.

In table 9, the first category of the dependent variable that we can compare with the reference category is the level "Economic reason". The output displayed above depicted that the quantitative variable number of sibling has significant effect on the odds of preferring economic reason compared to family influence since the p-value is 0.009. The odds ratio or Exp (B) for the number of sibling is 0.479 which is less than 1 and indicates that as the number of sibling increase by one, the odds of women preferring economic reason for migrating compared to family influence decreases by 52.1%. The p-value for the other quantitative variable age is 0.029 which indicates that the age has significant effect on the odds of mentioning economic reason as reason for migration compared to family as reason of migration at 5% level of significant. Its odds ratio is found to be 0.937 that depicts as age increases by 1 year the odds of choosing economic reason as reason for migration compared to the other reason "family influence" as reason for migration decreases by 6.3%.

The family size is the other quantitative independent variable considered in this study. But the p-value for family size is 0.089 which is greater than 0.05. Thus, it has no significant effect on the odds of choosing economy as reason of migration compared to the other reason family influence at 5% level of significance.

The existence of family member who migrated to Arab countries is the other factor that influences the odds of preferring economic reason for migrating to Arab countries compared to preferring family influence. The p-value for this variable is found to be 0.006 which indicates that variable has significant effect on the odds of preferring economic reason for migrating to Arab countries compared to preferring family influence. The odds ratio for this variable is 1.45 showing that the odds of choosing economic reason as reason for migration compared to the other reason family influence for women who has family member who migrated to Arab countries is 45% higher than that of women who do not have family member who migrated to these countries.

The other variable considered in this model and has an effect on the odds of preferring economic reason for migrating to Arab countries compared to preferring family influence is the existence of father alive or dead. But the p-value for the variable is 0.526 which shows that whether the father is alive or dead does not influence the odds of preferring economic reason for migrating to Arab countries compared to preferring family influence.

The other objective of this model output is assessing the effect of the variables included in the model on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence. The p-value for the variable number of sibling is 0.187 that indicates the variable has no significant effect on the odds of preferring a reason

"has a friend who migrated" for migrating to Arab countries compared to preferring family influence as it is greater than 0.05.

The p-value for the other quantitative variable age is 0.049 which indicates that the age has significant effect on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence at 5% level of significant. Its odds ratio is found to be 0.98 that depicts as age increases by 1 year the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to the other reason "family influence" as reason for migration decreases by 2%.

The family size is the other quantitative independent variable considered. The p-value for family size is 0.002 which is less than 0.05. which has significant effect on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence as other reason at 5% level of significant. Its odds ratio is found to be 1.797 that depicts as family size increases by 1 person the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to the other reason "family influence" as reason for migration decreases by 5%.

The other interest of this model is examining the influence of having a friend who migrated to Arab countries on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence. On the basis of the model output, the p-value is 0.275 which indicates that whether a woman has a friend migrated or not has no effect on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence at 5% level of significance.

The existence of father alive or dead is believed to affect the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence. On the basis of the table 9 output above, the p-value for the variable is 0.025 which is less than 0.05 that shows that whether the father alive or not has a significant effect on the odds of preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family influence at 5% level of significance. The odds ratio for this variable is 0.244 which depicted that the odds of woman who has a father alive compared to woman whose father is dead in preferring a reason "has a friend who migrated" for migrating to Arab countries compared to preferring family decreased by 75.6%.

The odds of preferring "system is good" as the reason to migrate to Arab countries compared to the other reason "family influence" is influenced by the same independent variables considered in the above analysis. The p-value for the variable number of sibling is 0.034 that indicates the variable has significant effect on the odds of preferring a reason "system is good" as the reason to migrate to Arab countries compared to the other reason "family influence" for migrating to Arab countries compared to preferring family influence as it is less than 0.05. As number of siblings increases by one, the odds of preferring "system is good" as the reason to migrate to Arab countries compared to the other reason "family influence" decreases by 64.2% at 5% level of significance.

The p-value for the other quantitative variable age is (0.745)> 0.05 which indicates that the age has no significant effect on the odds of preferring a reason "system is good" for migrating to Arab countries compared to preferring family influence at 5% level of significant. As its effect is insignificant, it is irrelevant to consider its odds ratio and interpret it.

The family size is the other quantitative independent variable considered in this study. The p-value for family size is 0.05 which is less than or equal to 0.05 which states that it has significant effect on the odds of preferring a reason "system is good" for migrating to Arab countries compared to preferring family influence as other reason at 5% level of significant. Its odds ratio is found to be 2.371 that illustrate that as family size increases by 1 person the odds of preferring a reason "system is good" for migrating to Arab countries compared to the other reason "family influence" increases by 2.371 times at 5% level of significance.

Having or a family member or not who migrated to Arab countries is the other factor that influence odds of preferring a reason "system is good" for migrating to Arab countries compared to preferring family influence. But its p- value is 0.44 which is greater than 5% which indicates that the variable has no effect on odds of preferring a reason "system is good" for migrating to Arab countries compared to preferring family influence at 5% level of significance.

The existence of father alive or dead is believed to affect the odds of preferring a reason "the system is good" for migrating to Arab countries compared to preferring family influence. On the basis of the table 9 output above, the p-value for the variable is 0.701 which is greater than 0.05 showing that whether the father alive or not has no significant effect on the odds of preferring a reason "the system is good" for migrating to Arab countries compared to preferring family influence.

The other pair of comparison in the dependent variable is mentioning "workload" as reason for migrating to Arab countries compared to preferring family influence. On the basis of the table output 9, none of the independent variables considered in the above interpretation does not have significance effect on the odds of choosing " work load" as reason for migration compared to the other reason the family influence at 5% level of significance.

DISCUSSION

According to a study conducted by Henok *etal*. (2017), the irregular migrants are mainly young in the age range twenty to twenty seven. This study also concluded that the majority of the women who have a plan to migrate to Arab countries are young and in the age range 18 to 24. Thus, the result matches with the study conducted by Henok *etal*. (2017).

Regarding to the marital status of migrants, a study conducted by Kassegne & Gashaw (2017) found that majority of them are single and married but, from the descriptive statistics of this study depicted that the majority of the women who have a plan to migrate to Arab countries are single constituting eighty five percent of the sample of women who participated in this study.

A similar study conducted by Henok *etal*. (2017) concluded that majority of the women who migrated to Arab countries have a primary and secondary education. The same finding has been

found in this study illustrating that the majority of the women in the Southern Ethiopia and having a plan to migrate to Arab countries have a primary and secondary education.

The regression model output of the study conducted by Henok *etal*. (2017) and Kassegne& Gashaw (2017) individual level factors such as the migrant's gender, age, educational achievement and perception of availability of economic opportunities in destination countries are important determinants of travel mode. This study also concluded that the age of the women is the determinant and significant factors affecting the plan of the women to migrate to Arab countries. Thus, the findings of this study in relation to age are consistent with the study conducted by Henok *et al*. (2017) and Kassegne& Gashaw (2017).

CONCLUSION AND RECOMMENDATION

This study aimed at investigating the main causes of very high migration of women to Arab countries from south Ethiopia particularly. To realize this objective, the study used primary data which was collected from 330 representative women from various zones of the Southern Region. The interview guide was used to extract information from the selected women using the random sampling technique. The descriptive like tables and charts and inferential statistics like binary and multinomial logistic regression analysis were employed to examine the factors influencing the women's plan to migrate and the reasons of migration of women to Arab countries respectively.

From the descriptive statistics, we can easily observe that about 90% of the women had primary and secondary education. Those who can't read and illiterate category constitute only 6.37% of the total women. Regarding the migration experience of women to Arab countries, only 12% had the experience. The descriptive statistics also used to assess who the decision maker is for the woman to migrate to Arab countries and found that more than 42 % of the women mentioned that their father is the one who decided for their migration. Only 35% of the women responded that the women themselves are the one who decided their migration. The women were asked to give their response on the plan to migrate and 98.5% of the women said that they have the plan to migrate to Arab countries. The women interest of the destination country has been analyzed and the majority (58.77%) responded that their destination country will be Dubai followed by Saudi-Arabia (25.23%). Lastly, it was found that majority of the woman has no information about the countries of their destination.

The inferential statistics examine the factors affecting the plan of women to migrate and the reasons of migration using the binary logistic regression and multinomial logistic regression. Accordingly, it was found that the age of the women and the number of siblings that the woman had has significant effect on the plan of women to migrate to Arab countries. Moreover, the multinomial logistic regression pinpoint that the factors like number of siblings, age of the woman and having the family member who migrated to Arab countries have significant effect preferring the economic reason as reason of migration to family influence as reason of migration. Similarly, the number of sibling that a woman had is found to be a significant factor for preferring the suitability of the system as reason of migration to family influence as reason of migration at 5% level of significance.

On the basis of the result found from this study, the researcher recommended that

- ✓ As one of the results indicate that the father of the women is the one who decides the women to migrate or not, it is recommended that the concerned bodies should design a strategy to contact and arrange a discussion session with fathers of the women about the advantage and disadvantage of the migration.
- ✓ The agencies which delivered the training for the women before processing the visa should include content about the destination countries in their training packages so that the woman would be in a position to easily manage everything around.
- ✓ Since the number of siblings is one of the factor that initiate the women interest to migrate to Arab countries, it would be better for government and other concerned bodies to work on having a small family size through provision of contraceptives and creating awareness on the importance of having small family size.

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Nutritional Intake and Awareness in Performance Enhancement and Post Exercise Recovery in Some Selected South Nations and Nationalities People Representatives Athletics Clubs

Mekdes Mamo

Corresponding author: Email:mekdi74@gmail.com, Department of sport science,

ABSTRACT

Nutrition plays major role in every physical fitness program. Despite many advances in nutritional intake, awareness in performance enhancement, sports nutrition-associated issues are still a challenge globally, specifically in SNNRP. There is a very limited research on the nutritional intake, awareness and post exercise recovery in SNNRP. The aim of this study was to determine and assess nutritional intake, awareness, in performance enhancement of athletes in SNNPP clubs. Through stratified sampling, 716 male and female athletes were selected from the population of SNNRP. A total of 257 athletes filled out the questionnaires fully. it was conducted in a one year period. The study was a cross sectional survey based on self-reported questionnaires. Data were analysed using SPSS computer software version 20; nutritional intakes also analysed by using ESHA software version 8.1. Majority of SNNRP athletes (52.5%) had poor awareness on sport nutrition. In conclusion, SNNRP athletes have poor awareness and very poor practice on their intake. Actual practice of sport nutrition is low at post exercise as well. Pearson chi square did not indicated a significant association between age and awareness of nutrition ($\chi2$ value 6.324, p = 0.388). Pearson correlation indicated a weak correlation between gender and awareness (independent t test = 0.079 and p = 0.973) while Pearson chi-square experience and ANOVA did not have a significant association with awareness ($\chi2$ = 5.084, p =0.749).one way ANOVA, and chi-square test and one sample t test indicate a significant association of age, experience and gender with attitude (p<0.05).There is a need to enhance sport nutrition education to improve on awareness, and practices of sport nutrition issues and to establish proper structures and policies of nutrition in order to improve their performance and health.

Keywords: *Awareness, nutritional intake, performance enhancement, track and field Athletes.*

INTRODUCTION

Background of the Study

Nutrition is an important component of any physical fitness program. The main dietary goal of active individuals is to obtain adequate nutrition to optimize their health and fitness or sports performance. According to the international Olympic committee sport medicine manual (2000) on fundamental elements of athlete diet, the human body requires more than 50 essential nutrients on a daily basis.

The International Society of Sports Nutrition (Jonnalagadda *et al*., 2001) suggests the first aspect of maximizing performance and training through nutrition is to be sure athletes are consuming

enough calories to offset the amount of calories they are expending on a daily (Abood,2004) basis. Total energy intake is an important aspect of nutrition for athletes, but unfortunately this concept is often misunderstood. They also don't realize that this can actually be a detriment to their performance and health. Athletes participating in intense training hours per day, or high-volume intense training, hours per day, like most elite athletes do, have significantly increased calorie needs (Hinton *et al.,*2004).

Track and field events are one of the athletics parts covering races at distance from 800m to marathon (42 km) and jumping and throwing. These runners face special challenges in training and competition (Burke *etal.,* 2007).

Therefore, the purpose of this research was to assess nutritional intake and awareness in performance enhancement and post exercise recovery in some selected south nations and nationalities people representative athletics clubs.

Statement of the problem

According to Morse and Driskell (2009), athletes are largely unaware of their nutrition needs, the importance of meeting these needs, and also how to meet these needs. For example, rapid weight loss can lead to loss of lean body mass, increase the risk of weight regain and compromise endurance (Position of the ADA, 2000).

However, the link between nutrition awareness and dietary intake is complex and may be influenced by many other factors including taste and food preference and cultural, religious, and family beliefs. Furthermore, convenience and skill in shopping and food preparation, including label reading, can alter food intake (Nestle *et al*., 1998; Obayashi *et al*., 2003). Athletes may often rely on coaches for nutrition guidance in certain sports. Therefore, when coaches are misinformed about nutrition, this becomes a potential problem for athletes, as well (Cotugna*et al*., 2005).

Some SNNPR athletes have experienced injuries which are nutrition related prior to local or international competitions and, as a result, have been dropped out of the competition (Burke *et al*., 2007).

Most SNNRP club athletes grow up in the countryside, and this, may affect their educational level to become low. Incorporating good dietary practices as part of a training program is one way to help optimize training adaptations and prevent overtraining (JSS, 2011).

Significance of the study

The significance of sport nutrition is unquestionable to boost sports performance. However, proper amount of nutrients from both macro and micro nutrients including supplements should be given to according to the physical exercise demand of each sport.

It would be important to help formulate guidelines and support athletes towards improvement of good performance. This study contributes significantly to the existing literature because it

provides updated insight on the current state of nutrition awareness and dietary intakes among athletes.

Objectives
General objectives
➢ To assess nutritional intake and awareness in performance enhancement and post exercise recovery in some selected south nations and nationalities people representative athletics clubs.

Specific Objectives:

o To assess the awareness of sport specific nutrition among runner.
o To assess their nutritional intake on sport specific nutrition based on their specialization.
o To assess the dietary composition and nutrient intake and compare with RDA (Recommended Dietary Allowance)
o To assess the attitude of runners towards nutrition.
o To determine if there is any significant intake difference among males and females.
o To identify individual and institutional factors that affects their nutritional practice.

MATERIALS AND METHODS

Description of the study area

The study was conducted in SNNPR. This is located in the southern and south western part of Ethiopia. The region has an area of 110,931km^2 that is approximately 10% of the country's total area, according to 2007statstics. In this city, there are a number of athletics clubs that are available both in first and second division and also, there are a lot of projects. Based on age categories, all these clubs and projects are governed by the governmental as well as in private basis. So my focusing area was only on governmental athletics clubs. Those are Hagereselam, Sidama buna, and Hawassa kenema, Zebidar,Alicho, Debubpolice, Wendokubaniya.

Study Subject

Source population

The source population was all athletes in club who reside in SNNPR state of Ethiopia. Athletes with the age group between 18 to 30 and training experiences above one year in the same clubs and who were willing to participate in the study were included.

Table 1. Source of population and clubs of the participants

Club's name							Race & sex						
	Mid	M	F	Lon	M	F	Thr	M	F	Jump	M	F	Total
Hagereselam	85	45	40	79	40	39	76	45	31	74	44	30	314
Sidama buna	51	26	25	52	32	20	50	26	24	49	25	24	202
Hawassa ken	55	35	20	50	30	20	50	27	23	45	27	18	200
Grand total	**191**	**106**	**85**	**181**	**102**	**79**	**176**	**98**	**78**	**168**	**96**	**72**	**716**

Note: Mid- Middle distance, F-Female, M-Male, Thr-Throwing, Jump-Jumping

Target Population and Study frame

The researcher particularly targeted at 716 athletes. Scope of events ranged from 800 to 10,000 meters track races, marathon and throwing and jumping events.

Table 2. The race of athletes participate

Races	Male		Female		Total
Middle	800m	15	800m	8	23
distance	1500m	10	1500m	5	15
	3000m Steeplechase	8	3000m Steeplechase	8	27
	3000m	9	3000m	10	19
Long	5000m	10	5000m	10	25
distance	10,000m	7	10,000m	13	20
	21 km	11	21 km	11	20
	42km	13	42km	13	23
Throwing	Shot put	10	Shot put	9	23
	Discuss	10	Discuss	10	18
	Javelin	8	Javelin	9	13
Jumping	Long jump	8	Long jump	8	14
	High jump	6	High jump	8	10
	Pol vault	5	Pol vault	5	8
Total		**130**		**127**	**257**

Study Design

The design that was used to investigate the problem was a cross sectional survey design. This design was found suitable for the study because of its versatility, efficiency and ability to be generalized.

Sample Size determination

In Athletics SNNPR Athletics clubs, there were 716 athletes who compete at national levels in all races. The sample size was determined based on Israel (2009). The table was derived from a formula developed by Yamane (1967) which sets the confidence level at 95%, p value at 0.05 and levels of precisions at ±5 %. The formula is illustrated below;

$$n = \frac{N}{1+N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision. The formula was applied to the study as illustrated below;

$$n = \frac{716}{1+716(0.05)^2} = 257$$

Stratified sampling procedure (Krejcie and Morgan, 1970) was used to determine actual composition of the sample in terms of gender and age.

Sampling Techniques and Procedures

SNNPR was purposively selected for the study because the area the study was conducted is found in SNNPR. There were Hagereselam, Sidama buna, and Hawassa kenema, Zebidar, Debub police, Wendo kubaniya, Alicho athletics clubs. From these, the researcher selected three clubs by using lottery methods (Hagereselam, Hawassa kenema, Sidamabuna). From these, three clubs were selected through stratified sampling method. They are Hagere Selam, Sidama Bunna and Hawassa Kenema. Then probability proportion size method was used to sample athletes. Finally, a simple random sampling method was used to select the required sample size from each selected clubs (Hagereselam, Hawassakenema, Siamabuna).
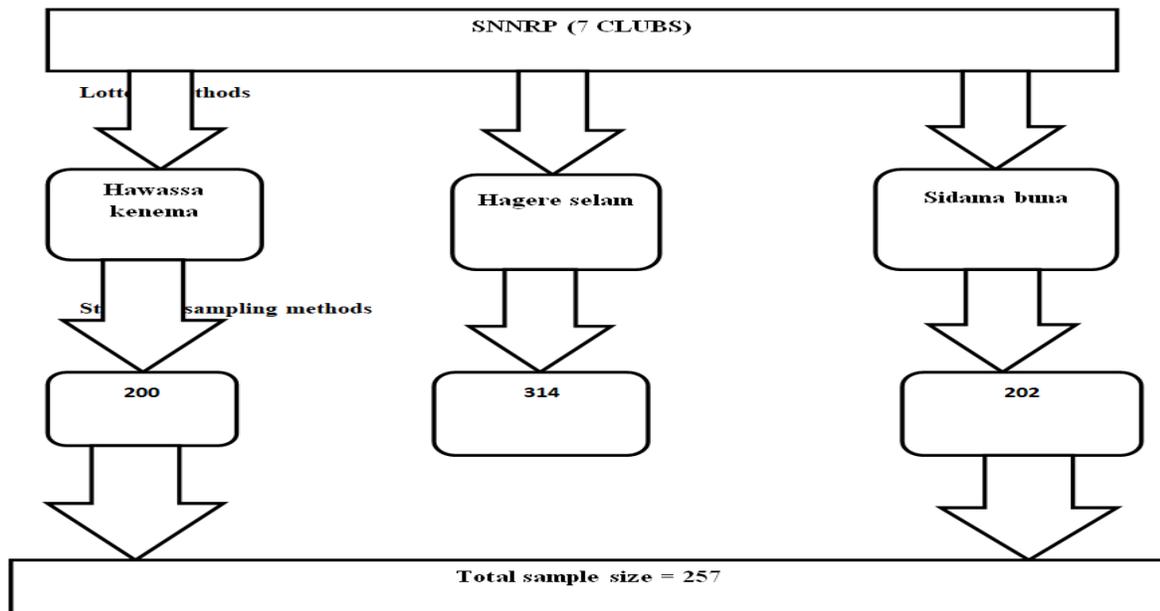
Figure 1. Sampling techniques and procedures

Study methodology

Questionnaire

Structured questionnaires were used to obtain information on the socio demographic characteristics of the athlete's, and their awareness, and nutritional intake of the questionnaire (Bloomquist,1985).

Recall methods for 24 hour

Individual food consumption was assessed using the 24-hour recall interview methods because all athletes did not take food on their clubs all the time as explained by (Gibson and Ferguson, 1999).

Individual Food Frequency

The individual food frequency table consists of all the foods that are essential for a middle and long distance runner.

Data Management and theoretical frame work

The model comprises five components that are individual and institutional factors that influence sport nutrition, awareness of nutrition, thought or feelings of nutrition's and their practices. The model predicts that cognitive, affective and behavioural characteristics are affected by individual and institutional factors, low awareness about sport nutrition, mediocre feelings about sport nutrition and low BMI shows in the figure below.

Figure 2. Conceptual frame work

(Derived from KAP in doping Selinachebet Model by 2010)

RESULTS, DATA PRESENTATION AND ANALYSIS

Dietary Intake result

24 hour recall analysis

The dietary intake of the athletes (n=257) was analysed and discussed. The assessment was done using 24 hour recall and QFFQ (quantitative food frequency questionnaire).The 24hour recall data was used with independent T test for differences of recommended intakes (RDN) and actual intakes denoted by diffenergy, diffprotein, diffCHO, difffat, difffibre, diffphosphorus, diffiron, diffcalcium, diffthiamine, diffriboflavin, and diffniacin. The mean nutrient intakes of energy, carbohydrates, fat, fibre and calcium were below the RDN for each nutrient. The nutrient intakes for proteins, prosperous, iron, thiamine, riboflavin, niacin for the athlete were above the recommended intake. For energy, CHO, fat, fibre, phosphorus, calcium, and iron all the athletes in this study were below the RDN. All males and females athlete were below the RDN for the above nutrient, and the difference is significance (2-tailed) at 95% confidence intervals. On the other hand, for protein, thiamine, riboflavin, and niacin, the difference was not significant from RDN (see table below)

Table 3: Recomended dietary nutrient compare with 24 (independent t test)

	Sex	Mean	T	Df	Sig. (2-Tailed)
Diff energy	Male	1706.7320	11.725	48	0.000*
	Female	764.4786			
Diff protein	Male	-16.4930	0.908	48	0.369
	Female	-19.7488			
Diff fat	Male	62.2867	5.216	48	0.000*
	Female	21.1266			
Diff CHO	Male	117.5326	7.119	48	0.000*
	Female	3.6217			
Diff fibre	Male	90.3485	6.037	48	0.000*
	Female	56.5050			
Diff calcium	Male	601.1061	-2.415	48	0.020*
	Female	719.0391			
Diff phosphorus	Male	-954.0468	-3.435	48	0.001*
	Female	-600.7300			
Diff iron	Male	-58.3595	-2.940	48	0.005*
	Female	-41.3680			
Diff thiamine	Male	-0.3131	0.425	48	0.673
	Female	-0.3458			
Diff revo	Male	-7.5913	-1.463	48	0.150
	Female	1.8795			
Diff niacin	Male	-1.4788	0.633	48	0.480
	Female	-0.5848			

Note: diff means (difference)

Observed intake difference in energy is compared with recommended intakes RDN and the results shows in thiamine, riboflavin, niacin and protein did not show any significance difference among male and female participants as compared to the slandered RDA.

Assessment of awareness on sports nutrition runners

A total of 24 questions were raised to test athletes' actual awareness of sport nutrition on four scoring methods major areas; macro nutrient, micro nutrient, water and sport drinks. Scores were computed for each section and graded. Four point rating scale was then used to grade the scores and results presented in percentage, frequency, pie charts and t test for significance. The grading was done as follows: Excellent $\geq$ 80%, Good 60%-79% = Average 40%-59% = Poor $\leq$ 39. Based on this score, majority of respondents (52.5%) have from poor to bad nutritional awareness. This could be due to their educational back ground very low. Because of this and other reasons, they are forced to have poor awareness about sport nutrition (See table below).

Table 4-Frequency and percentages of awareness score

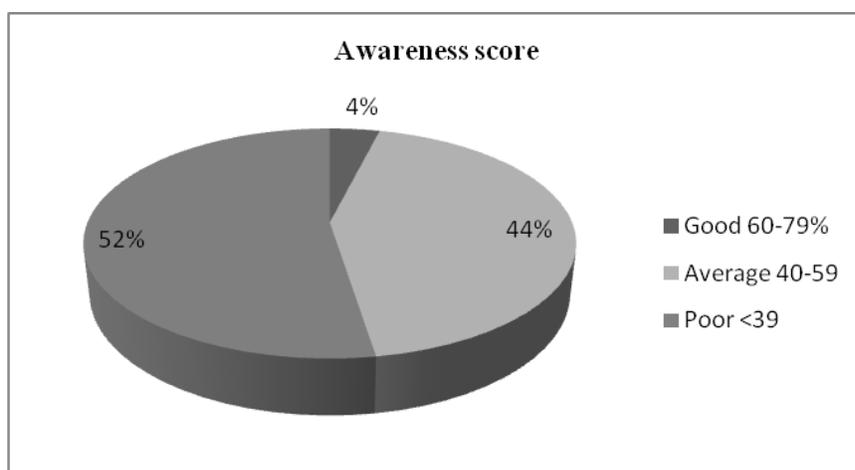| Standard score	Frequency	Per cent
Excellent >89%	Nil	Nil
Very good 80-89	Nil	Nil
Good 60-79%	10	3.9
Average 40-59	112	43.6
Poor <40	135	52.5
Total	257	100.0

Figure 3. Standard score of awareness

Factors that Influence nutritional intakes

Athletes were asked to rank factors from the most serious problem (1) which is number one to the least serious problem (9) which is number nine. Lack of money was indicated that influences athletes nutritional status, with the mean score 2.96 of the athletes in the study mentioning it. This was followed by family size as the second most serious factor with the mean 4.08, and unable to get balanced was indicated as third with mean 4.18. Having less appetite and weather condition were mentioned as the least serious factors by athletes with the mean 5.98 and 7.11, respectively. Assessment of institutional factors on their nutritional intakes and majority of the athletes responded that lack of budget was the strongest factor, with the mean2.68 of the athletes in the study mentioning it. This was followed by lack of training, with mean 4.24, followed by being unable to getting healthy food. Weather condition and coach knowledge were least factors mentioned by athletes with the mean 7.11and 7.30, respectively.

Attitude of Athletes towards Sport Nutrition

The subjects were surveyed on their attitudes towards sports nutrition. A sixteen-item attitude scale was used to assess athletes' attitude towards sport nutrition. The respondents were asked about nutrition, on a five-point likert-scale, to determine the extent to which they agreed or disagreed with statements concerning nutrition, their training in various events, how sport nutrition is perceived and reported by the public and their desire to achieve.

The findings show that majority of the athletes 64.9(23 %) strongly agree with statements that support the practice of nutrition. The 79.3 (27.33%) agreed with the statements while a further 22% disagreed and 16 strongly disagree with the statements. Only 6.3% chose undecided. Those who agreed with the statements at varying degrees totalled up to 50.33%, while those who strongly agreed or agree were only 38%strongly disagree or disagree. This indicates a strong positive attitude of the athletes towards sport nutrition.

DISCUSSION

Socio-Demographic Characteristics

Majority (78.6%) of the respondents were between 18and 23 years of age. Recent study of the Kenyan middle and long distance runners found out that the majority of athletes are between the age of 18 and 24 years (Kibata, 2011). However, the percentage of males was greater than that of females, i.e., (66.9%) and (33.1%) respectively. This shows gender imbalance, which could be due to cultural influence on females not to participate with males in sport activities.

Regarding education, in the current study, only (1.2. %) of the athletes had tertiary education. But young American athletes of the same age groups are all college graduates (IAAF Consensus Statement, 2007). In Ethiopia, most athletes grow up in the rural areas of the country and because of various socio-economic factors they do not get education opportunities for higher education's (interview with athletes).

Assessment of Awareness on Sport Nutrition among Athletes

The findings of the study indicated that SNNPR athletes (52.5 %) have low awareness about sport nutrition. This finding is similar to the findings of a study carried out in India among selected sport person (Mahalakshmi *et al*., 2012). In that study, similar to the situation in SNNPR there is lack of nutrition knowledge. Another study which was carried out in Kenya among elite athletes also showed similar findings (Kibata, 2011). Kibata's study showed that only 8.4% females had normal nutritional status (BMI 18.5), the remaining majority being either moderately or severely malnourished. The findings of the current study were also comparable to a study conducted in America, among college soft ball players (Grete *et al*., 2011) the findings of which indicated that the nutritional knowledge scores of the player was 36%, and that 65% of the player failed the test, due to low nutritional knowledge. Similar studies conducted in Iran elite college athletes (Azizi *et al*., 2010) and showed comparable results. Their study was designed for understanding the nutrition knowledge and attitude of elite college athletes. Based on their result, the knowledge of Iranian college athletes was moderate. The study suggested that nutrition knowledge and attitudes of Iranian college athletes need to improve.

However, the findings of this study, contradict to those of a similar study, which was carried out among Indian professional sportsmen. That study indicated that the knowledge levels of athletes were high in athletics than football and volleyball (Peerkhan and Srinivasan, 2010).

SNNRP athletes' awareness of sport, specific to nutrition was established to be low as compared to athletes of other nations like Indian, American and Kenya.

Dietary Intakes

This refers to the achievements of the recommended intakes of energy, CHO, protein, fat, fibre, iron and calcium, Riboflavin niacin and thiamine which are the important nutrients for athletes for good health benefits, endurance and stamina. We found out that knowledge on the importance of carbohydrates to an athlete was clear but the knowledge of the micro-nutrients iron and calcium and their importance in the body was very low (Burke, 2004).

Calcium is important in the diet of an endurance athlete as reduced bone density or failure to optimize peak bone mass may be a risk factor for the development of stress fractures during their athletic career, and more importantly, the earlier onset, or increased risk of osteoporosis in later life (MacKelvie, 2000). The female athletes consumed below the recommended amount of protein but more than half of the male athletes consumed above the recommended amount. It is suggested that endurance athletes should consume 1.2g to 1.4g of protein per kg of body weight per day to cater for the strenuous training prior to competitions (Deakin, 2000). The recommended dietary intake of iron for athletes is between 10mg and 14mg per day for optimized performance.

Factors that Influence nutritional Intake among Athletes

Regarding the question of what may influence athletes' nutritional intakes among athletes, this study classified factors as individual and institutional. The most serious to the least serious with the mean value (2.96) factors were financial problems, lack of nutritional training, absence of nutritionist, training load, lack of awareness about nutrition on the part of coach, athletes and managers with mean value of 7.11.This finding is relative to the findings of most studies in Africa countries.

Nutritional Statuses of SNNPR athletes

The nutritional status, especially of the female athlete was worrying as only 26.0% of the total number had normal nutritional status to the slandered which is 18.5. The other 74.0% had poor nutritional status under weight (<18.5). From the information received from the key informants the female athlete run very well during training and have a good record time but prior to major competitions the speed, stamina and endurance slows down.

This finding was similar to the findings about Kenyan female athletes (Kibata, 2011). They skipped meals more often than the male athletes. The female endurance athletes reported experiencing amenorrhea due to heavy training. Although it might be widely prevalent among some athletic groups, it is clearly not a healthy or desirable state. Sports medicine experts have described the syndrome as the "female athlete triad". This describes the common presentation of disordered eating, menstrual dysfunction, and reduced bone health among distance and track female athletes in Washington DC (Manore, 2002) which could also be the case with the female SNNPR athletes

Summery

The first objective sought to assess the awareness of sport nutrition among SNNPR athletes. The findings established that they had poor awareness of sport nutrition with a mean score of 31.1%, about the selected macro, micronutrients, fluid, and sport drinks. The findings reflected a positive attitude towards nutrition among majority of the athletes, with up to 50.33% of the respondents agreeing with statements in favour of sport nutrition. About 38% of the respondents either strongly disagreed or disagreed with the statements.

The objectives of dietary intake were to assess the intake adequacy of the athletes. Through 24-hour recall methods and food frequency questionnaire, the results indicated that the intake was low for some major nutrients, and for some macro and micronutrients, the assessment showed below the recommended amount.

The objective was to determine their status according to the cut-off point, which is under weight, normal and overweight, nutritional status. Majority of the athletes (74.1%) had poor nutritional status (under- weight <18.5). From the information received the athlete may run very well during training and have a good record time but prior to major competitions, the speed, stamina and endurance slows down majority of the athletes had inconsistent score. The reasons given by the athletes from most serious to least serious reason for poor nutritional practices were financial problems (with the mean value 2.96), lack of nutritional training, absence of nutritionist, training

load, lack of knowledge about nutrition on the part of coaches, athletes and managers and the weather condition (with the mean value of 7.11).

CONCLUSIONS

From the study, it can be concluded that SNNPR athletes have very low awareness of sports nutrition with slight variation on sport specific nutrition issues. It can further be concluded that the athletes were not informed of their nutritional intake in pre and post exercise time, lack substantial information on macro, micro, fluids and use of supplements. On assessment of attitude, SNNPR athletes can also be said to be approving of sport nutritional intake. This was seen in their strong positive attitude towards their nutritional intake. The prevalence of nutritional intake in the SNNPR was established to be very low.

The concerned sports organizations and offices of government should explore all possible means of addressing the problem, which may include improving access to sport nutrition information and developing sport nutrition structures and regulations.

RECOMMENDATIONS

The findings of the research revealed low (52.5%) awareness of sport nutrition, macro, micro, fluids and supplements. It is, therefore, highly recommended that the government, through the relevant sports associations establish nutrition education programme and ensure that such programme are effectively administered. Majority of the athletes indicated workshops as being very useful. Possible actions could be establishing annual free workshops per region either funded by the regional government or the national government or both. It should further be made a requirement to undertake nutrition seminar/workshop. Sport federation should endeavour to enhance access to this information by athletes by varying the means of communication. It is also recommended that more survey has to be done on nutritional intake and awareness of sport nutrition among Ethiopian athletes without restricting it to elitism or particular events.

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Malnutrition, Anemia and Associated Risk Factors in Selected Districts of Sidama region, Southern Ethiopia

Melesse Birmeka[*],TiruhaHabte, Zufan Bedewi, KassayeBalkewWorkagegn

Department of Biology (*E-Mail:melesseb@yahoo.com)

ABSTRACT

Malnutrition is a global public health problem with major consequences in developing countries. Thus, a survey of factors associated with under nutrition in different regions is a very important parameter in developing appropriate prevention and control strategies. This study aimed to investigate the status and the association of under nutrition, anemia and local risk factors on the well-being of primary schoolchildren living in Sidama regional state, Ethiopia. A community based cross-sectional study was carried out among 346 schoolchildren aged 7-14 years in two districts of Sidama Zone. Stool samples were collected and examined using simple mount and concentration technique. Socio-demographic information was collected using a structured questionnaire. Anthropometric measurement was taken at the time of interview. Hematological method was used to determine anemia. Logistic regression analysis was used to determine the association between under nutrition, stunting and underweight with socio-demographic factors, intestinal parasitic infections (IPIs) and anemia. The overall prevalence of under nutrition was 34.3% which was explained by (22%stunted and18%underweight).Maleness, having age category 7-9 years, illiterate parents, family members >5,birth order >2,presence of dirt in the finger and child infected with IPI were more likely to be undernourished than their respective category. The odds of stunting was high in children having illiterate parents, parents who were only depend on farming, children had no clean finger and children infected with IPI. Children who were in the age category 7-9 years were less likely to be stunted (protective). Femaleness, children with family members >5, having illiterate parents, children who had no clean finger and children infected with IPI were more likely to be underweight than the respective category. Age category 7-9 years was found to be protective by 46% from underweight. Similarly, children with birth order ≤2 were found to be protective by 81 % from underweight. Under-nutrition is highly associated with IPI, absence of clean finger, educational status, family size and age. Health education and provision of additional food supplements would be important to reduce the problem of under-nutrition.

Keywords: *Schoolchildren, Under nutrition, Risk factors, Prevalence*

1. INTRODUCTION

Access to nutritionally adequate and safe food is a right of each individual. Even though, there is enough food for all, inequitable access is the main problem globally. Under nutrition is the outcome of insufficient food intake and recurrent infectious diseases that includes a group of disorders like stunting, wasting and underweight (UNICEF, 2006).Under nutrition is associated with faltered growth, delayed mental development, and reduced intellectual capacity. Under nutrition decreases host resistance to infection and, the infectious diseases predispose the host to further infection (UNICEF, 1989; Mata, 1990). They can also no longer sustain natural bodily capacities to resist infectious diseases (Shrimpton *et al*., 2001).Under nutrition-infection complex is the most widespread public health problem in the world. This combined effect lower the

resistance of the host to the infection decreasing cellular and humeral immunity and leads to an infectious process greater-than expected severity (Stephenson *et al.*, 2000b).

In developing countries, the main immediate causes of under nutrition are inadequate dietary intake and infectious disease. Beyond the individual effects of these factors, they have also a synergistic interaction effect (UNICEF, 1989; Mata, 1990).

Inadequate dietary intake such as protein energy malnutrition and micronutrient deficiencies is major concerns among children from low income countries. A PEM deficiency causes several problems such as stunt growth and underweight. For instance, in the developing countries,52 % and 34-62% of the schoolchildren are stunted and underweight respectively (De Onis *et al.*, 2012; WHO, 2006).Sub-Saharan Africa has the second largest number of stunted and underweight children next to south Asia (Stevens *et al.*, 2012).In Ethiopia, 44.4 % of children under the age of five years are stunted, 25 % are underweight, and 9 % are wasted (CSA, 2014). While micronutrients such as iron deficiency is one of the world's common single nutrient deficiencies (Stoltzfus, 2003), and about a quarter of the world's populations are affected by anemia (WHO, 2008). Effects of early stunting on cognitive deficits can persist throughout later life (Mendez and Adair, 1999) and successive generations (Walker *et al.*, 2015). Iron deficiencies also affect the role of the synthesis of neurotransmitters and myelination of neurons (Perignon *et al.*, 2014). Deficiency of iron has been associated with poorer cognitive performance in children and was implicated in long lasting effects even after treatment for iron deficiency (Lozoff *et al.*, 2006). Infectious diseases such as intestinal parasitic diseases, in association with nutritional deficiencies, remain killers of humans and conditions are worse in children (Crompton and Nesheim, 2002; Hotez *et al.*, 2006).

Although, Ethiopia has demonstrated promising progress in reducing levels of under nutrition over the past decade, the baseline levels of under nutrition remain so high that the country still needs to continue substantial investment in nutrition (CSA, 2014). According to Ethiopian Demographic and Health Survey, there is a substantial regional variation of under nutrition in Ethiopia (Olaf and Michael, 2005). Even though there are studies conducted in Ethiopia, little is known about the prevalence and associated factors of under nutrition and anemia in the study area. Furthermore,under nutrition and anemia hasdiverse and complex basis, due to this reason, the specific causes varied with variations in region and period of time. Hence, current information about risk factors of the problems for different region is helpful to design integrated, timely and appropriate strategies to effectively control the diseases. This study aimed to examine the status and the association of under nutrition, anemia and local risk factors on the well-being of Primary schoolchildren in selected districts of Sidama regional state, Southern Ethiopia.

MATERIALS AND METHODS
Study area and study population

The study was conducted at Hawassa Zuria and Boricha districts among the thirty-two districts of Sidama regional state, Southern Ethiopia. Sidama region is located 275 kms Southeast of Addis Ababa, the capital city of Ethiopia. The study participants were children aged 7-14 years randomly selected from Enbulodikicha primary school of Hawassa-Zuria district and Korangogema primary school of Boricha district.

Study design

A randomized school based cross-sectional study was conducted between November and December 2019 n two public primary schools in the community of Sidama, in Hawassa Zuria and Boricha districts. The study was carried out in collaboration with local (district) health and education sectors.

Sample size and sampling method

The source population included all students aged 7-14 years, using a single-population proportion formula; the sample size was calculated based on the following assumptions: An assumption of 31% past use prevalence was used based on research conducted in primary schoolchildren (Degarege*et al*., 2015).This would give a sample size of 329. Also it was assumed with a 5% margin of error at 95% confidence interval and Z = standard score corresponds to 1.96.With a non-response rate of 5%, the total sample size was computed to be 346. The total sample size was distributed proportionally to the selected schools(Korangogema,187/346 andEnbulodikicha,159/346) based on total number of students and, then allocated to each grade proportionally. Finally, individual student fulfilling the inclusion criterion was randomly selected to be the study participant.

Anthropometric measurements

Weight and height data on each study subject was collected by lab assistant. Weighing of each student was done with minimal clothing and to the nearest 0.1kg. Boys were weighed wearing their trousers, while girls were weighed wearing their minimal dresses. Measurement of height was carried out without wearing shoes, to the nearest 0.1cm. Raw anthropometric data (height, weight, age and sex) was converted to nutritional indicators using WHO anthro plus software. A child was considered undernourished when either (weight- for age- z score or body mass index for-age z score <-2) or stunted (height-for-age z score <-2).These anthropometric measurements were determined according to the World Health Organization (WHO) guidelines (1995).

Simple mount technique

A direct wet fecal smear was prepared by emulsification of 2mg of the feces on a glass slide in one drop of Lugol's iodine. The sample was covered with a cover slip and systematically observed at low and high magnification using a light microscope in order to identify any mature parasites, cysts or eggs present. This was done by experienced, laboratory technicians on the day of collection in the field laboratory.

Formol-ether concentration method

Stool samples were collected from 346 schoolchildren and preserved in 10% formalin and transported to Biology Department laboratory, Hawassa University. Then they were analyzed using formol-ether concentration technique as described by Ritchie (1948). The results were used to report the prevalence of intestinal parasitic infections.

Blood sampling and hematological measurements

Hemoglobin concentration was determined from finger prick blood sample using a portable hemoglobin analyzing system HB 301+. Hemoglobin concentration classification was defined based on the reference ranges Hb adjusted for altitude in children. Then individuals were classified as anemic or non-anemic according to the WHO age/gender cut-off limits (WHO, 2001).

Data Analysis

The nutritional data was imported to WHO Anthroplus Software. Thus, the software converted raw nutritional data into Z- scores of the indices taking age and sex into consideration, using NCHS reference population standard of WHO reference 2007 (5-19 years). The data was then exported to SPSS Version 20 program for analysis. P value less than 0.05 was considered as statistically significant. Univariate logistic regression analyses was conducted to identify the association of nutritional status with IPI, anemia and others socio-demographic factors.

Ethical consideration

The study was conducted after ethical clearance was obtained from Hawassa University College of Health Science. Each study participant was included in the study after they gave their permission and their result was kept confidential.

RESULTS

Socio-demographic characteristics

A total of 346 children (55.78% male) and (44.22% female) were included in the study. Most (98.3%) of the children were Sidama ethnic group. Utmost (90.8%) children were protestant in religion. Almost 68.5% of the children had no clean finger.About 72.3% of the children had daily meals of less than three times a day prior to the survey. Nearly 64.7% of the children used water from unprotected source and 65.5% did not wash hands before eating.

Table 1 Socio-demographic/economic and environmental characteristics of children and their parents in Boricha and Hawassa Zuria Districts, Sidama regional state.

Variable	Categories	Number of observations	Relative frequency
Sex	Male	193	55.8
	Female	153	44.2
Age	7-9yr	150	43.4
	10-14yr	196	56.6
Ethnicity	Sidama	340	98.3
	Others	6	0.7
Religion	Protestant	314	90.8
	Others	32	9.2
Marital status	Married	255	73.7
	Widowed &others	91	26.3
Family size	2-5	127	36.7
	>5	219	63.3
Educational status	Illiterate	265	76.6
	Literate	81	23.4
Family income	<1000	121	35
	1000-2000	167	48.3
	>2000	58	16.7
Presenceofillnessinlasttwoweeks	Yes	50	14.5
	No	296	85.5
Presence of dirt in the finger	Yes	237	68.5
	No	109	31.5
Meal frequency	≥3	96	27.7
	<3	250	72.3
Birth order	≤2	130	37.6
	>2	216	62.4
Parent occupation	Farmer	240	69.4
	Others	106	30.6
Latrine availability	Yes	201	58
	No	145	42
Water supply	Protected source	122	35.3
	Unprotected source	224	64.7
Main decision maker of household	Male parent	200	57.8
	Female parent	52	15
	Both jointly	94	27.2
Washing hands before eating	Yes	118	34.1
	No	228	65.9
Washing hands after defecation	Yes	66	19
	No	280	81
Wearing shoes	Yes	255	73.7
	No	91	26.3

About 83/346(23.9%) of children were IPI infected (Boricha 34/187(18%), Hawassa Zuria 49/159 (30.8%)).Analyses of the potential risk factors explored for the IPI showed, 48(24.7%) of males, and 35(22.8%) of females had at least one IPIs, but it was not statistically significant (P>0.05) (Table 2). The schoolchildren who had clean finger, wash hands before meal, presence of latrine in their home, age category 7-9 years, presence of educated parents and consuming water from protected source showed significant association or protective from IPI. They were less likely to be infected with IPI. This shows hygienic condition matters on the transmission of IPI. In other words, latrine availability in a family, washing hands before eating, presence of clean finger, presence of literate parents, age category 7-9 years and using water from protected source were found to be protective from IPI and it showed reduction each by 68%,73%,89%,76%,56% and 77% from IPI respectively (Table 2).

Table 2 Factors associated with IPI among school children in Boricha and Hawassa-Zuria Districts, Sidama regional state

Variable	Categories	No (%) with IPI	OR(95%CI)	P-value
Sex	Male	48 (24.74)	1.09(0.66-1.8)	0.7
	Female	35 (23.03)	1	
Age	7 - 9yr	24(16)	0.44(0.25-0.75)	0.002
	10-14yr	(30.1)	1	
Educational status of parents	Illiterate	43(17.36)	1	<0.0001
	Literate	37 (45.68)	0.24(0.14-.42)	
Presence of dirt in the finger	Yes	26 (10.97)	1	<0.0001
	No	57 (52.29)	0.11(.06-0.19)	
Water supply	Protected	12 (9.84)	0.23(0.12-0.45)	<0.0001
	Unprotected	71 (31.70)	1	
Washing hands before eating	Yes	13 (11.02)	0.27(0.4-0.53)	0.0001
	No	70 (30.70)	1	
Availability of latrine	Yes	31(15.42)	0.32(0.19-.54)	
	No	52 (35.86)	1	<0.0001

*The percentage is calculated from the total examined for the respective characteristic

Out of the 346 children, 34.3% were undernourished (stunted 22% and underweight 18%).The odds of IPI in children who were male sex were 2 times more likely to be undernourished. Children who had no clean finger were 1.7 times more likely to be undernourished than who had clean finger. Similarly, schoolchildren who had family members more than five were 5.4 times more likely to be undernourished. And also, children who had illiterate parents were 9.5 times more likely to be under nourished. Children having age category 7-9 years were protective from under nutrition and it showed reduction by49%.

Table 3 Factors associated with under nutrition among school children in Boricha and Hawassa Zuria Districts, Sidama region

Variable	Categories	No (%) with Under nutrition	OR(95%CI)	P-value
Sex	Male	81 (42.27)	2.12(1.3-3.3)	0.001
	Female	39 (25.66)	1	
Age	7-9yr	40(26.67)	0.51(0.32-0.81)	0.004
	10-14yr	81 (41.33)	1	
Family size	2-5	75 (59.06)	1	<.0.0001
	>5	46 (21.00)	5.4(3.35-8.76)	
Educational status	Illiterate	115 (43.40)	9.5(4.02-22.7)	<0.0001
	Literate	6 (7.41)	1	
Meal frequency	≥3	36 (37.5)	1	0.54
	<3	85 (34)	1.16(0.71-1.8)	
Birth order	≤2	58 (44.62)	1	0.003
	>2	63 (29.17)	1.9(1.24-3.7)	
Presence of dirt in the finger	Yes	91 (38.40)	1.69(1.03-2.7)	0.037
	No	29 (26.85)	1	
IPI	Yes	51 (61.45)	4.39(2.6-7.38)	<0.0001
	No	70 (26.62)	1	

*The percentage is calculated from the total examined for the respective characteristic

Among selected determinants with stunting, age (7-9years), large family size (>5), the presence of IPI, presence of dirt in the finger, having illiterate parents and parent occupation with only engaged in farming were significantly associated with stunting (HAZ <-2SD).The odds of stunting was high in children having with large family size, parents only participated in farming, having illiterate parents, children with dirt in the finger and children infected with IPI (Table 4).

Children with age category 7-9 years and children having family members more than five were found to be protective from stunting and it showed reduction by 59% and 62% respectively from stunting (probability to be stunted is 0.41 and 0.38 respectively) (Table 4).

Table 4 Factors associated with stunting among schoolchildren in Boricha and Hawassa Zuria Districts, Sidama region.

Variable	Categories	Stunting		OR(95%CI)	P-value
		Yes	No		
Sex	Male	44	150	1	0.71
	Female	32	120	1.1(0.65-1.8)	
Age	7-9yr	21	129	0.41(0.23-0.72)	0.002
	10-14yr	55	141	1	
Marital status	Married	47	208	0.48(0.28-0.83)	0.008
	Widowed& others	29	62	1	
Family size	2-5	16	111	0.38(0.2-0.69)	0.0001
	>5	60	159	1	
Educational status	Illiterate	68	197	3.14(1.4-6.87)	0.004
	Literate	8	73	1	
Parent occupation	Farmer	47	59	5.79(3.35-10.0)	<0.0001
	Mixed	29	211	1	
Presence of dirt in the finger	Yes	67	170	4.37(2.09-9.16)	0.0001
	No	9	100	1	
Presence of IPI	Yes	63	20	60.5(28.5-128.3)	<0.0001
	No	13	250	1	

*The percentage is calculated from the total examined for the respective characteristic

Factors associated with underweight were performed on selected correlates of WAZ <-2SD for age Z- score. Of these factors, being female, age category 7-9 years old, children with family members more than five, having illiterate parents, birth order≤2, children with no clean finger and children infected with IPI were significantly associated from underweight(WAZ < -2SD).

Age category 7-9 years was found to be protective by 46% from underweight. Similarly, children with birth order≤2 were found to be protective by 81 % from underweight (probability to be underweight is19%) (Table 5).

Table 5 Factors associated with underweight among schoolchildren in Boricha and Hawassa-Zuria Districts, Sidama regional state

Variable	Categories	Underweight		OR(95%CI)	P-value
		Yes	No		
Sex	Male	50	143	1	
	Female	13	140	3.76(1.95-7.2)	0.0001
Age	7-9yr	20130		0.54(.30-.97)	0.04
	10-14yr	43	153	1	
Family size	2-5	33	94	1	0.004
	>5	30	189	2.2(1.27-3.84)	
Educational status	Illiterate	58207		14.25(1.64-11.01)	0.002
	Literate	576		1	
Birth order	≤2	8	122	0.19(.8-0.41)	<.0001
	>2	55	161	1	
Parent occupation	Farmer	50	190	1	
	Mixed	13	93	1.88(0.97-3.6)	0.059
Presence of dirt in the finger	Yes	50	187	1.97(1.02-3.81)	0.04
	No	13	96	1	
IPI	Yes	18	65	16.1(8.4-30.7)	<.0001
	No	45	218	1	

*The percentage is calculated from the total examined for the respective characteristic

Univariate analysis for association between anthropometric measurements, IPI and the prevalence of anemia showed no statistical significant association. The occurrence of anemia was 8.6%(12/187(6.4%) in Boricha and18/159(11.3%) in Hawssa Zuria Districts in children that had no association with the occurrence IPI or under nutrition in the study population.

Table 6 Anemia and its association with under nutrition and IPI among schoolchildren, in Boricha and Hawassa Zuria Districts, Sidama region.

Variable	Categories	Anemia		OR(95%CI)	P-value
		Yes	**No**		
BMI for age	Yes	13	108	1.4(0.68-3.14)	0.31
	No	17	208	1	
Height for age	Yes	25	245	1.4(0.53-3.92)	0.46
	No	5	71	1	
Weight for age	Yes	7	56	1.4(0.57-3.4)	0.44
	No	23	260	1	
IPI	Yes	10	73	1.6(0.74-3.7)	0.21
	No	20	243	1	

*The percentage is calculated from the total examined for the respective characteristic

In Boricha district, about26.3% (49/187) of the children were undernourished (9/34 stunted,8/23underweight). In Hawassa-Zuria district,71/159(44.7%) were undernourished(22/42 stunted,19/39 underweight).Univariate analysis of under nutrition in selected correlates of Boricha and Hawassa Zuria districts separately showed that femaleness, children with more than five family members, children who had illiterate parents, children who were anemic and children infected with IPI were more likely to be under nourished than the respective category. Furthermore, Children in the age category 7-9 years were found to be protective by 60% from under nutrition in both districts (Table 7).

Table 7 Comparison of selected determinant factors of under nutrition among the schoolchildren in Boricha and Hawassa Zuria Districts, Sidama regional state.

Variable	Residence						
	Boricha				**Hawassa-Zuria**		
	Under nutrition * N(%)		**OR(95% CI)**	**P-value**	**Under nutrition * N (%)**		**OR(95%CI)**	**P-value**
	Yes	**No**						
Sex								
Female	47	59	32.8(7.6-140.35)	<0.0001	48		6.2(3.13-12.5)	<0.0001
Male	2	79	1		22		1	
					23	66		
Age in years								
7-9	1566		0.48(0.24-.96)	0.038	2544		0.51(0.27-0.98)	0.04
10-14	3472		1		4743		1	
Family size								
2-5	3326		1		4226		1	
>5	13112		10.9(5.5-23.6)	<0.0001	29 62		3.45(1.78-6.67)	0.0002
Education status	53 73		14.03(4.1-47.2)	<0.0001	6277		10.8(3.3-35.1)	0.0001
Illiterate	358		1		9 11		1	
Literate								
Water supply								
Protected	20		1.17(0.60-2.29)	0.63	25	26	1.29(0.66-2.52)	0.44
Unprotected	51		1		46	62	1	
	29							
	87							
Anemia								
Yes	6		2.61(0.83-8.19)	0.09	13	4	4.7(1.40-15.1)	0.009
No	7		1		58		1	
	43				84			
	131							
IPI								
Yes	20	11	26.5(10-70.4)	<0.0001	31		2.47(1.25-4.87)	0.008
No	10146		1		21		1	
					40			
					67			

*The percentage is calculated from the total examined for the respective characteristic

DISCUSSION

The present study indicated that coexisting under nutrition in schoolchildren were found to be higher in study population, as compared to what has been reported earlier from different parts of Ethiopia. For instance, some studies documented a lower prevalence of under nutrition for the urban centers of Ethiopia, underweight (27.1%) and stunted (11.2%) in Durbete town, North West Ethiopia (Alelegn*et al*., 2015) and stunted (19.6%) and underweight (15.9%) in Addis Ababa (Degarege*et al*., 2015). This indicated that in urban centers, the nutritional status is relatively better than in the rural regions of Ethiopia. However, the prevalence of underweight

and/or stunting detected among the present study participants was lower to the recent reports among school-age children in different parts of Ethiopia (Degarege and Erko, 2013; Herrador *et al*., 2014). Similarly high prevalent findings were also reported on the prevalence of stunting (42.7%) and underweight (59.7%) in school-age children from different localities in Ethiopia (Reji *et al*., 2011; Nguyen *et al*., 2012; Mekonnen *et al*., 2013). The significant differences could be due to variations in the factors affecting under nutrition in the different regions of rural Ethiopia.

The possible explanation for the middle age children (10-14 years) to have been more under nourished than the younger age group may be that, younger age (less than 10 years) were more protected by parents so that they have better access to nutritious food and as they are small children, no heavy work is assigned to them. As a result, they are subjected to less energy wastage that will contribute to stunting, whereas the middle age group (10-14 years old) are known to be highly active and participate in the household chores, helping parents. Similarly, children with no IPI were less undernourished because of lack of negative impact as the result of infection.

The lower prevalence of under nutrition (34.3%) compared to that reported from North West Ethiopia, with prevalence rate of 37.2% (Mekonnen *et al*., 2013) may be an indication of regional variability in nutritional quality and availability. The lower proportion of undernourished female children found in the study might be a reflection of difference in food accessibility between the sexes. It is possible that, as females stay at home after school, they may have better access to food at home. Possible reasons for the observed positive association of poor nutritional status with IPI include morbidity associated weight loss and altered absorption of micro and macronutrients (Stephenson *et al*., 2000a). As a possible indication of regional variation, the prevalence of underweight in the two study sites was lower than that reported in a study done in Northwest Ethiopia (59.7%) (Mekonnen *et al*., 2013).

The under nutrition detected in the schoolchildren who were infected with IPI could be due to the fact that IPIs cause diarrhea, lower appetite and malabsorption, in addition to the parasites competing for food, and some causing blood loss that would lead to under nutrition (Crompton and Nesheim, 2002; Muller and Krawinkel, 2005).

Regarding possible association of IPI with risk factors among schoolchildren, several studies had identified a range of socio-demographic risk factors (Haileamalk, 2005; Amare *et al*., 2007; Alemu *et al*., 2011; Ayalew *et al*., 2011; Gebrehiwot *et al*., 2014). These were the same risk factors such as the odds of IPI increasing in children who did not wash hands before eating, defecation in open fields, consuming unprotected water and presence of large family sizes that are associated with increase in the prevalence of IPI in the two study districts. This is an indication of little difference in the socio-economic condition of the population in different parts of Ethiopia.

The present study has shown that the prevalence of anemia among school age children was 8.4% to be lower (27 - 37.6%) with that reported for school age children in different regions of Ethiopia (Assefa *et al*., 2014; Herrador *et al*., 2014).This is also an indication of significant difference in the socio-economic conditions of Ethiopian populations in different parts of the

country. The differences in the prevalence of anemia among school-age children in different regions of the country may be partly explained by its multifactorial causes. As a result, the risk factors of anemia may not be exactly similar in all areas as reported by WHO (2001).

Furthermore, although in rural Ethiopia, the diets of the population are predominantly plant-based and low in animal products and the daily consumption of such diets for longer periods may increase the relative risk of decencies of iron (Umeta *et al*., 2000).

CONCLUSION

The study has provided evidence for under nutrition, IPI and anemia that the livelihood of the schoolchildren in Boricha and Hawassa Zuria Districts is adversely affected. Sex, age, education, personal hygiene, availability of latrine and IPI were main predictors of under nutrition in children. There should be a need to improve socio-economic status of the community through implementing different intervention strategies to alleviate the co-morbidity of malnutrition, IPI and anemia on the well-being of school children under Ethiopian health services condition.

Ethics approval and consent to participate

Approval for this study was done by the Ethics Committee of Hawassa University College of Health Science. The ethical considerations were addressed by treating positive children using standard drugs under the supervision of a local nurse.

Acknowledgments

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Assessment of Bacterial and Parasitic Infections in Commercially Important Fishes

P.Natarajan[1*],Kassaye Balkew,[1] Zufan Bediwi,[2] Beyene Dabo[2] &Mesele Abera[3]

[1]Department of Aquatic Sciences, Fisheries and Aquaculture
[2]Department of Biology, Hawassa University
[3]Department of Veterinary Science, Hawassa University
(*E-mail: drpnatarajan123@gmail.com)

ABSTRACT

Parasites and pathogens constitute one of the most important factors affecting both capture and culture fisheries causing great economic loss to fishing and aquaculture industry. As aquaculture is developing fast as a substitute for capture fisheries, attention is now focused on disease incidences in cultivable fish species. The present paper describes the incidence of bacterial pathogens and metazoan parasites on cultivable fish species such as Nile tilapia, African Catfish and the Barbus from Lake Hawassa. Standard mythologies were followed for the collection of water samples, fish species and metazoan parasites of fish. Isolation and identification of bacterial pathogens, experimental infection, haematology, histopathology and antibrogram tests were carried out by following standard procedures. Most of the water quality parameters registered were above normal which influenced infection both by bacteria and metazoan parasites. Haematological parameters showed lower values in infected fish than the control fish and that, the affected fish showed histopathological alterations in fish tissues. In conclusion, the cultivable fishes are subjected to infection by diverse groups of parasites and pathogens and this warrants the protection of Hawassa Lake from any further deterioration especially due to pollutants.

Keywords*: Bacterial pathogens, metazoan parasites, infestation, haematology, histopathology, antibiogram, cultivable fish.*

INTRODUCTION

Parasites and diseases constitute one of the most important problems in fisheries and aquaculture. A large number of parasites and disease incidences due to microbial infections in fish populations have been reported, and literature regarding this is enormous (Azad *et al.,* 2001;Cai*et al.,*2004).Fish disease reduces fish production by affecting the normal physiology of fish and if left uncontrolled, it can result in mass mortalities. Disease is universally recognized as one of the most serious threats to commercial success of fisheries and aquaculture. Parasitic, bacterial, protozoan and viral diseases of fish are among those diseases which have great economic and public health importance particularly in the tropics. In many cases, they have proved to be a serious problem causing economic loss to fishing and aquaculture industry. In fish farming, they may lead to epidemics and mortalities, and as the culture of fish becomes more intensive and wide spread, infection will be a serious concern in aquaculture (Goja, 2013).

Among microbial diseases, diseases caused by bacteria especially, the infection with Gram-negative bacteria is still the foremost threat to aquaculture (Subasinghe*et al.,* 2001).In intensive aquaculture system, fishes are usually cultured under high densities, and thus overcrowding tends to adversely affect the health of cultured fish making them susceptible to infectious diseases. Disease outbreaks are increasingly being recognized as potential constraints as they cause financial losses through reduced meat quality and at times through fish mortalities (Smith *et al*., 2003).Ventura and Grizzle(1987) reported that bacterial gill diseases, hemorrhagic septicemia and furunculosis are infectious diseases known to be precipitated by adverse environmental changes.

The incidence of bacterial pathogens represent a significant constraint to fish productionThe heterotrophic bacterial population present in water and sediment is of great importance as most often these bacterial population turns to be pathogenic and affect health and wellbeing of the fish under unfavorable environmental conditions. According to Walker and Winton (2010) water quality of fish rearing sites, microbial population in water and sediment play a significant role in overall performance and wellbeing of the fish. Bacteria are responsible for many diseases and heavy mortalities in farmed fish. *Aeromonas*spp, *Pseudomonas fluorescens, Vibrio anguillarum, Flavobacteriumcolumnare, Edwardsiellatarda, Streptococcus*spp and *Enterococcus*spp are commonly affecting the cultured fish (Plumb, 1997).

Fishes also harbor major levels of parasitic infections and have a role in the maintenance of biological and behavioral diversity in their hosts. In wild waters, more than 80 to 90% of fishes harbor at least one species of parasite (Combes, 1991). Parasitism is much more common and diverse in wild conditions than in fish farms and hatcheries. The incidence and abundance of parasites depend on host's mode of life, and both biological and environmental characteristics. Factors such as age, sex, feeding behavior of fish mainly influence the parasitic incidences. Zender and Kesting (1996) reported that parasitic incidences are predominantly determined by the feeding behavior of the fish. Fish in schools and extensive migration of fish population influence parasitic incidences. Thus investigation on parasitic communities is useful for the knowledge they provide on community structure and dynamics (Esch*et al.,* 1990). The study of parasites and diseases is important in fisheries and aquaculture as it affects the production potential, besides this, it also reduces the market value of fish species as they cause damage and make the fish unsuitable for human consumption.

Health of aquatic organisms cannot be measured directly; instead, it can be measured though hematological and histopathological observations. Histology and histopathology can be used as bio-monitoring tools or indicators of health studies as they provide early warning signs of disease and also used to diagnose the nature of the disease. Tissue alterations in fish may be due to stressing agents of the environment or induced by pathogens compromising the growth and survival of animals (Santosh *et al*., 2017).

Even though, adequate understanding of parasitic and bacterial diseases is available worldwide, studies on disease prevalence due to parasitic and bacterial pathogens and its impact on host fish in Ethiopia is very much limited (Tefera Wondimu, 1990; Eshetu Yimer, 2000). Therefore, the present study was undertaken with a view to investigate in detail the prevalence of bacterial and parasitic infections on Nile tilapia, *Oreochromis niloticus, African catfish Clariasgariepinus*and the Barb*, Barbus intermedius.*

OBJECTIVE

General objective

The general objective of this project was to study in detail the occurrence and abundance of parasites and pathogens, and their impacts on commercially important food fishes.

Specific objectives

- ❖ To evaluate water quality parameters of Hawassa Lake as stress factor for onset of infection in commercially important food fishes
- ❖ To evaluate the prevalence and intensity of infestations of different kinds of parasites
- ❖ To isolate and identify bacterial pathogens that produce diseases in fish
- ❖ To assess the host– parasite relationship

MATERIALS AND METHODS

Description of the study area

The study was conducted in Hawassa Lake,Hawassa. Hawassa is the capital city of Southern Nations, Nationalities and People's Regional State (SNNPR). It is located 275 km south of the capital city of Ethiopia, Addis Ababa. Lake Hawassa is located at 6º 33º – 7º 33º N and 38º 22º – 38º 29º E, in southern Ethiopia at an altitude of 1,680 m above sea level (Fig. 1) (Yitayal Alemu *et al*., 2017). The lake is one of the Ethiopian Rift Valley Lakes and has a surface area of 90 km² (GirmaTilahun and Gunnel Ahlgren, 2009). The maximum and mean depth of the lake is 21.6 m and 11 m respectively (Elias Dadebo, 2000). It is an endorheic lake with no visible outlet and receives most of its water from the Tikur Wuha River (Yemane Gebreegziabher, 2004). Unlike the other southern rift valley lakes in Ethiopia, Lake Hawassa harbors low fish species diversityand the commercially important fish species found in the lake include Nile tilapia, *Oreochromis niloticus*(Linnaeus, 1758); African catfish, *Clariasgariepinus* (Burchell, 1822); African big barb, *Labeobarbus intermedius* (Rüppell 1835; DemekeAdmassu 1996). Tilapia constitutes about 90% of the total production, while Barbus and Catfish contribute only about 2-3% and 7-8% respectively (Sai Ram Patnaik, 2014). There are two landing sites in Hawassa Lake and they are Amora Gedel and TikurWuha(Fig. 1).
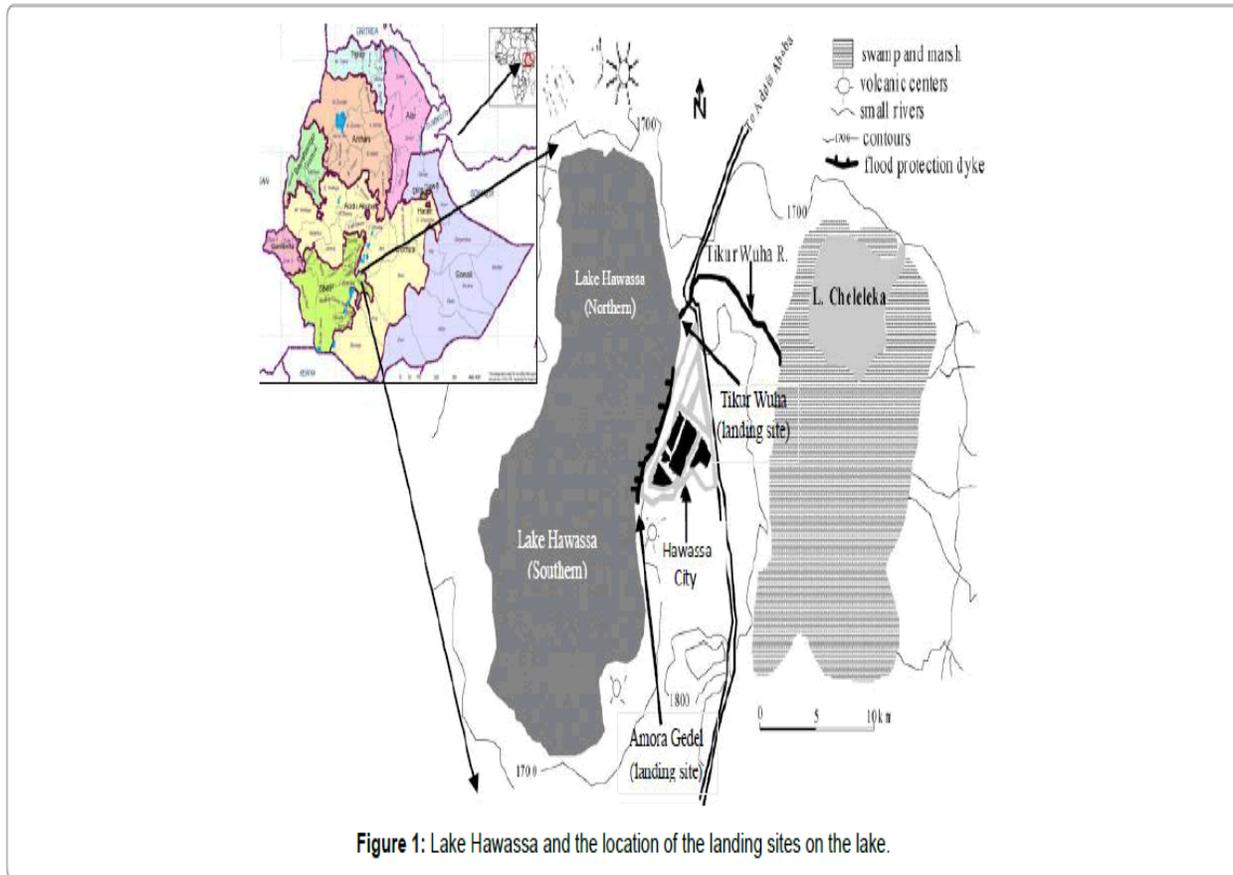
Figure 1: Lake Hawassa and the location of the landing sites on the lake.

Disease symptoms

Laceration, body swelling, abnormalities, laceration, scale loss, fin and tail rot, necrosis if any found on the body surface of fish were considered as symptoms of the disease. Internal organs were also examined for disease symptoms. For internal examination, incision on the body surface through ventral surface was made by using sterile scalpel. Immediately after making an incision, observations were made for the presence of the symptoms. 70% ethanol was applied on the body surface of the fish to prevent the entry of other microorganisms. The regional and sectional distribution of such lesions were noted and calculated for percentage distribution of such malformations.

Collection of water samples from Hawassa Lake

Water samples were collected from five sites in Hawassa Lake which include: Physico-chemical characters and nutrients. Temperature; pH, Dissolved Oxygen, Turbidity, EC, TDS, Nitrate, Phosphate were measured using commercially available testing kit (Sera®, GmbH, Germany). Temperature, dissolved oxygen (DO), conductivity and pH were measured in-situ using a portable multi-parameter probe a (Model HQ40D, HACH Instruments). The method of Santosh and Singh (2007) was also followed for estimating water quality.

Isolation of bacterial population

Water and fish sample collection

Water sample

Water samples were taken from the stocking pond by using 100 ml of sterilized glass bottles under the water surface with the depth of 10 to 15cm for bacteriological investigation in the laboratory. The entire water sample was kept in an ice box before transferring to the Veterinary Laboratory, Hawassa University. 1 ml water sample was mixed with 9 ml of sterile 0.85% saline solution in the bottle, then 10 fold serial dilution was made. In the laboratory, all water samples were stored in freezer at 4^0C until microbiological analyses.

Fish sample

The fish samples *(Oreochromis niloticus)* for the study were collected from the Fish Research and Multiplication Station, Hawassa Research and Breading Center and kept in plastic bags. The samples in plastic bags were then taken to Hawassa University Veterinary Laboratory for the isolation and identification of pathogenic bacteria. Nile tilapia (*O. niloticus)* with sizes ranging between 14cm and 21cm and weight between 43.2g and 139g were collected from the Research Centre pond by seine net. Disease symptoms (laceration, swelling, necrosis, scale loss, fin and tail rot) if any found on the body surface of the fish were considered for the isolation of bacterial pathogens. Internal organs were also examined for disease symptoms. For internal examination, incision on the body surface through ventral surface was made by using sterile scalpel/ scissors. Immediately after making an incision, 70% ethanol was applied on the body surface of the fish to prevent the entry of other microorganisms. Bacteria were isolated from body surface, gills, liver, intestine and kidney of fish aseptically and serial dilutions were made. One gram sample from different organs of each fish was mixed with 9 ml of 0.1% sterile peptone water in sterile bottles. The bottles were closed and shaken thoroughly for 5 minutes and allowed to stand for 10 minutes, after which a 10fold serial dilution was carried out.

Preparation of serial dilution

Nine milliliters of sterile distilled water was poured aseptically in to ten test tubes and 1 ml of the original mixed fish sample was added to the first test tube and mixed thoroughly. Another 1 ml was taken from the first tube and added to the second test tube and mixed very well. From the second test tube another 1 ml was taken and introduced in to the third test tube and mixed very well. This procedure was continued until the tenth test tube. Similarly, 1 ml water sample was mixed with 9 ml of sterile 0.85% saline solution in the bottle, then 10-fold serial dilutions was carried out. The water sample and fish were therefore diluted from 10^{-1}- 10^{-10} for each fish organ.

Inoculation of plates

From each serially diluted test tubes of water sample and sample fish of each organ, 0.1 ml was taken by pipette and dispensed and cultured by glass spread method on petri plate containing nutrient agar. All plates were incubated in an inverted position at 37^0C temperature in an

incubator for 24 hours. Then concentration of heterotrophic bacterial load in water sample and in different organs was counted under dark field colony counter equipped with a guide plate ruled in square centimeters. Plates containing 30-300 colonies were used to calculate the bacterial population and recorded as $CFUml^{-1}$ and $CFU\ g^{-1}$ in water sample and in different organs respectively according to Austin and Austin (1999). All counts were done in duplicates and the average used as final estimate of the microbial load of the sample. To determine the counts in $CFU\ ml^{-1}$ of sample, the formula for standard plate count used was as follows:

Estimate of Microbial Load =
  Number of Colonies X Dilution Factor divided by Volume of Inoculum used

Subculture of bacteria in water and fish

Inoculated nutrient agar medium were observed for the presence of bacterial growth after 24 hours incubation. The bacterial colonies present were sub-cultured onto petri plate containing Mac Conkey agar medium by streak plate method and incubated in an inverted position at 37^0C in an incubator for 24 hours

Pure culture of Vibrio Bacteria

Pure cultures of the bacterial organisms were identified by using the standard procedures (Austin and Austin (2007). After culturing the sample on nutrient agar, suspected colony were picked up and re-streaked on new plate of selective medium (Mac Conkey Agar and TCBS agar). Identification of the pure culture was made by examining the colony morphology, as well as by examining the shape, arrangement, staining characteristics, motility, oxidase activity, and oxidation-fermentation properties (Plumb *et al.,* 1982; Austin and Austin, 1999). Some of the biochemical characterization of potential pathogens techniques used for the identification is described below

Morphological characterization of vibrio bacteria

Pure cultures of the isolated bacteria were identified by biochemical characterization following the criteria proposed in the Bergey's Manual of Determinative Bacteriology (Garrity, 2001). Culture from the re-streaked plate of Mac Conkey Agar was transferred to sterile test tube containing 10 ml nutrient broth by using sterilized wire loop and kept for 24 hrs. Then the nutrient containing bacteria was inoculated into TCBS agar plates by swabbing and the plates were incubated at 37^0C for 24 hrs. The bacteria were then ready to observe for their morphological characters.

Shape identification

Identification of the isolated bacteria were determined by using differential staining following Gram's staining method to differentiate the cell wall and arrangement of bacteria. The stained slides were observed under oil immersion of 10x objectives of a light microscope to determine the shape and arrangement of bacteria

Gram's staining

Gram's staining was performed by using clean and dry slide and a loop full pure cultured bacteria was taken by using sterilized wire loop and placed on a clean slide. A drop of distilled water was added over it and then mixed with the culture to form a thin film and then the slide was allowed to dry by holding it above the flame by avoiding excess heating. After drying, crystal violet was added and spent for 1 minute, which was then washed with drop of water, Gram's iodine solution was then added and spent for 1minute and subsequently it was washed by drop of water. To decolorize the smear preparation, the slide was washed with ethanol (95%) for 30 sec and washed with water thereafter. The slide was covered with safranin for another 1minute and washed with water and then dried. Finally, observation was made under 10 x magnifications in a light microscope to determine the shape and arrangement of bacteria.

Biochemical characterization of bacteria

Catalase test

Catalase test was made simply by making a smear of the test organism and then adding a drop of 3% hydrogen peroxide over it. Oxygen bubbling reaction became visible and so the test is positive.

Oxidase test

Oxidase test was conducted according to the following procedures. Reagent "A" (1% X-naphthol in absolute ethanol) and reagent "B" (1% N, N-dimethyl p-phenylene-diamne hydrochloride in a distilled water) were mixed in the ratio of 2:3 immediately before use. Using sterilized loop isolates were picked and covered with 1-2 drops of the reagent, and the formation of purple coloration within 30 seconds indicates the positive results.

Hydrogen sulfide (H2S) test

Triple Sugar Iron Agar medium was used for hydrogen sulfide test. 6ml of triple sugar Iron agar medium was inoculated into the test tube and the butt is stabbed and slant was streaked and incubated at 37 ^{0}C for 24 hrs to detect the production of hydrogen sulfide. The presence of black coloration on slant is considered as presumptive test for positive results. Oxidative and fermentative degradation of glucose, lactose and sucrose and gas production were also tested on TSA.

Starch hydrolysis test

Gram's iodine was used to detect the bacteria for starch hydrolysis. Pure culture of bacteria on sterile Petridish plates were grown and treated with few drops of Gram's iodine, and development of clear zone immediately after adding the iodine indicates the starch hydrolysis.

Non-Biochemical Tests

Motility test

The motility test was done by using motility medium. Pure culture of suspected colonies were inoculated into motility media using a sterile wire needle and stab the media with the culture in straight and withdraw the sterile needle very carefully to avoid destroying the straight line. After incubating the sample at 25 ^{0}C for 18-48 hrs, observations were made. It was checked whether the bacteria have migrated away from the original line of inoculation. Bacterial growth away from the line of inoculation indicates that the test organism is motile (positive).

Collection, preservation and identification of parasites

Fish species for the evidence of parasites were collected from Hawassa Lake using seine net. Random sampling of fish was made.Care was taken to see that the fishing gear do not cause any damage to body surface while collecting the fish species. Fish were removed from the fishing gears with minimum stress, and that the collected fish species were immediately transferred to appropriate containers for transportation to the laboratory. Care was also taken to reduce the stress while transporting the fish to the Biology Department Laboratory of Hawassa University Main Campus and also at the Biology Laboratory at Hawassa University Agricultural Campus from the collection site. On arrival to the laboratory, fish species were separated and stocked in appropriate containers (plastic containers, fiber glass tanks or glass aquarium tanks). Size of containers was decided based on the size and density of stocking. The transported fish were given appropriate artificial diets in the holding tanks. Nylon mesh net was used to collect samples from the holding tank. The fish that were examined for parasites were anesthetized using appropriate anesthetizing agent. Collected parasites were stored in appropriate preservatives such as 70% alcohol 4%or 5% formalin and the cut tissues for histological preparations were fixed in Bouin's fluid (75% formalin, 20% picric acid and 5% glacial acetic acid). Identification of fish parasites was made using appropriate key for the identification of fish parasites. Parasites were identified based on the Key for the identification of parasites (Natarajan, 1987; Paperna, 1996)

Infestation

Prevalence of Infestation (PI) and Intensity of infestation (II)

In order to calculate the different aspects of prevalence and intensity of infestation in relation to host fish, data recording the length, weight and sex of host fish was recorded along with the number of parasites collected. The prevalence and intensity of infestation were determined as described by Natarajan (1976); Margolis *et al.(* 1982); and Rajagopalasamy and Natarajan (1987)*.*

Prevalence of Infestation (PI):

PI= Total number of infested fish x 100/Total number of fish examined: and is expressed as % of infestation

Intensity of Infestation (II):

II=Total number of parasites collected /Total number of infested fishes and will be expressed in numbers.

Experimental infection

For pathogenicity test, a total of 30 healthy *O. niloticus* with a mean weight of 30 g and mean length of 14 cm were obtained from the Hawassa Research and Breeding Center. Collected *O. niloticus* were acclimatized for 7 days in 40 liter fiberglass tank in the laboratory. Fish were equally divided into two groups, non-injected as control and the other group as injected. Treated fishes were intramuscularly (IM) injected with 0.1ml bacterial suspension containing 1×10^6 cfu ml^{-1} according to Younes *et al.* (2016).Each group (n=15) of fish were monitored for 14 days and were fed with pelleted feed at 3 % of the body weight of fish per day. One-third of water was replaced daily and mortality if any was recorded. The gross external and internal examination of fish was done for the development of disease symptoms.

Hematology

Blood samples were drawn by severing the dorsal aorta of fish by way of physical stunning of the fish. Hemoglobin (Hb) content of blood samples was estimated using SahlisHemoglobinometer, and Hematocrit (Hct) by centrifuging samples obtained ¾ directly via 75 μlmicrohematology tubes or blood capillary tube (Hematology centrifuge, SR10000, Thailand). Blood glucose (touch screen glucose reader, Accu-Chek Advantage 2 Roche) was estimated according to the method of Azevedo*et al.* (2006).

Histopathology

About 1cm^3 muscle, gill, liver and intestinal tissues were fixed in Bouin's fluid (75% picric acid, 20% formalin and 5 % glacial acetic acid).After 24 hrs of fixation, the tissues were washed in 70 % alcohol and were then processed in an automatic tissue processor for dehydration, clearing and infiltration. The samples were then embedded in melted paraffin wax, trimmed and sectioned in microtome at 5μ thickness. The ribbon with sections obtained was placed on water bath at a temperature of 40^0C which were then mounted on glass slide with a mounting media. After storing the slides in slide racks for a day, the slides were treated with xylol to remove the paraffin wax from the sections. After clearing the sections in alcohol grades and then in xylol and benzene, the sections were stained in hematoxylin and eosin. The stained sections on slides were then mounted on slides with coverslip using DPX. The stained slides were kept for drying and were examined under a stereo zoom binocular microscope and photographs of sections were taken using microphotography.

Antibiogram Test

It was carried out as per the methods of Rafael *et al.* (2014)

- ❖ The antibiotic sensitivity test was determined by disc diffusion method.
- ❖ Ampicillin (10µg/ml),
- ❖ Azithromycin (15µg/ml)
- ❖ Erythromycin (15µg/ml)
- ❖ Streptomycin (30µg/ml) and
- ❖ Tetracycline (30µg/ml)
- ❖ 200 µl of suspended culture was spread over the surface of Mueller-Hinton agar (Thermo Fisher Scientific Inc., Waltham, MA, USA) plate.
- ❖ After drying, the antibiotic discs were placed over the plates and incubated at 24 °C for 24 h.
- ❖ The result of measured zone diameter can be compared with a standard chart to obtain susceptible (S) and resistant (R) values

RESULTS:

Water quality Characters:

Water quality characteristics of Hawassa Lake is presented in Table 1.

Table 1. Water quality characters of Lake Hawassa

Sampling Site	Temp (^{0}C)	pH	DO (ppm)	Turbidity (NTUS)	EC (uS/cm)	TDS (ppm)	NO^2 (ppm)	PO$_4$ (ppm)
Airport-S1	25.3±0.52	9.18±0.05	7.78±0.02	8.71±0.1	1955±1.4	978.5±1	4.2±1.5	1.28±0.1
Tikur Wuha-S2	22.5±0.4	6.8±0.5	4.8±0.04	26.6±0.7	1029.8±1.1	518.5±0.2	3.2±0.1	1.34±0.05
Fikir Hayik-S3	25.3±0.4	8.86±0.2	8.7±0.2	9.7±0.1	1625±3.6	857±2.2	4.7±0.3	1.32±0.2
Amora Gadel S4	28.2±0.2	8.15±0.2	8.25±0.2	8.38±0.2	1831±0.5	912±0.6	3.7±0.7	1.35±0.06
Around Lake-S5	25.8±0.5	8.85±0.2	8.08±0.2	27.8±0.7	1842.5±1.2	833.5±1.4	6.8±0.6	1.38±0.02
WHO 2004	<40	6.5-8.5	5-7	5.0	750	500	4.5	0.1

From the results presented in the table, it is seen that the water quality parameters show variation in their physic-chemical parameters. Temperature ranged between 22.5 and 28.2 0^C. This variation might be due to weather condition, nature of the bottom and the presence of algal components in the lake. pH ranged between 6.8 and 9.18. Though pH is mainly within the range suitable for the life of aquatic organisms, the higher pH noticed at times may be due to the discharge of wastes from the industries and other agricultural practices turbidly ranged from 8.38 to 27.8. The turbidly values reported are higher than the recommended values and this condition is not suitable for aquatic life in the environment. Also the electrical conductivity which is also towards the higher side TDS showed very high values which indicate that these values to a larger extent can stress the fish. Nitrate concentration is mostly within the range, however, the phosphate values are very high and it shows the pollution condition of the sampled sites in the lake. Thus it is evident that these physico chemical factors to a larger extent cause stress to the fish.

Bacterial Pathogens:

Bacterial pathogens isolated from the tissues of *Oreochromis niloticus* is presented in Table 2**.** It is seen that bacterial species isolated from the tissues *of O.niloticus* include *Aeromonas* species, *Edwardsiella* species, *Escherichia* species, *Pseudomonas* species, *Salmonella* species and *Vibrio*species. The prevalence of isolates ranged between the minimum of 11.5 percent by*Edwarsiella*species to a maximum of 23% by Escherichia species. Followed by *Escherichia* species, the prevalence was dominated by *Pseudomonas* species (19.2%). The prevalence of other isolates such as *Aeromonas, Salmoinella* and *Vibrio* were found to be the same, 15.4 % each.It is thus clear*that O. niloticus* is more susceptible to *Escherichia* bacteria followed by *Pseudomonas* species.

Table 2. Bacterial isolates and their prevalence in *Oreochromis niloticus*

Bacterial Isolates	No of Isolates(n=26)	Prevalence (%)
Aeromonas species	4	15.4
Edwardsiella species	3	11.5
Escherichia species	6	23.0
Pseudomonas species.	5	19.2
Salmonella species	4	15.4
Vibrio species	4	15.4

Metazoan Parasites

The collection included ecto- parasites and diverse groups ofendoparasites and they are branchiuran parasites found on body surface, gills and gill cavity; larval digeneans on body surface, branchial tissues and musculature; adult digenean and cestode parasites were found in the intestine; and nematodes in a variety of locations such as musculature, branchial cavity, pericardial cavity, mesenteries, liver, intestine, kidney, gall bladder and gonad (Table 3.)

Table 3: Metazoan parasites of Oreochromis*niloticus, Clariasgariepinus and Labeobarbus intermedius*

Oreochromis niloticus	*Clariasgariepinus*	*Labeobarbus intermedius*
Larval digenea:	Branchiuran	Branchiuran
-Clinostomum	*-Dolapsranarum*	*-Argulusafricanus*
-Euclinostomum		
Cestode:	Digenia	*Digenea*
-Ligula sp.	*-Euclenostomum(Larvae)*	*-Clinostomum*
	-Adult digenean(unidentified)	
Nematode*:*	Cestode:	Cestode
-Contracaecum*sp*	*-Protocephalus*sp	*-Bothriocephalus*
-Camallanus*sp*	*-Bothriocephalus*sp	
Acanthocephala*:*	Nematode:	Nematode
-Eoucanthocephala*sp*	*-Contracaecum*sp	*- Contracaecum*
	*-Cucullanus*sp	

Infestation: Three hundred and sixty (360) Nile Tilapia *Oreochromis niloticus* collected from the Lake Hawassa for a period of one year from February 2019 to January 2020 were examined for the evidence of parasites. The overall prevalence and intensity of infestation is presented in Table 4. It is seen in the table that out of a total of 360 *Oreochromis niloticus* examined, 172 fishes were infested by different kinds of internal parasites and the total number of parasites obtained was 1573 and thus the prevalence of infestation was 47.8% and intensity 9.2. The prevalence of infestation although showed a fluctuating trend, it was minimum in February (30%) and maximum in May, July and August with 56.7%. The intensity was minimum in June (7.5) and maximum in February (11.1).

Table4: Prevalence and intensity of infection in Nile tilapia *Oreochromis niloticus*

Sr. No	Month/Yr 2019/2020	No of fish examined	No of fish infested (Prevalence %)	No. of parasites collected (Intensity)
1	February	30	09.0 (30.0)	10(11.1)
2	March	30	13.0(43.3)	115(8.9)
3	April	30	15.0(50.0)	129(8.6)
4	May	30	17.0 (56.7)	182(10.7)
5.	June	30	15.0 (50.0)	112 (7.5)
6.	July	30	17.0 (56.7)	160(9.4)
7.	August	30	17.0 (56.7)	154(9.1)
8.	September	30	16.0(53.3)	130(8.1)
9.	October	30	15.0(50.0)	126(8.4)
10.	November	30	14.0(46.7)	130(9.3)
11.	December	30	13.0(43.3)	120(9.2)
12.	January	30	11.0(36.7)	115(10.5)
	Total	360	172 (47.8)	1573 (9.2)

Oreochromis niloticus was infected by diverse groups of parasites and they were larval and adult digenea, cestoda and nematodes. The prevalence of each parasite is given in Table 5

Table: 5: Prevalence of internal parasites of *Oreochromis niloticus.*

Yearand Months	Clinostomum	Digenia	Cestoda	Nematoda	Total
Feb. 2019	25 (25.0)	10 (10.0)	5(5.0)	60 (60.0)	100
Mar.2019	30 (26.1)	10(8.7)	5(4.4)	70 (60.9)	115
Apr. 2019	35 (27.1)	10(7.6)	4(3.1)	80 (62.0)	129
May. 2019	40 (22.0)	12(6.6)	10(5.5)	120 (65.9)	182
Jun.2019	22(19.6)	5(4.5)	5(4.5)	80 (71.4)	112
Jul.2019	14 (8.8)	7(4.4)	7(4.4)	132(82.5)	160
Aug.2019	30(19.5)	7(4.6)	7(4.6)	110(71.4)	154
Sep.2019	25 (19.2)	6(4.6)	3(2.3)	96(73.9)	130
Oct.2019	30(23.8)	4(3.2)	2(1.6)	90(71.4)	126
Nov.2019	25(19.2)	5(3.9)	5(3.9)	95(73.1)	130
Dec.2019	40(33.3)	12(10.0)	8(6.7)	60 (50.0)	120
Jan.2020	32(27.8)	7(6.1)	5(4.4)	71(61.7)	115
Total	**348(22.1)**	**95(6.0)**	**66(4.2)**	**1064(67.6)**	**1573**

The results show that *O.nilotics* was susceptible to infection by different kinds of internal parasites and that their prevalence varies according to different groups of parasites and different months. The results show that among the four groups of parasites collected, the prevalence of nematode parasites was maximum (67.6%) followed by larval digeneans (22.1%).The cestode infestation was found to be the least(4.2%) The infestation in relation to different months indicated that, the prevalence of infestation of nematode parasite was maximum in July (82.5%) and minimum in December (50%).Cestode shows the maximum prevalence in December (6.7%) and minimum of 1.6% in October. Digeneans parasites while showed maximum prevalence in February and December with 10% each the minimum occurrence was in October with 3.2%.Next to nematodes, larval digeneans showed the maximum prevalence and it was maximum in December with 33.3% and minimum in July with 8.8% .The nematode infestation was high in all the months and it showed a trend that the infestation was steadily increasing from February to July and thereafter started showing a fluctuating trend. The prevalence and intensity of infestation in relation to length groups is presented in Table 6.

The results of the study show that, as length group increased, the prevalence also increased. The minimum prevalence (36.0%) was noted in the lowest length group(17-19cm) while the highest prevalence(57.6%) was found in the highest length group(23-25cm).However, the intensity showed an inverse relationship that the intensity of infestation showed a gradual decrease with increasing length groups, maximum intensity(10.7) was in the lowest length group(17-19) and minimum intensity (8.8) in the highest length group(23-25).

Table 6: Infestation in relation to length groups

Sr. No	Length group	No of fish Examined	No. of fish infested (%)	No.of Parasites
1	17-19	75	27.0 (36.0)	288 (10.7)
2	19-21	90	40.0 (44.4)	360 (9.0)
3	21-23	96	48.0 (50.0)	425 (8.9)
4	23-25	99	57.0 (57.6)	500 (8.8)
	Total	360	172(47.8)	1573 (9.2)

The prevalence and intensity of infestation in relation to sex is presented in Table7.

The results of the prevalence of infestation in relation to sex of the fish indicate that, the prevalence was more in females (30%) than in males (17.8%). While the overall intensity was 9.2, the intensity of infection was more in females (5.7) than in males (3.5). The relationship between infestation (Prevalence and Intensity) in relation to different months presents a picture that, the infestation was more in females than in males in all the months. Further, it ranged between 10% in February to 26.7% in September in males and between 20% in February and 43.3 % in females. The intensity also showed that, in all the months, it was more in females than in males and that in males it ranged between 35% in January to 62%in August and in females it ranged from 60% in February to 100% in July.

A total of forty (40) infected fishes were examined for the evidence of external symptoms. The observable symptoms shown by infested fish include body lesions, scale loss, blood parches, discoloration (whitish patches), excess mucus secretion, scale loss, fin disintegration, fin tissue damage, fin and tail rot. In order to assess the distribution of such lesions, the body was dived in to different regions such as anterior region (Tip of head to the end of Branchial cover), middle region (between the end of branchial cover to the middle portion of the body), posterior region (between end of middle region of the body to the caudal peduncle) and on different fins (Fig.).

A total number of 99 lesions were observed in 40 infested fishes. Their distribution according to region wise was 13.1 % in anterior region, 35.4% in middle region and 51.5% in posterior region. The distribution in relation to fins showed that, out of 48 lesions observed caudal fin was affected by 35.4%, 25% by anal fin, 10.4% by dorsal fin, 12.5% pectoral fin and16.7% by pelvic fin. It is thus clear that the infection was more towards the posterior regions of the body and that the anal fin was affected more.

Table 7: The prevalence in relation to sex of the fish is presented

Month/Y 2019/2020	No Examined			No infested			Prevalence (%)			Intensity		
	M	F	T	M	F	T	M	F	T	M	F	T
February	14	16	30	3	6	9	10.0	20.0	30.0	40	60	100
March	12	18	30	5	8	13	16.7	26.7	43.3	45	70	115
April	11	19	30	6	9	15	20.0	30.0	50.0	50	79	129
May	10	20	30	7	10	17	23.3	33.3	56.7	50	132	182
June	13	17	30	6	9	15	20.0	30.0	50.0	48	64	112
July	10	20	30	7	10	17	23.0	33.3	56.67	60	100	160
August	8	22	30	4	13	17	13.3	43.3	56.67	62	92	154
September	14	16	30	8	8	16	26.7	26.7	53.33	55	75	130
October	10	20	30	6	9	15	20.0	30.0	50.0	36	90	126
November	14	16	30	5	9	14	16.7	30.0	46.67	64	66	130
December	10	20	30	4	9	13	13.3	30.0	43.33	54	66	120
January	6	22	30	3	8	11	10.0	26.7	36.67	35	80	115
Total			360	64	108	172	17.8	30.0	(47.8)	599 (3.5)	974 (5.7)	1573 (9.2)

A total of 45 *Labeobarbus intermedius* was collected of which only 10 fish were infested and thus the prevalence of infestation was 22.2 %. The prevalence of infestation was 55% in *Clariasgariepinus* as 33 fishes were infected out of 60 fishes examined.

Fig.2.Parasites of *Clariasgariepinus*

Experimental Infection:

Clinical findings: The fingerlings received the injection of bacterial isolates showed non clinical symptoms such as inactiveness and surface breathing in the aquaria. After 12-48 hrs following the injections of bacteria (1x106 CFU ml-1), all fish fingerlings became less active and showed disease symptoms. In all cases the rate of feeding decreased. After 24 hrs of injection, the dorsal portion of the body became darkened and mild hyperemia of the pectoral and ventral fin bases were observed. Later, hyperemia extended to the pectoral and ventral fin bases as well as at the margins of the vent. Fin rot developed at the tips of the caudal fin. Injected fish developed extensive hemorrhages at the ventral body part and the fish became lethargic and remained at the bottom of the experimental tank. Significant hyperemia on the base of the fins, severe fin rot and fin erosion were observed, There was loss of scales and excess mucus secretion around the body surface was evident. Infected fish revealed pale gills, fluid accumulation in intestine, pale liver and enlarged gall bladder filled with emerald-black secretion.The control group was normal without any visible clinical symptoms.

Fig.3: External Clinical Symptoms in *Oreochromis niloticus* developed after experimental infection

Fig.4: Internal symptoms of diseases in *Oreochromis niloticus*

Antibiogram:

Antibiotic resistance test was done using six antibiotics and the resultsobtained are presented in Table 8.After confirmation that the bacteria were *Vibrio,* antibioticsusceptibility test was carried out and the zone of inhibition was measured.

Table 8. Antibiotic test against Vibrio species infection in *Oreochromis niloticus*

Antimicrobial agents	Concentration	Zone of inhibition/ clearance (mm)	Sensitivity
Gentamycin	10μg	18	S
Tetracycline	10μg	13	S
Aamoxicillin	30 μg	12	S
Kanamycin	5μg	7	M
Streptomycin	10 μg	7	M
Ampicillin	10 μg	-	R
Erythromycin	15 μg	-	R

It is seen from the results that Gentamycin, Tetracycline, Amoxicillin were sensitive to Vibrio species; and Ampicillin and erythromycin were resistant to infection. Kanamycin and Streptomycin were moderately sensitive to vibrio species. The zone of inhibition was higher in Gentamycin (18mm) while it was 7 mmeach inKanamycin and Streptomycin.

Hematological alterations in *Oreochromis niloticus* owing to *Vibrio* bacterial infection is presented in Table 9. The results clearly show a picture that the blood parameters and the blood biochemistry showed a picture of declining trend in all the parameters examined in infected fishes. The declining trend of blood parameters such as hematocrit and hemoglobinand blood

biochemistry such as glucose, triglyceride, total serum protein albumin and globulin indicate that the infected fishes are anemic and liable to be infected by diverse groups of pathogens and parasites.

Table 9: Hematological and Biochemical parameters of infected and uninfected *Oreochromis niloticus*

Parameters	Uninfected group	Infected group
Haematocrit (%)	53.6 ± 0.1a	33.4 ± 0.9b
Haemoglobin (Mg/dl)	6.33 ± 0.37a	3 ± 0.38b
Glucose (mg/dl)	55.1 ± 2.8a	43.5 0.94b
Triglyceride (mg/dl	4.7 ± 0.14a	3.47 ± 0.16b
Total serum protein (mg/dl	7.63 ± 0.42a	4 ± 0.21b
Albumin (mg/dl)	6 ± 0.46a	2.75 ± 0.12b
Globulin (mg/dl	1.44 ±0.10a	1.31±0.06a

Histopathology:

*Skin:*The present study demonstrates that, the skin of control fish exhibits a normal architecture, and there was no damage or other pathological symptoms. Injected fish bacteria showed focal sloughing of epidermis, congested and hemorrhagic dermis, aggregates of melanomacrophagecells.
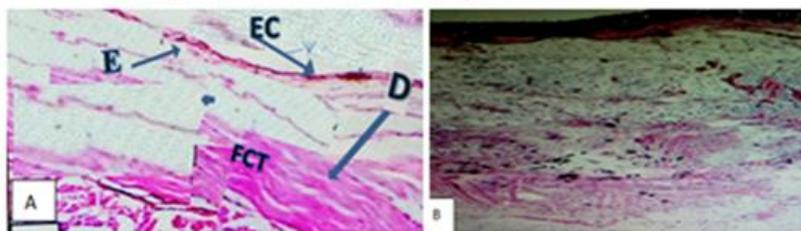
Fig. 5 Photomicrography showing the skin of Nile tilapia, where A is normal skin showing dermis(D),epithelium (E),epithelial cells (EC) fibrous connective tissues(FCT);(B) focal sloughing of epidermis, congested and hemorrhagic dermis, melanomacrophage cells

*Gill:*A-normal gill showing primary lamellar epithelium (PLE) and secondary lamellae (SL), B - complete necrosis and sloughing of lamellar epithelium, C- partial fusion of secondary lamellae (PF) and hyperplasia (H), D -epithelial lifting (EL), E and F - cell necrosis and raptures.
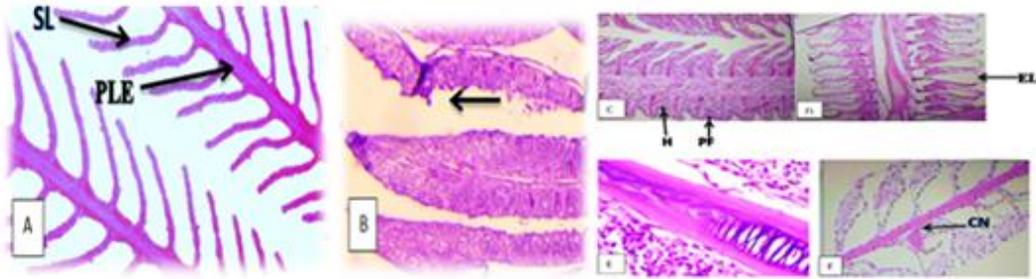
Fig. 6 Photomicrography of gill: A-normal gill showing primary lamellar epithelium (PLE) and secondary lamellae (SL), B -complete necrosis and sloughing of lamellar epithelium, C- partial fusion of secondary lamellae (PF) and hyperplasia (H), D -epithelial lifting (EL), E and F - cell necrosis and raptures.

Muscle: The present study demonstrates that muscle of control fish exhibits a normalarchitecture, and there was no damage or other pathological alterations. Histopathological examination of muscle tissue infected with *Vibrio* showed intramyofibrillar space, disintegrated myofibrils, necrosis, vacuolar degeneration in muscle fibre and gap formation between muscle bundles which ultimately led to muscle degeneration
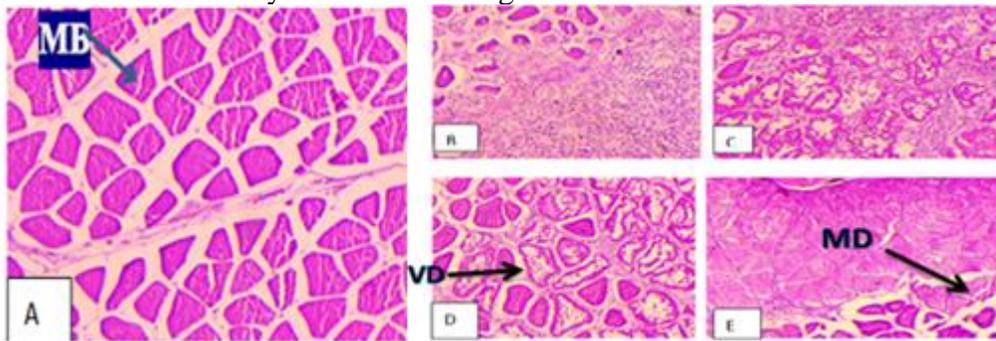
Fig.7. Photomicrography showing the muscle of Nile tilapia:A-normal muscle showing muscle bundle (MB);B-disintegrated myofibrils,C-necrosis, D-vacuolar degeneration in muscle fiber (VD) and gap formation between muscle bundles (E) muscle degeneration (MD)

*Liver:*Extensive hemorrhagic areas of focal necrosis, presence of a number of inflammatory lesions and granuloma, infiltration of macrophages, affected hepatocytes with enlarged nucleus and loss of cellular integrity, appearance of epithelioid like cells, pigmented macrophage aggregates and granuloma
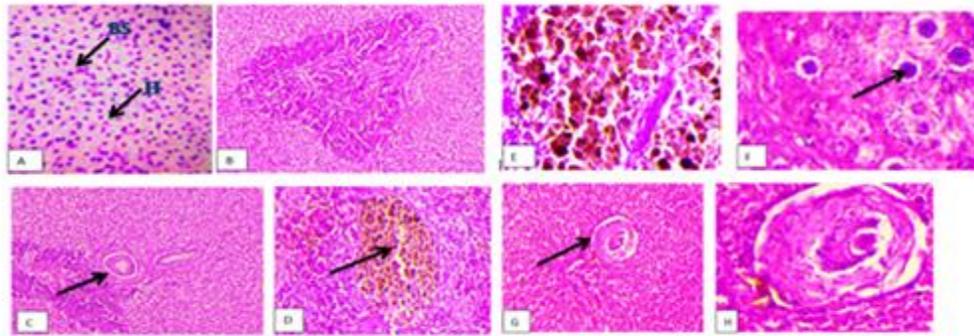
Fig.8: *Photomicrography of liver: A-normal liver showing hepatocytes and blood sinusoids; B and C-hemorrhage into areas of focal necrosis, inflammatory lesions and granuloma;D- pigmented macrophage aggregates and granuloma;E-Infiltration of macrophages affected hepatocytes showed loss of cellular integrity; F-hepatocytes with conspicuously enlarged nucleus; G and H- Fatty liver.*

*Intestine:*Intestine of control fish did not show any change and the cells are intact. However injected fish showed several alteration.
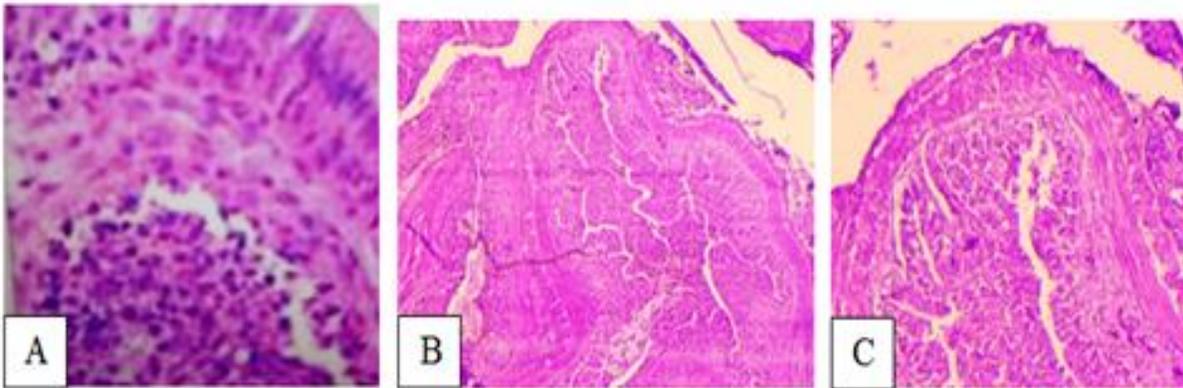
Fig.9: Normal intestine (A), *Submucosal edema and atrophy with necrosis (B and C).*

Conclusion and Recommendation

- Hawassa Lake is polluted due to man induced factors especially due to discharges of industrial effluents, siltation due to cattle grazing, wetland cultivation, effluent discharges due to domestic and recreation.
- Because of these activities, water quality of the lake is affected
- This lead to the infection of fish by diverse groups of pathogens and parasites
- Both pathogens and parasites affect the health status of the fish
- This is affecting the quality of fish for human consumption
- In the long run, it would affect production through reduced recruitment of fingerlings and fish kills

Recommendation:

❖ There is need to create increasing awareness to conserve Hawassa Lake

❖ In depth study on bioaccumulation of pollutants in fish tissues is mandatory

❖ Human health considerations- especially due to parasites of zoonotic significance has to be undertake

❖ Strict enforcement of laws to protect the lake from further deterioration due to pollution of different kinds have to be undertake on a priority basis.

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Assessment of Indigenous Knowledge of the Community on Native Plant and Exotic Species; The Case of Hawassa and Selected Townsin Sidama Region

Selamnesh Tesfaye*, AbigiyaGermame

Department of Biology (*Email: selam757@gmail.com)

ABSTRACT

Native plants are plants that are indigenous to a given area in geologic time. This includes plants that have developed, occur naturally or existed for many years in an area. Because native plants are adapted to local environmental conditions, they require far less water, saving time, money, and perhaps the most valuable natural resource, water. Unfortunately, most of the landscaping plants available at Hawassa city and Sidama region are exotic species whichare outcompeting native species and degrading habitat in remaining natural areas. Therefore, this study was intended to fill the knowledge gap about the importance of indigenous plants species in ecological protection and gives scientific insight to the wide community of study area. The study involved focal group discussion, semi-structured interviews, field observation on indigenous plants. In this study, a total of 160 individuals in the age range of 20 and above were randomly selected from four sub-city and four kebeles. Out of these, 30 key informants were purposively selected based on recommendation from elders and local authorities. The other 130 informants were selected randomly from the local people of the study area. The results showed that most of respondents have no enough knowledge about indigenous and exotic plant species. The results also indicated that most respondents (70%) were not aware of native and exotic plants species, whereas the remaining (30%) were aware. It is found out that exotic plants take a higher portion in being used as ascetic values, as straight tree and more proportion of indigenous plants are used for fertilizer, ecology construction, medicine because they need little caring and low water consumption. According to the respondents at the beginning the study area was covered by indigenous plant species like ficusspp ,Dodonaea angustifolia, Balanites aegyptiaca, Afrocarpusfalcatus Cordia Africana, Acacia , junipursprosera,andJacarandamimosifolia through time the new species introduced in to their areas with help of government organization know a dyes the area is dominated by exotic species plants Phoenix spp, Durantserecta ,Nerium oleaner , Cupressus sempervirens and the farmers prefer planting Eucalyptus spp in the home and farm land . Even though indigenous and exotic trees have their own values, exotic plants are displacing native pants and dominating in the study area; this is because in the study area, the observing thing is that reduced or weakened attention to the native species.

Key Words: *Exotic plant, Native plant, Indigenous knowledge, Importance*

INTRODUCTION

Background

Indigenous plants are those native to the region's natural habitat and are a key element to making this area attractive and unique (Sepahi, 2000; Calkins, 2005). Using indigenous plants in home gardens and landscaping projects not only helps to retain the visual character of our region, but also provide homes and food for our native wildlife (Gobster and Hull, 2000). Because indigenous plants are adapted to the local climate and soil conditions, they usually thrive with little or no maintenance.

Indigenous plants are sometimes allowed to co-exist with lawn grass, ground covers, or garden vegetables, especially if they are not aggressive growers. Indeed, some homeowners favor them, growing native specimens in their landscapes because of its well adapted to the soils, topography and climate of the area. Also Growing native plants can be rewarding in many ways. They add beauty with colorful flowers, foliage, texture, and scents. If planted in a suitable habitat, native plants are well adapted to our soils and climate. This reduces the need for supplemental water (once established) and maintenance (Detweiler, 2008).

In Ethiopia, forest plantations consist of mainly the exotic species, which is currently expanding its distribution and captured interest of the local people for its fast growth, easily establishment and maximum yield. Due to their high popularity currently, there is rapid expansion of plantations of exotic species in the highlands of Ethiopia. However, despite their advantages, different studies conducted in different countries and areas reported that the expansion of exotic seems to cause great detrimental effects on indigenous plant communities (Tererai*et al.,* 2013)

Plantation forestry can mitigate the pressure on natural forest resources but relies in most cases on fast-growing exotic species to ensure high production (FAO, 2003). Although patterns of water use by these exotics are potentially detrimental to ecosystem productivity through impacts on ecosystem water budget, indigenous species have been widely neglected, even though they are generally well adapted to their natural environment (Negash, 2003)

Landscaping choices have meaningful effects on the populations of birds and the insects they need to survive.Homeowners, landscapers, and local policy makers can benefit birds and other wildlife by simply selecting native plants when making their landscaping decisions (Benson and Roe, 2000).

Local community knowledge in the use and management of native plants and their ethical, biological and cultural implications are relevant and important factors in the management of natural resources (Fonseca-Kruel and Peixoto, 2004; Miranda and Hanazaki, 2008). However, it is known that popular knowledge of native plants has been diminishing over time, because of the plantation of exotic species.Preserving and enhancing the indigenous plant knowledge is actually rescuing a global heritage (Lambert *et al*., 1997)

In Ethiopia, there are many different types of indigenous trees. They are important as habitat and food for birds, and other organisms. Also provide important uses for humans such as traditional

medicines, food, bee forage, timber and timber products, fire wood, agricultural tool and others. Ecologically, they are also important for resource conservation, soil conservation, conserving and improving degraded soil (Azene Bekele, 2007).

Statements of the problems

The diversity of species across many parts of the world exists only because bioregions are separated by barriers, particularly large rivers, seas, oceans, mountains, and deserts. Humans can introduce species that have never met in their evolutionary history, on varying time scales ranging from days to decades (Long, 1981; Vermeij, 1991). Humans are moving species across the globe at an unprecedented rate. Those working to address invasive species view this as an increased risk to indigenous species. As humans introduce plants to new locations for cultivation, or transport them by accident, some of them may become invasive species, damaging native plant communities. Invasive species can have profound effects on ecosystems by changing ecosystem structure, function, species abundance, and community composition. Besides ecological damage, these species can also damage agriculture, infrastructure, and cultural assets. Government agencies and environmental groups are directing increasing resources to addressing these species. Unfortunately, most of the landscaping plants available in Hawassa city and Sidama region are species that outcompeting native species and degrading habitat in the remaining natural areas. Therefore, this study was intended to fill the knowledge gap about the indigenous plants species in ecological protection and gives scientific insight to the wide community of Hawassa city and Sidama region. This will in turn ensures the sustainability of indigenous plant species in the study area.

Significance of the study

The research will have a vital importance in analyzing the indigenous knowledge of the community on native plants and would contribute to the increased efficiency, effectiveness and sustainability in environmental protection taking the case of Hawassa and selected cities in Sidama region as a sample. So it provides the basis for problem-solving strategies for local communities. The research will also be helpful to policy makers as an input. The study will serve as input for further researches in the area and a good reference for those interested to have basic knowledge of the issue. The public at large will be benefited if the finding inculcated by the policy makers.

Objective

General objective

To assess the indigenous knowledge of the community on native and exotic plant Species at Hawassa and selected cities in Sidama region.

Specific objectives
- To identify the existing indigenous knowledge of the community about native plant species
- To compare the knowledge of local community about the importance of indigenous plant species over exotic plants in study areas
- To develop understanding of the extent and impact of displacing native plants byexotic plants
- To raise awareness among the local community about indigenous plant species mainly about the extent and impact of displacing native plants by exotic plants

MATERIALS AND METHODS

Description of the study area

The study was conducted in Hawassa city and Sidama region. Hawassa city is the capital of Sidama Regional state, located 275 km from Addis Ababa, capital of Ethiopia. It is surrounded by Lake Hawassa in the west, Hawassa zuria woreda in the south and east part, and Oromiya Region in the north. The town lies between 07° 05' latitude north and 38° 29' longitude east, with an altitude of 1,697 m above sea level, and covers a total area of 50 km2 and has a mean annual rainfall and temperature of 997.6 mm and 20.9°C, respectively. Based on figures from the Central statistical agency (2007), Hawassa city has an estimated population of 259,803, and is home to more than 46 ethnic groups.

Data collection

The study involved focal group discussion, semi-structured interviews, questioners, field observation to obtain knowledge of the local community on native plants, use of native plant, and threats of native plants. The size of the sample does not necessarily depend on the total population, but depends on the available fund, time and other reasons (Storck *et al*., 1991). For the questionnaire survey, 4 sub cities were selected from the 8 sub city, of Hawassa city and 4 kebeles were selected from Yirgalem and Wondogenet based on vegetation cover, altitude range.

In this study, a total of 160 individuals in the age range of 20 and above were randomly selected from four sub-city and four kebeles out of these, 30 key informants were purposively selected based on recommendation from elders and local authorities (Kebele administration leaders), The choice of key informants followed the suggestion made by Martin (1995).

The other 130 informants were selected randomly from the local people of the study area. Interviews were conducted based on a semi-structured checklist of the topics consisting questions prepared beforehand in English, and translated to Amharic and Sidamu Affo languages.

Data analysis

A descriptive statistical method such as percentage and frequency were employed to analyze and summarize the data.

RESULTSAND DISCUSSION

Socio-demographic data

A total of 160   respondents participated in the study with 62.5% (100) of respondents participated from of Hawassa 4 sub cities and 37.5% (30) participated from 4 kebeles of Yirgalem and Wondogenet.There was gender disparity in the villages with higher number of males (75%) than females (25%). Most of the respondents were aged with 35-65 year-old range and the rest (were female with 26-50 age range. Respondents were mainly farmers (90 cases), urban homeowners (30 cases), agriculturalists (20 cases) and landscape designers (20 cases) based on their occupation. The majority of the households had stayed in the area for over 25 years followed by those who have stayed in the area for 10–20, while those who have stayed in the region for less than 10 years were few in proportion.

Attitude of individuals about indigenous and native plant species

The study served the attitude of the community about indigenous an exotic plant species. Most of respondents do not have adequate knowledge about indigenous and exotic plant species. The results indicated that most respondents (70%) had inadequate knowledge identifying the exotic plants and also importance and impact of native and exotic plants whereas the remaining (30%) had enough knowledge about the two plant species. From the general informants aged 45 years and above appeared to be more aware of indigenous plants compared to young respondents with age range of 18–25 years.
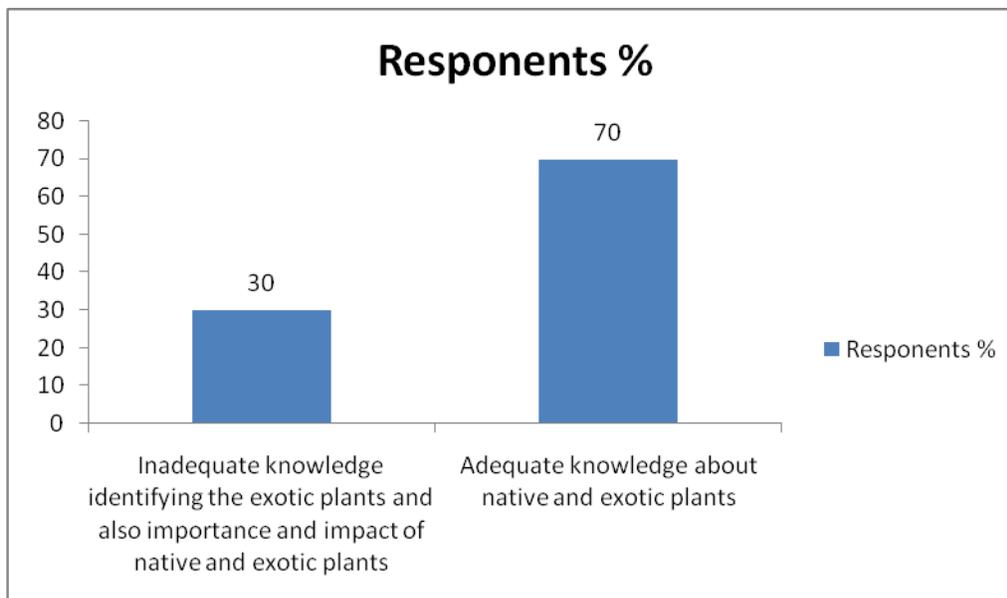
Fig.1. Attitude of individuals about indigenous and native plant species

The research will have a vital importance in analyzing the indigenous knowledge of the community on native plants which would contribute to increased efficiency, effectiveness and sustainability in environmental protection..

The study assessed the perception of the community about indigenous and native plant species vary, the local community doesn't, have enough knowledge about the two species most of the respondents from local community identify only eucalyptus as exotic spp and they grow this species on their farm land and also home lands without considering its impacts. Studies show that local community knowledge in the use and management of native plants and their ethical, biological and cultural implications are relevant and important factors in the management of natural resources (Fonseca-Kruel and Peixoto, 2004; Miranda and Hanazaki, 2008). However, it is known that popular knowledge of native plants has been diminishing over time, because of the plantation of exotic species. Preserving and enhancing the indigenous plant knowledge is actually rescuing a global heritage (Lambert *et al*., 1997)

Hawassa is a home for most of the ethnic groups which have distinctive language, culture, custom, traditional beliefs and cultural diversity. This shows that there is a rich indigenous knowledge about plant species. However the level of awareness of traditional knowledge on indigenous plant species of the community was significantly different among respondents across levels of age. Only old men and women have some knowledge about indigenous plants.

The young generation is not well aware about traditional knowledge and does not accept this knowledge due to the influence of modernization because of this there is no plantation of indigenous trees in study areas so we can say that Indigenous plants were highly affected by urbanization, modernization and also knowledge gap

Importance of indigenous plant species over exotic plants in study areas

N.B. Because of the general informants and the key informants mentioned several uses for each tree species at a time, the total number of general informants was greater than 130 and key informants beyond 30 in all cases. As a result, the total percent of the general informants and key informants was beyond 100%.This is due to recounting of the general informants and key informants.

Comparative Analysis

Table 1 Comparing indigenous vs. exotic N=the sum of informants who choose each Socio-economic importance

Comparison of Socio economic importance of indigenous and exotic trees	Indigenous		Exotic	
	N	**%**	**N**	**%**
According to general informants Fertilizer	86	66	7	**5**
For construction	82	63	57 (eucalyptus	44
Medicinal use	90	69	10	8
Availability of Seeds easily	60	46	32	25
Ascetic values	47	36	91	70
easy for cleaning (as straight tree)	0	0	89	68
decrees car accident (as straight tree)	0	0	86	66
Take small surface area	39	30	60	46
Low water consumption	87	67	32	25
Easily grow (Needs little caring)	85	65	14	11
High germination and development	40	31	69	53
High ecological importance	60	46	38	29
Total	**676**	**519**	**575**	**442**
Key informants Fertilizer	26	87	3	10
For construction	27	90	9	30
Medicinal use	28	93	3	10
Availability of Seeds easily	25	83	5	17
Ascetic values	15	50	28	93
easy for cleaning (as straight tree)	0	0	26	87
decrees car accident (as straight tree)	0	0	26	87
Take small surface area	6	20	23	77
Low water consumption	27	90	3	10
Easily grow (Needs little caring)	25	83	3	10
High germination and development	7	23	21	70
High ecological importance	25	83	4	13
Total	**211**	**702**	**148**	**494**

The comparison analyses made based on socio economic importance of indigenous and exotic tree species shown that more proportion of the respondents (69% general informants) and (93% key informants) put indigenous plants are used for medicinal use in the study area that of exotic plants (8%). And a little bit more proportion of indigenous plants (67% general informants) and (90% key informants) need low water consumption. The Exotic plants take a higher portion are being used as Ascetic values (70% general informants) and (93% key informants) than that of the indigenous ones. When we see the construction purpose, they are mostly made of indigenous plants (82% general informants, 90% key informants) and exotic plants (57% general informants, 30% key informants) mainly eucalyptus. Exotics (29% general informants,13% key informants) took smaller proportion in giving the advantage ecology over indigenous ones (46% general

informants, 83% key informants). For they need little caring, greater proportion took indigenous ones (65%) than exotic (11%).

The study found that most of respondent from the community have no enough knowledge about the exotic and indigenous plants. As the above table most of the respondents did not included in the analysis this is because most of the respondents from the community were not aware of the two plant species. But key informants have knowledge about exotic and indigenous plants. The study found out that Exotic plants take a higher portion in being used as Ascetic values, as straight tree and more proportion of indigenous plants are used for Fertilizer, ecology, construction, medicinal use ,low needs little caring and low water consumption in the study area. Comparative study showed that Dozens of chemical fertilizer is produced in factories to maintain and reclaim soil fertility, but the reliance on artificial fertilizer alone is not advisable due to environmental pollution. Thus, indigenous plant species can maintain soil fertility without any extra cost (Legese *et al*.,2009). Also according to Dorner (2010), native plants are valued for their, ecological, and aesthetic benefits in addition to the growing societal belief in their intrinsic value as living species. According to the respondents even though they list the importance of the exotic plants, they totally believe that indigenous plants have more importance. They said that even for the nursery site of exotic plant, they had taken the soil from a place where indigenous plants were found.

If planted in a suitable habitat, native plants are well adapted to our soils and climate. This reduces the need for supplemental water (once established) and maintenance (Detweiler, 2008). Respondents from greener believe that indigenous plants are more important but they chose exotic plants for beautification of the town this is because they believe that exotic one are more attractive, easy for cleaning and decrease car accident as striate tree due to its canopy. Their interests make them to neglect the indigenous one and the impacts of the exotic one. Contrary, the study conducted by Calkins (2005) and Sepahi (2000) had shown indigenous plants are those native to the region's natural habitat and are a key element to making the area attractive and unique.

Native plant species provide the keystone elements for ecosystem restoration. Native plants help to increase the local population of native plant species, providing numerous benefits. There are specific associations of my corrhizae with plants, invertebrates with woody debris, pollinators with flowers, and birds with structural habitat that can only be rebuilt by planting native plants (Jeanette, 2010)

Extent and impact of displacing native plants by exotic plants

According to the respondents in the study area, plant species are changed through time. From the general informants, elder ones and key informants listed a plants that are dominant in the area, but this plants are decreasing now; even, some are not seen easily in their area. They said that before the study, area was covered by indigenous plant species; however, through time, the new species were introduced into their areas; as a result, now, the area is dominated by these new species. Government organization has a contribution for the spread of these species. Agricultural office of greener department stated that they started beautification of the town by aiming to cover the city about 23-24 % of the total area with these new species .

Table 2.Dominate Plant species in the study area before and now a days list by the respondents

Dominant Plant list before introduction of exotic plants	
Family name	**Scientific name**
Arecaceae	Ficus spp ,
Sapindaceae	Dodonaea angustifolia
Zygophyllaceae	Balanites aegyptiaca
Podocarpaceae	Afrocarpusfalcatus
Boraginaceae	Cordia Africana
Fabaceae	Acacia spp
Cupressaceae	Junipursprosera
Bignoniaceae	Jacaranda mimosifolia
Fabaceae	Tamarindus indica
Dominant Plant species now a day	
Arecaceae	Phoenix spp
Verbenaceae	Durantserecta
Apocynaceae	Nerium oleaner
Myrtaceae	Eucalyptus spp
Cupressaceae	Cupressus sempervirens
Araucariaceae	Araucaria spp

As the result showed that, in the study area, most of the indigenous plants are displaced by the exotic one. Plantations consist of mainly the exotic species which is currently expanding its distribution and captured interest of the local people for its fast growth, easily establishment and maximum yield. Due to their high popularity currently, there is rapid expansion of plantations of exotic species in the study area. However, despite of the advantages, different studies conducted in different countries and areas reported that the expansion of exotic species seem to cause great detrimental effects on indigenous plant communities.

Non-native species cause changes in the ecosystems to which they are introduced. These changes, or some of them, are usually termed as impacts as they have both the direct and indirect impacts and they can be manifold and potentially damage the ecosystems and biodiversity. The direct impact is more of aggressive competition for resources and all elopathic property and the indirect impact is changing the interests of society and making them neglect the indigenous species. In the management aspect, however, the indirect impact seems less recognized by ecologists, environmentalists, and other concerning bodies on the area (Tamirat and Hyunshik, 2009).

Also the structure and composition of native plant communities changed with increasing cover of exotic species (Tererai*et al*., 2013).The recent studies have shown that non-native forest plantations can cause the extinction of species (Pereira *et al*.,2012) either by reducing or weakening the attention of the local people that is given to the native species. May be all the above reasons cause decrease on species diversity and land coverage of indigenous plants in some study area; also, they cause ecological change.

CONCLUSION AND RECOMMENDATION

Conclusion

In Ethiopia, many different types of indigenous and exotic trees occur and are utilized by local communities for various purposes. However, little is known about the preference of the people with regard to the benefit of the trees. Indigenous knowledge of the community on native plants and would contribute to the increased efficiency, effectiveness and sustainability in environmental protection. The objective of the study was to assess the Indigenous Knowledge of the Community on Native and exotic Plant Species. The study result indicated that the local community has no enough knowledge about the exotic plants; they simply get from nursery site and grow them on their farmland and homelands without knowing its negative impacts. On the other hand, key informants are well informed about the two plant species. The respondents from agricultural office greener departments indicate that they chose exotic plants as aesthetic values for beatification of the town; exotic plants need small surface area and also are easy for cleaning and decreases car accented due to its small canopy. But they agree that indigenous plants have high ecological importance, low water consumption and medicinal use. Even if they list the importance of exotic plants, they believe that it is important to protect indigenous species because they have often evolved to cope with particular conditions, circumstances or situations and also Exotic species can have profound effects on ecosystems by changing ecosystem structure, function, species abundance, and community composition.

According to the respondents, at the beginning, the study area was covered with indigenous plant species like Ficus spp.,*Dodonaea angustifolia*, *Balanites aegyptiaca*, *Afrocarpusfalcatus*,*Cordia Africana*, Acacia,*Junipursprosera*, and *Jacaranda mimosifolia;* through time the new species were introduced in to their areas with help of government, so now a days, the area is dominated by exotic species plants Phoenix spp, *Durantserecta*,*Nerium oleaner*, *Cupressus sempervirens* and the farmers prefer planting Eucalyptus spp.

Even though indigenous and exotic trees have their own values, exotic plants are displacing native pants and dominating the study area. Also in the study area, observing thing is that reduced or weakened attention of the local people to the native species.

Recommendation

For sustainable uses, the forester should be creating awareness to the communities regarding indigenous and exotic plants and its impact.

By the case of expansion of exotic plants in the study area, the concerned body should create awareness to the community for planting indigenous trees like that of exotic trees rather than deforestation.

This result implies that a high plantation of exotic species in the study area plays a significant role in fostering for the regeneration of indigenous woody species diversity; therefore, there must be an increase in the plantation of indigenous instead of exotic plants.

Exotic plants are known to present a wide range of threats to native eco-systems and human well-being and; therefore, governmental agencies and non-governmental organizations are frequently mandated to prevent the introduction of exotic species and minimize their negative effects.

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The Effect of Analogical Reasoning in Learning Counter-Intuitive Physics Concepts in Secondary Schools of the Technology Village of Hawassa University

Mohammed Abdela* and Samuel Assefa

Department of Physics (*E-mail: zerituamede6062@gmail.com)

ABSTRACT

This study was aimed at exploring the appropriateness of analogical examples in secondary school physics textbooks, and the teachers in enhancing conceptual understanding to counter intuitive physics concepts, and the resulting misconceptions by secondary school students. The study was conducted in Sidama regional state's secondary schools. Qualitative research design was employed. Two sets of data sources were used in this study: physics textbooks and students. Physics textbooks were used as the sources of data to determine the appropriateness of analogical presentations. From each textbook, certain topics that we believe were counter intuitive were selected purposely. Moreover, 64 students were interviewed. In order to determine the appropriateness of the analogies, we have brought the data obtained in the textbooks, the observation data into their respective units of analysis. In this study, we attempted to construct created categories based on our insight developed from exhaustive reviewing of literature and based on empirical data obtained. The study found that the use of previously learned concepts as analogy, students' intuitive knowledge or real-life examples as analogy and surface similarity were focused instead of deep structural similarities. Moreover, in most cases, analogies are considered as true descriptions of concepts. It was also found that students have developed several misconceptions due to inappropriate use of analogies. The study recommended that the development of guidelines in using analogies and to focus on deep structural similarities than surface features.

Keywords: *Analogy, Counter-intuitive, learning, misconception, Physics*

INTRODUCTION

Background of the study

Learning from constructivists is not merely the transfer of knowledge but as an active construction of meanings on the part of learners that demand the fundamental restructuring of the already existing conceptual system (Vosniadou, 1994; Duit, 1996; Windschitl, 2002). Learning from the constructivists' perspective is seen as knowledge construction which is described as a generation of links between stored memories and new experiences or between prior knowledge and actual learning or between past experiences and items of knowledge (Windschitl, 2002; Rockmore, 2005). Therefore, the construction of new meanings requires that an individual seeks to integrate new knowledge with existing relevant concepts and propositions in their cognitive structure on the basis of the already existing knowledge (Libarkin & Kurdziel, 2001; Novak, 2002). Therefore, what the learner already knows is the key factor in Duit & Rhoneck (1997).

In facilitating conceptual understanding of physics concepts, analogies play significant roles by making abstract concepts comprehended by students. Since science learning is about creating images in the mind, in trying to understand abstract concepts, students need images and visualizations in addition to words and; thus, teaching should support this image formation (Berg, 2004). Ideally, analogies can help students to build meaningful relations between what they already know and what they are setting out to learn (Glynn & Takahashi, 1988). Simply stated, an analogy is a process of identifying similarities between two concepts. An analogy is a process of identifying similarities between two concepts. The familiar concept is called the analog and the unfamiliar science concept is called the target and it has features also called attributes (Ugur *et al*., 2012; Glynn*et al*., 1998). The familiar concept is called the analog (base) and the unfamiliar science concept is called the target (Glynn, 1991; Bailer-Jones, 2002; Ugur *et al.*, 2012). Thus, the essence of analogy is the seeing of how something new (target) is like something old (source). Thus, it involves the mapping of two domains called base and target.

The core purpose of the use of analogy as a strategy in teaching is that of developing an understanding of abstract phenomena from concrete reference (Heywood, 2010). Analogies allow new material, especially abstracts concepts, to be more easily assimilated with students' prior knowledge, enabling them to develop a more scientific understanding of the concept (Ugur*et al*., 2012). The approach to teaching through analogy is an attempt to make more accessible what is essentially abstract and intangible because it cannot itself be experienced and only manifestations of it are evident (Heywood, 2002). While using analogical instruction, analogies should address the correspondence of its attributes and the relationships between the target concepts. In order to make the connections more explicitly, the science teacher must become familiar with students' difficulties in understanding scientific concepts in order to design meaningful materials to provide meaningful learning. In short, when analogical instruction is used, it is highly probable that these lead to a significantly improved understanding of scientific conception and the elimination of alternative conceptions (Ugur*et al*., 2012).

There are two kinds of aspects that may be similar in base and target: (a) simple properties or surface features such as geometrical appearances or color or (b) deep features or structural properties (Duit*et al*., 2001). Some authors use the notion of analogy only when similarities are based on deep features as they usually have a greater explanatory power than surface similarities. But surface features may also be important in learning by analogy as they can sometimes guide the learner's attention to the deeper structural similarities (Gentner& Landers, 1985).

A number of investigators have discussed the important role of analogical reasoning in science (Disessa, 1983). Analogical reasoning is a process of mapping knowledge from a source domain of understanding to the target domain or problem situation (Vosniadou, 1989; Wong, 1993). Analogical reasoning is frequently characterized as a search for underlying schema or analogous relations in problem situations that support learners in critical engagement with abstract phenomena (Heywood, 2010). When the base domain is as unfamiliar to students as the target domain or the symmetrical nature of the analogy, relation may provide the possibility for "simultaneous" development of base and target a process of "piggy-backing" (Duit, 2001). Therefore, it is important to distinguish between two parts of an analogy, the analogous case and the analogy relation (Clement, 1988). Duit*et al*. (2001) noted that analogical relations are generally based on symmetry between base and target. Base and target can each be viewed as an

analogy for the other. This symmetry is of key importance in learning through analogies because the base frequently is equally unfamiliar to students. However, the symmetrical relations allow a stepwise construction of mutually constitutive understandings of both domains (Gooding, 1990).

Analogical reasoning is a process of mapping knowledge from a source domain of understanding to the target domain or problem situation (Vosniadou, 1989; Wong, 1993). Analogical reasoning is facilitated by two factors: a well-developed convergence schema in prior knowledge and the ability to recognize the target (problem situation) as an instance of the convergence schema (Wong, 1993). Learning by analogy is, therefore, not merely a one-directional process but includes switching perspectives between the two parts of the analogy. The permanent switch of perspectives is also of key importance as it allows an understanding to develop the context in which the analogical relation is embedded (Duit*et al*., 2001).

Statement of the problem

Research on students' learning difficulties in physics have primarily focused on identifying and documenting the various alternative conceptions held by students. In this regard, in physics education research, since the beginning of the 1980's, physics education was called the alternative conception agenda. Physics education research tradition is inspired by the fact that students often bring certain ideas and beliefs to formal classes that are not in harmony and even contrary to the correct scientific ideas (Özdemir & Clark, 2007). Hence, physics education, researchers have been engaged in identifying the types of alternative conceptions held by students about certain physics concepts in order to understand the aspects of students' knowledge and reasoning that present obstacle to learning (Packer &Goicoechea, 2000). These ideas that students bring with them, which influence the way learners interact with new learning in science, are often termed as "misconceptions" in older education literature, but now are called "alternative conceptions" or "preconceptions" in contemporary literature (Duit&Rhoneck, 1997; Libarkin&Kurdziel, 2001).

Studies on this area have identified that although students are exposed to the correct scientific concepts, it is difficult to expect conceptual change using traditional expository approaches because alternative conceptions are deeply entrenched in students' cognitive structure (Vosniadou, 2001). This led to the development of strategies that were believed to bring about conceptual change (Özdemir& Clark, 2007). Although these strategies were found to be superior to traditional approaches, they couldn't bring the desired changes in terms of students' conceptions (Duit, 1996; Duit&Rhoneck, 1997). Regarding this issue, the researchers argue that one of the major factors that contributed for students' misconception is inappropriate use of analogies in teaching counter intuitive physics concepts. Regarding the role analogies play in eliminating misconceptions, Harrison & and Treagust (1993) argue that analogies have the power to evoke rich, almost instantaneous, mental pictures that serve to challenge the hearer to transfer knowledge from a familiar to an unfamiliar domain. Similarly, Duit*et al*. (2001) argue that analogies can play a central role in restructuring of students' conceptual frameworks because learning processes often require major restructuring of students' already existing conceptions. Therefore, unless we are able to study the role analogies play in either eliminating or fostering misconceptions.

Although textbook writers and teachers have been using analogies to teach abstract physics concepts their effects on students understanding have not been explored yet. At the textbooks level we argue that simply providing as many activities as possible doesn't necessarily enhance students' understanding of physics concepts unless learning activities are structured appropriately in a constructive manner (Trumper, 2006). This study assumes that without understanding the ways analogies are provided in textbooks and their effect on students' reasoning it is difficult to have a complete picture of students learning difficulties. Therefore, it is important to study the appropriateness of analogies in facilitating students' construction of physics concepts. In this regard, in the Ethiopian context, we couldn't find any effort made by science education researchers to assess the appropriateness of analogies and their effect on students learning. Understanding the ways textbooks provide analogies is significant in determining the extent to which textbooks are developed in enhancing students' understanding of physics concepts.

Studies show that analogical instruction, when applied to physics students, will improve their understanding of physics concepts. For instance, an experimental study made by Ugur*et al*. (2012) on the effects of analogy on the elimination of students' misconceptions about direct current circuits, students' achievement revealed that teaching with analogy has a significantly positive effect on the elimination of misconception and achievement. However, science educators argue that although analogies are powerful means of making abstract concepts to be comprehended easily but uncritical use of analogies may generate misconceptions (Champagne*et al*.,1985; Berg, 2004). Since analogies are powerful in eliminating students' misconceptions, in the Ethiopian school physics analogies have been provided in many textbooks and also teachers are using analogical reasoning to teach many physics concepts like electricity, magnetism etc. However, the extents to which analogies serve the desired purposes and their effects on students understanding of physics concepts have not been explored yet. Therefore, it is timely to do research on this issue

This study assumes that one of the major problems for students learning counter intuitive physics concepts was inappropriate use of analogies. Science education scholars have been conducting many studies on why teaching through analogies is not successful in bringing about conceptual understanding among learners. For instance, Duit*et al*. (2001) found that misconceptions may be created where there is no common understanding between teachers or textbooks and students for instance, when both base and target analogy are viewed differently by learners and teachers. They further argue that many science teachers do not seem to be sensitive enough and falsely assume that students have similar positions regarding the analogy provided.

The researchers believe that, without understanding and explaining the effects of analogies on students' understanding of physics concepts in the Ethiopian schools, it is difficult to have a complete understanding about the problems of students' learning in physics. Therefore, we found significant to conduct this study due to the belief that understanding would help us to exert our efforts in developing appropriate physics education curricula and learning strategies. Hence, doing research on the appropriateness of analogies in school physics textbooks and their effect on students is significant in understanding the root causes of students' learning difficulties thereby helping the development of appropriate physics learning activities that could help students' learn physics concepts (Kirschner, 1992; Redish *et al*.,2004; Lising and Elby, 2005;

Dal, 2007). Therefore, this study is a breakthrough that could add new insight regarding the sources of students' learning difficulties in physics because it can help us to describe and explain problems of the Ethiopian school physics education.

Research questions

1. How appropriate are analogies presented secondary school physics textbooks?
2. What types of analogies are used by textbooks in teaching abstract physics concepts?
3. How appropriately physics textbooks use analogies in teaching physics concepts?
4. What misconceptions are held by students due to the analogical presentations?

Objectives

This study was aimed at exploring the appropriateness of analogical examples in secondary school physics textbooks in enhancing conceptual understanding to counter intuitive physics concepts and the resulting misconceptions by secondary school students.

More specifically it will attempt to:

1. Explore the ways analogies are used in physics textbooks in teaching abstract concepts
2. Examine the types of analogies used in physics textbooks and by teachers
3. To examine how appropriately physics teachers use analogies in teaching physics concepts
4. Explore the misconceptions that are held by students as a result of analogical presentations

Significance of the study

This study attempted to explore the appropriateness of the analogical presentations and the resulting misconceptions. Thus, this study is believed to provide new insight about the Ethiopian school physics education in many respects. Most physics education research have also took the planned curriculum for granted. As a result, they have focused directly on the transacted curriculum, rather than the planned curriculum. This study will prompt physics education research to the higher level from simply focusing on determining the adequacy of learning activities or assessing the use and misuse of certain teaching strategies etc towards questioning the appropriateness of the learning activities. Therefore, this study is not a mere repetition of what have been studied in certain contexts; rather it has raised new issues in science education research that could be used as a starting point for further investigation. Finally, this study doesn't only provide new area for further investigation but also curriculum experts and textbook writers can benefit from the results of the study by considering their problem-solving approaches and practices at the most fundamental level.

Scope of the study

Although various variables can be studied in assessing the role of analogies in enhancing conceptual understanding, this study focused on determining the appropriateness of analogical presentations in physics in the textbooks and the resulting misconceptions that are held by students. Geographically, the study is delimited to government secondary and preparatory schools that found in the technology villages of Hawassa University.

Limitation

Due to limited time resulting from COVID 19 pandemic we couldn't address adequate number of schools found in the technology village. Moreover, due to the same reason it was impossible to conduct adequate classroom observation. Initially the study was aimed at analyzing students' misconceptions that resulted due to analogies. However, due to the fact that schools were closed due to the pandemic we couldn't address some important topics that will be covered in the second semester. Thus, the study only focused on the topics that were covered in the first semester.

MATERIASL AND METHODS

Description of study area

The Sidama Region is one of the regional states of Ethiopia. It was formed on 18 June 2020 from the Southern Nations, Nationalities, and Peoples' Region (SNNPR) and transformation of the Sidama Zone after a 98.52% vote in favor of increased autonomy in the 2019 Sidama Referendum. It is named for the Sidama people, whose homeland is in the region. Sidama is bordered on the south by the Oromia Region (except for a short stretch in the middle where it shares a border with Gedeo zone), on the west by the Bilate River, which separates it from Wolayita zone, and on the north and east by the Oromia Region. Towns in Sidama include Hawasa, the capital of Sidama, Yirgalem and Wendo. Sidama who speak the Cushitic languages Sidama (also known as SidaamuAfoo) has a population of around 3.2 million in 2017.

Sidama has 879 kilometres of all-weather roads and 213 kilometers of dry-weather roads, for an average road density of 161 kilometres per 1,000 square kilometres. Sidama Region is the leading coffee producing region in Ethiopia, which contributes greatly to the foreign exchange of the federal government. The Central Statistical Agency (CSA) reported that 63,562 tons of coffee was produced in Sidama and Gedeo combined in the year ending in 2005, based on inspection records from the Ethiopian Coffee and Tea authority. This represents 63% of the SNNPR's output and 28% of Ethiopia's total output.

Sidama Region is lays northeast of Lake Abaya and southeast of Lake Hawasa. Sidama is bordered on the south by the Oromia Region (except for a short stretch in the middle where it shares a border with Gedeo zone), on the west by the Bilate River, which separates it from Wolayita zone, and on the north and east by the Oromia. The Sidama live between TikurWuha River in the north and Dilla town in the south, spread out in a cone-shaped area of the middle of southern Ethiopia. Sidama is generally a fertile area, varying from flat land (warm to hot) to highland (warm to cold).

Design and Methodology

In this study, the researchers used a qualitative research methodology as a guiding framework in understanding the appropriateness of analogical presentations used in the textbooks and by teachers because of the following reasons. The first rationale for using a qualitative methodology emerges from the philosophical beliefs that explaining social reality through the methods of natural sciences is inappropriate (Guba and Lincoln, 1994; Creswell & Plano, 2007; Wahyuni, 2012). The purpose that this study aimed at was the second rationale for choosing a qualitative research methodology in the interpretive research paradigm. We believe that a qualitative research methodology in the interpretive research paradigm is most suitable to develop new insight and understanding about the issue under study (Higgs & Cherry, 2009; Göran, 2012).

The third and interrelated reason was our axiological assumptions that neutrally observing the realities of the world is impossible (Hill, 1984). In this regard, we believe that understanding the problem under study demands subjectively interpreting relevant data. Thus, a qualitative research methodology gives freedom to generate meaning subjectively that would otherwise difficult using positivistic and quantitative approaches (Guba & Lincoln, 1994; Sale, 2002; Thomson, 2011; Wahyuni, 2012).

The study focused on textbooks and students. It was found that qualitative content analysis is appropriate to make inference about the appropriateness of analogies provided in the textbooks and the resulting misconceptions (Hsieh & Shannon, 2005; Cohen *et al*., 2000). In analyzing physics textbooks and students' misconceptions, the researchers used qualitative content analysis design due to the following reasons. The freedom it gives to purposely focus on certain parts of the textbooks that could provide relevant data; rather than gathering evidence from large amount of data using random sampling was the other reason to select qualitative content analysis design (Kreuger and Neuman, 2006). It is also chosen because the researchers believe that it is very difficult to find relevant data by relying on randomly selected contents. Focusing on certain statements or activities to find evidence and making inference is only allowed in qualitative content analysis design than in quantitative designs.

Data Sources and Subjects

To understand the analogical presentations by textbooks and teachers, the researchers selected secondary schools found in the technology village of Hawassa University. Qualitative analysis requires selecting the materials from which data is obtained and determining which sort of data is appropriate. Two sets of data sources, physics textbooks and students, were used in this study. Physics textbooks were used as the sources of data because regardless of other curriculum materials school textbooks are the major curriculum resources that could serve as determining the appropriateness of analogical presentations. Regarding the contents of textbooks, to find evidence about the ways physics textbooks provide analogies, all grade levels were selected as data source. From each textbook, certain topics that we believe counter intuitive were selected purposely. In this study, all grade levels i.e., grade 9, 10, 11 and 12 physics textbooks were used as data sources. Secondary school students were also the major sources for this study.

Sampling

The sampling strategies that were used in this study were both purposive and simple random sampling. Simple random sampling strategy was used to select the schools that were included in the study. The schools included in the study were four in number namely: Alamura secondary school from Hawassa city admiration, Yirgalem secondary school from Yirgalem city administration, Aletawondo secondary school from AletaWondo city administration, Chuko secondary school from Chuko city administration. To obtain data on the effect of analogical examples on students' conception of counter-intuitive concepts, students were interviewed. From each school, equal number of students i.e. 16 students were included in the study. Thus, a total of 64 students were interviewed. The interview was conducted by the researchers and classroom teachers. Because analogical examples are used only when the concepts are believed to be counter-intuitive or abstract, we intentionally selected the topics from each textbook. Thus, 12 topics from grade nine, 15 topics from grade 10, 8 topics from grade 11 and 8 topics from grade 12 were selected for analysis. Thus, a total of 43 analogical examples were analyzed.

Methods of Data analysis

Data analysis and interpretation in qualitative analysis require coding raw data and generating certain analytical categories followed by interpretation or giving meaning to raw data (Elo&Kynga, 2007; Starks & Brown, 2007; Given, 2008). The purpose of creating categories is to provide a means of describing the phenomenon, to increase understanding and to generate knowledge (Cavanagh, 1997). They are often developed based on (1) a priori (deductive) based on (2) actual data (inductive) and (3) synthetic approach. Qualitative analysis has developed procedures of inductive category development, which are oriented to the reductive processes (Mayring, 2000). According to Given (2008), categories are analytic units;in this case, categories were developed by qualitative researchers to conceptually organize findings related to a phenomenon studied. In qualitative studies, categories are mainly determined after initial inspection of the data and the purpose of the research must be exhaustive and mutually exclusive (Cohen *et al*., 2000).

In order to determine the appropriateness of the ways textbooks provide analogies, the data presented in the textbooks and the observation data into their respective units of analysis were brought/collected. After bringing relevant data into their analytical units, they were interpreted. In this study, we attempted to construct created categories based on our insight developed from exhaustive reviewing of literature and based on empirical data obtained. In this study, there are two major themes. The first one was the types of analogies presented and the second one was the appropriateness of the analogies presentedIn the former theme, the types of analogies were categorized into three. In the first category was real-life example analogies that have no association with the physics topic. In the second category, we placed the analogies given based on students' previous knowledge. In the third category was analogies that do not have any relation with the topic. For each category, the findings were interpreted based on the basic questions. Students' interviews data were analyzed based on their response to the questions asked by the researchers. Each response was analyzed with respect to each category. Comparisons were also made with previous findings.

DISCUSSION OF FINDINGS

The core purpose of the use of analogy as a strategy deployed in teaching is that of developing an understanding of abstract phenomena from concrete reference (Heywood, 2010). Analogies allow new material, especially abstracts concepts, to be more easily assimilated with students' prior knowledge, enabling them to develop a more scientific understanding of the concept (Ugur *et al.*, 2012). The approach to teaching about electricity through analogy is an attempt to make more accessible what is essentially abstract and intangible because it cannot be experienced. Only manifestations of it are evident (e.g. a bulb lighting) (Heywood, 2002). Therefore, it is no surprise that analogies play an important role in science education, since explanation of the abstract phenomena needs to be rooted in some existing or previous experience in order to interpret more complex ideas (Silva, 2006).

This section presents, analyzes and interprets data obtained from textbooks and students' interview.

The main objective of this study was to determine the extent to which physics textbooks employ analogies in enhancing conceptual understanding fundamental concepts and what misconceptions are enhanced as a result of analogical examples by secondary school students. More specifically we attempted to:

1. Explore the ways analogies are used in physics textbooks in teaching abstract concepts
2. Examine the types of analogies used in physics textbooks and by teachers
3. To examine how appropriately physics textbooks use analogies in teaching physics concepts
4. Explore the types of misconceptions that are held by students as a result of analogical presentations

In this study, a qualitative research methodology was used as a guiding framework in understanding the appropriateness of analogical presentations used in the textbooks, by teachers and the types of misconceptions developed as a result of analogical examples. To determine the appropriateness of the ways textbooks, provide analogies, the data presented in the textbooks and the observation data into their respective units of analysis were collected. After collecting relevant data into their analytical units, they were interpreted with respect to each category.

Textbook use of analogies

Types of analogies

In this section data obtained from textbooks will be presented and discussed based on the basic questions formulated.

Grade level	Number of Topics	Real-life	Surface structural similarity	Deep structural similarity
9	12	4	1	7
10	15	4	2	9
11	8	3	2	3
12	8	4	1	3
Total	43	15	6	22

The data presented in the table above shows that, from the 43 analogical examples, 15 are real-life analogies that are assumed to give concrete experience for learners, 6 have no direct relation with the topics and 22 are related with what students have known before learning the concepts.

The appropriateness of analogies

The appropriateness of analogies in helping students learn abstract physics concepts were evaluated based the criteria (1) whether the authors describe attributes that are shared by the analog and the target, (2) if analogies area seen as a true description of the target concepts and (3) if textbooks make aware of the points where analogy breaks down.

Analogies are used because they have the power to evoke rich, almost instantaneous, mental pictures that serve to challenge the hearer to transfer knowledge from a familiar to an unfamiliar domain (Treagust, 1993). The soundness of analogies can be evaluated by inspecting the degree that deep structure relations between the two domains, as opposed to surface similarities, form a basis for the analogical comparison. For example, an analogy comparing a tire to a shoe on the basis that both are black would be judged less appropriate than an analogy emphasizing that both are used to cover terrain (Wong, 1993).

Analogies as true descriptions of concepts

Analogical reasoning is a key feature of learning processes where every learning process includes a search for similarities between what is already known and the new, and the familiar and the unfamiliar (Wittrock &Alesandrini, 1990; Duit*et al*., 2001). Although analogies are very important tools of learning abstract physics, it should be noted that analogies are not a true representation of the concepts. Practically analogies do not share common attributes with the target concept, and as a result, unshared attributes between the analog and target are often a cause of misunderstanding when learners attempt to map unshared attributes from the analog to the target because of the fat that every analog breaks down somewhere (Ugur *et al*., 2012).

Uncritical use of analogies may generate misconceptions, and this is especially the case when unshared attributes are treated as valid, or when learners are unfamiliar with the analogy (Ugur*et al*., 2012). Indeed, in using any analogy, care needs to be taken to ensure that an impression is not conveyed that the analog is a true description of the target concept (Harrison and Treagust, 1993). Glynn*et al*.(1998) also note that "analogies are like double-edged swords, with the potential of facilitating comprehension and, at the same time, creating misconceptions" .

One of the problems that analogies create is the presence of unshared attributes between the analog and the target concept. The use of analogies is establishing relations between two different domains that are identical, or at least comparable. However, problem may occur when unshared attributes are treated as valid (Gentner&Gentner, 1983).

Unshared attributes between the analog and target are often a cause of misunderstanding for learners who attempt to transfer or map unshared attributes from the analog to the target. No analog shares all its attributes with the target, or, by definition, it would become an example; therefore, every analog breaks down somewhere (Ugur *et al*., 2012). As a result of unshared attributes between the analog and target concept are often a cause of misunderstanding for learners who attempt to transfer or map unshared attributes from the analog to the target. Therefore, to make analogical teaching more effective and appropriate and develop appropriate conceptions, it is important to describe the attributes that are shared and unshared by the analog

and the target concept. Despite this, physics textbooks use analogies without describing the attributes or considering the analogy is a true description of the target concept.

1. The use of previously learned concepts as analogy

Analogical reasoning can occur within the domain of physics. Analogies help students to build meaningful relations between what they already know and what they are setting out to learn (Glynn*et al.*, 1988). However, a significant body of research suggests that although analogies are significant in teaching abstract concepts sometimes, they may result in confusion (Duit, 1991).

The following was taken as a typical example from grade 10 physics textbook page 28. The analogy used to teach electron moving around the nucleus was the earth moving around the sun. Two types of forces are compared. Therefore, in trying to teach this concept the textbook writers use the earth orbiting around the sun. These are centripetal force and nuclear force. Centripetal force is a force responsible for objects to move in a circular path. This force acts always towards the center of the circular path. On the other hand, nuclear force is a force responsible to keep electrons move around the nucleus.

Analog(base)	Target
Earth orbiting the sun	Electron revolving around the nucleus or
	A car going around a bend or curve

Scientifically, the earth revolves around the sun in near perfect circle. Centripetal force exerted on the earth by the sun keeps its circular path. Similarly, electron revolves around the nucleus in a circular path and the car moves in a circular curved path both due to centripetal force. But the analogy (comparison) breaks on the type of force that provides the centripetal force in each case. In the case of Earth, the centripetal force is gravitational force between the sun and earth and attractive in nature whereas in the case of electron it is an attractive electric force and in the case of the car turning around the curve the centripetal force that keeps the car in the track the friction force between the tire of the car and the ground.

In the above example, analogical relation was established between two different domains that are assumed to be identical or comparable. In fact, in the above case the analogy and the target are comparable than identical and thus needs further description regarding where the analogy breaks down or the presence of unshared attributes. The reason is that both the motion of the earth around the sun and the motion of electrons around the nucleus are determined by an attractive force; that is why the earth orbits around the sun and around the atomic nucleus respectively. Even though the causes of attraction are not the same (gravitational versus electrostatic), that is why the relationships are perhaps more correctly called "comparable" than "identical." Although electrons and planets share the relationship of attraction, they differ hugely in attributes, such as size and physical make-up (Bailer-Jones, 2002). In this case, a spontaneous analogy might occur when the students are trying spontaneously shift their attention from the analogy to the target concept (Clement, 1988). In addition to this, students who have no clear understanding of the effect of force will be in difficulty to benefit from the comparisons.

Another typical example is taken from grade 10 physics textbook page 63 and 64. Analogy was established between a force between charges (coulombs law) and the law of universal

gravitation. The target concept is electric force between electric charges. Electrostatic force is proportional to the product of masses of the two bodies. It is also an inverse square force. The gravitational force is a pre taught concept for the students.

Analog(base)	Target
Gravitational force	Force between electric charges
$F = G \dfrac{m_1 x m_2}{r^2}$	$F = K \dfrac{q_1 x q_2}{r^2}$

In this case, Newton's law of gravitation is often used as analogous to Coulomb's law of electricity so that students transfer the equation of universal gravitation to understand coulomb's law of electricity. However, it is known that all features of the equation of universal gravitation are not similar to the coulomb's law of electricity. In fact, the use planetary motion as analogous to the flow of electrons is common in teaching physics. Both the motion of electrons and planets is determined by an attractive force which is why they orbit around the atomic nucleus and the sun respectively, even though the causes of attraction are not the same (gravitational versus electrostatic) which is why the relationships are perhaps more correctly called "comparable" than "identical." Although electrons and planets share the relationship of attraction, they differ hugely in attributes, such as size and physical make-up (Bailer-Jones, 2002).Therefore, in using this type of analogy, it is important to show that there is no correspondence in all attributes and there are points where relationships between the analogy and the target concept breaks (Ugur*et al*., 2012).

In the above case, both forces are proportional to product of two quantities and proportional to an inverse square distance. Yet the nature of the numerator products is different (one represents amount of matter contained by the body and the others are electric charges). The forces themselves are different in that gravitational force is an attractive force and significant for huge masses but electric forces can be either attractive and or repulsive depending on the sign of the charges. Hence, students may focus on the pattern or structural resemblance of the two equations, yet they may overlook the uncommon features between the forces.

2. The use of students' intuitive knowledge or real-life examples as analogy.

Analogies, which draw upon students' intuitive knowledge appear to be powerful tools for learning science (Duit*et al*.,2001). The study of science and physics in particular, provides for us an avenue through which we can understand the fundamental laws of nature, numerous everyday science concepts as well as many complex and abstract scientific techniques and processes. Physics in particular is often branded as a science of abstractions which are not easily understood unless related to everyday experiences.

Real-life experiences can also often have used to teach abstract concepts such as the flow of water in a pine is used as analogues to the flow of electricity. However, problems may occur when all the attributes of the analog are seen as similar to the target concept. A typical case was taken from grade 10 physics textbook page 81. It was intended to teach the flow of current in a wire as analogous to water flowing in a pipe. Electric current flow is the target concept.

When a battery is connected at the ends of a conducting wire, net charge will flow as an electric current.

Analog(base)	Target
Water flow in a pipe	Electric current flow in a wire

In physics education, electric current is often seen as analogous to water flowing through a pipe. When teaching about electricity it is better to use analogy because electricity is an abstract and intangible concept and cannot itself be experienced and only manifestations of it are evident (e.g. a bulb lighting) (Heywood, 2002). In an electric flowing through a conductor, pressure difference in the ends of the water pipe acts as a battery does at the ends of a wire. Both results the flow. A thick wire and a wider pipe both involve larger flow of current and water respectively. A thin wire has larger resistance (larger opposition to flow of current) similarly a constriction at a pipe blocks flow of water. Similarly, in the water flowing case, what actually flow in the pipe matter (molecules of water) yet is the same situation occurs in the conducting wire. Having the above and other similar comparisons, what is actually flowing in the wire and in the pipe poses misconception.

Despite its importance, in making the abstract concept electricity to be more concrete using a water flowing analogy, problems might occur when students try to transfer all attributes of water flowing through the pipe to electric current flowing through a conductor or when textbooks and teachers lack to show where the analogy breaks or tell the attributes that the two do not share. In other words, the two are not identical but comparable. Indeed, some students try to transfer most or all of the analog structure into the target content and then describe the target content with direct reference to analog features. In the case of electric current in a conducting wire, the flow of current is interrupted when one of its ends is detached where as in the water flowing case this is not true. When electric currents in wires are compared to water flowing in pipes, some students try to transfer most or all of the analog structure into the target content and then describe the target content with direct reference to analog features. As a result, students may conclude that electricity will leak out of a switched-on power point that has no plug in it.

When a pine is detached from the water pump, for instance, the water continues to flow out. In the contrary when the wire is removed from the battery electric current stops flowing. Therefore, when electric currents in wires are compared to water flowing in pipes, there is a possibility that students conclude that electricity will leak out of a switched-on power point that has no plug in it. Therefore, using any analogy, care needs to be taken to ensure that an impression is not conveyed that the analog is a true description of the target concept (Harrison and Treagust, 1993; Ugur*et al*., 2012). Hence, to help students understand the new concept, textbooks and teachers should describe where the analogy breaks down or describe the attributes that the analogy the target concept do not share.

The use of this analogy has two major problems. The first one is students' lack of adequate knowledge base about the analogy itself and the second taking all the attributes the analog and the target concept.

Another typical case was taken from grade 10 physics textbook page 226. Camera was taken as analogous to a human eye. The human eye is the target concept and camera as analogy.

Analog(base)	Target
Camera	Human eye
Lens: glass	-lens: living tissue
- image formed on: film (white board screen)	- image formed on retina
- for digital camera the film converts image into computer file	

In the former case, when students' do not have adequate knowledge of the analogy or enter the learning situation with a poor knowledge base with respect to the target domain,oor analogical transfer might result due to students' absence of adequate knowledge about the analogy itself. In this case, one of the challenges of using the camera as analogous to the human eye is that student's absence of adequate knowledge about how the camera works or unfamiliarity of the complexity of a camera itself.

Analogies are also used between conceptual domains in the different subjects such as physics and biology. For instance, analogy can be drawn between a camera, and the human eye (Glynn*et al*., 1998). *However, sometimes misunderstanding may occur when they use human eye analogy to teach the function of camera.* While the human eye focuses by using the cornea and the muscles surrounding the lens, a camera is focused by altering the distance between the lens and film (Glynn *et al*., 1997). *However, it should be noted that camera and the human eye do not share similar features. Thus, text*books and teachers should make their students aware of the point at which this analogy breaks down or describe unshared attributes or features.

In both the Camera and the human eye, the image formed on light sensitive surfaces but one is a living cell connected to a brain with a nerve and the other is a film coated with chemicals. Moreover, because most structural features of the camera resemble the eye parts yet to map them to the target requires full understanding of the camera. Therefore, using camera as analogues to a human eye requires first a full understanding of the parts and functions of a camera or not using the analogy.

The other challenge associated with the use of illustrative analogy, the human eye is like a camera use of camera is the presence of unshared attributes or dissimilarities between the analog and the target concept. Here it should become clear that the human eye and a camera focus is very different ways. For instance, whereas the human eye focuses by using the cornea and the muscles surrounding the lens, a camera is focused by altering the distance between the lens and film. Therefore, rather than trying to sweep this analogical inconsistency, teachers should make their students aware of the point at which this analogy breaks down or describe the different attributes that camera and human eye do not share. Otherwise, learners become functionally fixed on the surface details of the analog that are not present in the target problem content.

Absence of basic knowledge is also one of the problems is using such types of analogies. Sometimes, the base domain is as unfamiliar to students as the target domain. Students' understandings of the base domain therefore also require major restructuring. However, the symmetrical nature of the analogy relation may provide the possibility for "simultaneous"

development of base and target a process of "piggy-backing". However, a problem may occur when learners are unfamiliar with the analogy (Ugur *et al*., 2012). This phenomenon is known as poor analogical transfer. Poor analogical transfer may occur when students enter the learning situation with a weak knowledge base with respect to the target problem domain. In these instances, learners become functionally fixed on the surface details of the analog that are not present in the target problem content. On the other hand, sometimes, the base domain is as unfamiliar to students as the target domain. In this case, the symmetrical nature of the analogy relation may provide the possibility for "simultaneous" development of base and target a process of "piggy-backing".

3. Surface similarity vs deep structural similarities

If analogies are used effectively, they can enhance learning by building conceptual bridges between old and new knowledge; if used ineffectively, they can hinder learning by causing misconceptions. Knowing how to use analogies effectively is an important part of teachers' pedagogical content knowledge (Gess-Newsome, 1999). However, as Glynn*et al*. (1998) argue it is risky to use analogies without thinking about them. There are cases by which authors' analogies increase are often ineffective, failing to increase students' recall of text information (Gilbert, 1989). One of the reasons was due to lack of clear guidelines the distinctions among a target concept, features of the concept, examples of the concept, and an analogy become blurred in students' minds.

An analogy involves the mapping of two domains called base and target. Certain features (aspects) are similar in both situations and constitute the analogical relation (Duit*et al*., 2001). There are two kinds of aspects that may be similar in base and target: (a) simple properties or surface features such as geometrical appearances, color etcor (b) deep features or structural properties (Duit*et al*., 2001). Some authors use the notion of analogy only when similarities are based on deep features as they usually have a greater explanatory power than surface similarities, but surface features may also be important in learning by analogy as they can sometimes guide the learner's attention to the deeper structural similarities (Gentner & Landers, 1985).

In the example below taken from grade 10 page 85, analogy of people filled in a corridor separated by a door as analogous to a switch in the case of an electric circuit. The target concept is the source of electric current in a circuit. A cell or a battery provides potential difference to a circuit. It is electrical energy given to each charge per unit charge for the charge to circulate around the circuit.

Analog(base)	Target
People filled in a corridor	Source of electric current

The whole place is filled with people who form an endless queue. The door is shut. That means nobody moves forward. Once the door is open (switch is open), all the people immediately start to move. They can keep circulating round and round the corridor forming a current. Opening the door or switching the circuit on does not mean there is motion rather makes the people in the corridor or the charge in the circuit free to move! For the charges there has to be something pushing or pumping mechanism which we call it technically the CELL. However, the use of this analogy might create confusion because there are unshared attributes. For instance, the size of the people in the corridor and the charges are not comparable. Opening the door is not followed by an external pressure yet in the electrical circuit a potential difference has to be given for a

complete circulation of charges. Therefore, the authors should tell students where the analogy breaks or the various attributes that the analogy and the target do not share.

A similar example is taken from grade 10 physics textbook page 165. It was intended to compare motion of HOLES with motion of CHAIR. The target concept is motion of ''HOLES'' in a lattice formed by doping a trivalent atom on pure semiconductor like silicon. One of the mechanisms that semiconductors are made to conduct electricity is by adding impurity (trivalent atom or pentavalent atoms) on a pure semiconductor. Theses impurities result either free electrons or deficient in electrons. The deficient in electrons are considered to be positive charges or unpaired vacant spaces. The vacant spaces are called "holes".

As the motion of free electrons produces conduction in the n-type semiconductors, the motion of holes is responsible for conduction in P-type semiconductors.

Analog(base)	Target
Motion of empty chair	Motion of HOLES

As an analogy, ten chairs are placed in a row and ten persons are let to sit on the chairs. Ask one of the persons sitting at one of the ends of the row to stand and move away so that the chair will be vacant. If the person next to the empty chair takes it leaving his chair, his chair becomes empty. Likewise, if other persons do the same, the empty chair will be at the other end of the row.

The relative position of the empty space is moved. As the persons move to the right, the empty chair moves to the left relatively. The motion of holes through the semiconductor lattice is like the motion of the empty chair in the line.

The feature of the analog to be used here is the chair is empty and ready to be filled similarly in the crystal lattice there is a vacant space to be filled by electrons. Both the empty space and the holes move relatively. But what is important in the lattice is the implication of the motion of the holes. The relative movement of holes signifies conduction (electricity). What is actually in motion is the person not the chair. The chair appears to be empty each time rather than "moving". This will potentially lead to misconception. The other break in the analogy is the empty chair is occupied by a person whereas holes are filled by electrons that are detached from the crystal.

The following typical case was taken from grade 10 physics textbook. The topic is analyzing (modeling) electromagnetic waves. Electromagnetic waves are the target concept. The electromagnetic waves are produced when charges are accelerated in electric field and magnetic field. The wave is formed when a magnetic field and an electric field are at right angles to each other. Electromagnetic waves are transverse waves.

Analog(base)	Target
Stretched hands of students	Electromagnetic waves

Twenty students are made to make line so that when the first student stretches his/her hand vertically upward, the next adjacent student hands out in front of him/her. This way, the hands make perpendicular representing magnetic field and electric field as in an electromagnetic wave. The electromagnetic wave vibrates the magnetic field and electric being perpendicular. The perpendicularly stretched hands help to show the perpendicularity of the magnetic and electric field but the electromagnetic wave pattern is continuous and transverse. The hands have spacing

and represent a discrete pattern. The stretched hands are human arrangements that are difficult to make analogies for vibrations of waves.

The other analogical presentation was intended to teach from vibration of sound. Sound wave is a longitudinal wave in which the particle of a medium vibrates parallel to wave motion. It is a series of compression and rarefaction.

Analog(base)	Target
Wobbling of candle flame	Vibration of sound wave

A candle placed in front of a speaker wobbles side to side when the sound is played. The wobbling is due to the sound wave coming out of the speaker.

Adjacent air molecules moving back and forth result the propagation of sound wave along the direction of the molecules. Yet the flame represents the motion of air molecules. The continuous high and low pressure exerted on the air molecules results compression and rarefaction of air molecules. The effect of the pressure is hard to explain on the flame as the flame and the air molecules are not identical.

The following typical case was taken from grade 11 physics textbook page 40. The target concept is reference frame. Literally frame of a reference is considered to be a place or a point in which the motion of a body is compared with. It can be also represented by a coordinate system.

Analog(base)	Target
Speaking one of Ethiopian's language	Frames of reference

Different people in different parts of Ethiopia speak different language and have different cultures. This gives them different frames of reference. Amharic speaking people as their first language have different frame of reference from people who speaks Afan Oromo.

The above analogy was not properly used although reference frame is an abstract idea using such analogies might mislead students

The analog does not convey the specific purpose of the frame of reference. What is compared using the frame of reference is not mentioned. A reference frame is to describe whether an object is moving, at rest or accelerating with respect to the reference frame.

A similar typical case was taken from grade 12 physics textbook page 37. The target concept is a heat engine. A heat engine is a device that transforms heat energy into mechanical work. It is a device designed to do useful mechanical work with heat source (a device or body that supplies heat) and heat sink (a body which absorbs heat from other bodies with which it is in thermal contact). Obvious examples include petrol, diesel and jet engines;

Analog(base)	Target
Drinking bird	Heat engine

Heat pump as a heat engine yet working in reverse direction and a circular motion in pages 46 and 61 respectively are two of the analogies used in grade 12 as a pre learned concepts. The drinking bird is considered as analogous to a heat engine that uses the temperature difference between the room and the water to convert heat energy to mechanical work. Like all heat engines, the drinking bird works through thermodynamic cycle. The bird starts off vertical with a wet foam head. It then runs through the following process:
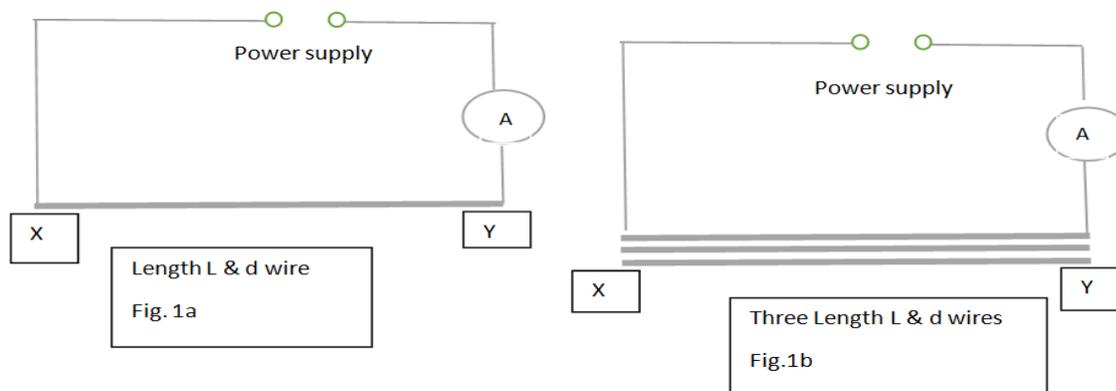
1. The water evaporates from the foam head; this evaporation lowers the temperature of the glass head.

2. This temperature drop causes some of the vapor in the head to condense. The lower temperature and condensation cause the pressure to drop in the head (from the ideal gas law).

3. As there is now a small pressure difference between the head and the base, liquid is drawn up the tube.

4. As liquid flows into the head, the bird becomes unbalanced and tips over.

5. When it tips, the head re-enters the water and becomes wet again. At the same time the bottom end of the neck tube rises above the surface of the liquid. A small bubble of vapor rises up the tube through this gap, displacing liquid as it goes. This causes liquid to flow back to the bottom bulb. This equalizes the pressure.

6. With the liquid back in the bottom bulb the bird tips back to the vertical; the process then repeats.

Both the drinking bird and the engine use a temperature gradient to do mechanical work. Yet heat engines require a heat source (hotter) and a heat sink (colder) distinctly. The engine involves complex first and second laws of thermodynamics. The analog itself is a little bit difficult to be grasped compared to the target.

Discussion interview results

The interviews were conducted by using well-structured questions that involves the analogy. The questions were designed to explore the types of misconceptions that are developed as a result of analogical examples and to evaluate how students map the important features of the analog on to the target concept. Depending on the amount of analogy used in each grade level, five and two test questions were administered for grade ten and the remaining grade levels respectively. The interview questions were similar for all the grade levels.

The question Q1 was asked to grade 10 students after they were exposed to an analog of water flowing through a pipe as analogous to the flow of current in a conducting wire. When the diameter of the pipe increases, more volume of water flows; otherwise flow of water will decrease. As the number of wires with the same length increases, the diameter will increase and students are expected to relate this with effect of the increase in diameter of a pipe.

Power supply

A

X

Y

Length L & d wire

Fig. 1a

Power supply

A

X

Y

Three Length L & d wires

Fig.1b

When three such wires are connected as in figure above to complete the circuit, what will happen to the current in the circuit? The answers given by the Students were:

- No current flows   -Small current will flow   -Nothing(more student's response)
- Six times as in fig.1a(increase)   disguise

The answers of students for this application question show that the analogy used is not helping students to understand the target concept. A direct question together with the analogy (Q2 below) improved the response of the students reducing their misconception. Student's responses are:

-Wider wire (more students' response)   -thicker wire
- Long wire   - large area wire

> Q2. As more water flows through a wider water pipe, more electric current will flow in _____ wire.

The student's response tells us, apparently, misconception is reduced taking the meaning of wider wire, thick wire and large area wire is the same and they can be condition for more current flow. Yet, in analogy there is a big difference between the concepts of wider wire and thick (or large area) wire. The former is the feature of a pipe not a wire and the latter is the feature of a wire. Hence, students are still thinking in the analog perspective and do not map the important features of the analog to the target concept.

Using earth revolving around the sun as an analogy (Q3) is shown to reduce the misconceptions in centripetal force. Almost all students (grade ten) mentioned at least one example a situation that involves centripetal force.

> **Q3.** Force on earth revolving around the sun is example of centripetal force. What other situation can you mention that has similar force as on the earth?

The following two questions (Q4 and Q5) are structured in such a way that two test questions were asked based on the corresponding analogies. This helps to fill the potential gaps created by the open ended questions. The third question is used to identify whether or not the analogy resulted misconception.

> **Q4**. An Electromagnetic wave is plotted that is propagating in the z axis as shown.

4.1 The electric field vibrates in the Y-axis as shown. Based on the stretching hand concept, how does the magnetic field vibrate?
  A. Along Z-axis
  B. Along X-axis
  C. Along Y-axis
4.2 The reason for choosing your answer in 4.1 is
  A. Magnetic field is perpendicular to electric field
  B. Magnetic field is parallel to electric field
  C. Magnetic field and electric fields are the same
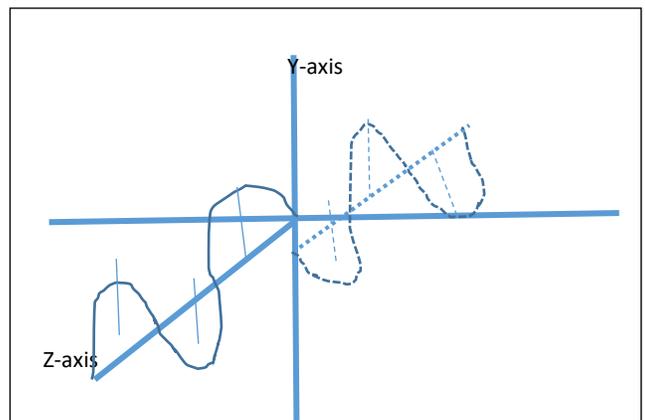
Q5.1 Based on the idea of Motion of empty chair, in a P-type semiconductor electricity is conducted by
     A.   Holes   B. Motion of Holes   B. motion of electrons   C. motion of both electrons and holes
5.2 The reasons for choosing your answer in question 5.1 is
     A.   Holes are majority charge carriers in p-type semiconductor
     B.   Electrons are majority charge carriers in p-type semiconductor
     C.   Both holes and electrons are majority charge carriers in p-type semiconductor.

To analyze the effect of analogy on questions Q4 and Q5, the responses of Q4.3 and Q5.3 are used to know whether misconceptions are resulted or not. Accordingly, more grade 10 students are very confident even though they are wrong in answering 4.1 and 4.2. Hence the stretching hand analogy does not benefit much in understanding electromagnetic wave. This also confirms the possible analogy breaksthat is discussed in the text book analogy analysis. More students are very confident in answering questions 5.1 and 5.2. It can be said that the analogy does not lead students to misconceptions since those very confident students answered questions 5.1 and 5.2.

Q6. Vibration of sound wave is like Wobbling of candle flame that is placed in front of a speaker. When a sound wave travels to the right side (towards east) in air, how do the air particles move?

Grade nine Students' responses for question Q6 are: *to the right or east (more students), upward (North), back and forth, in all directions*

The sound wave is longitudinal wave in which sound wave travels along the vibration of air particle. The vibration of air particle is similar to the wobbling of the flame. The wobbling is not a forward or backward one directional movement. Hence, majority of students missed this left and right or back and forth motion. The analog leads to misconception.

In addition to Q6, grade 9 students are asked a question (Q7) that directly relates the analog inclined plane and the target concept screw.

Q7. A screw can be considered as an inclined plane wrapped around a cylinder. The circumference **(πd)** of the screw corresponds to _____ of the inclined plane.**[Underline the correct corresponding]**
Height/Length/Adjacent side /number of pitch/angle

The question (Q7) is a direct analogy question that requires simple recollection of their knowledge. Hence it's expected that more students answer the question correctly by picking the Length of the inclined plane. In the question, an alternative ANGLE is systematically added to know whether the analog is with them. Yet still the analogy led to misconception since significant number of students chose ANGLE which is very much similar to circumference but has nothing to do with the circumference of the screw.

Grade 11 students were given two questions one a well-structured three step alternative type question as in Q4 and Q5 on accuracy and precision, and the other an application question on reference frame.

Q8. Grade 11 students did an experiment to measure the thickness of a single paper. The actual thickness of the paper is 0.2mm. The five measurements recorded are: 0.8mm, 0.8mm, 0.75mm, 0.8mm and 0.75mm. (Answer the questions based on shooting on target concept)
    8.1 These five measurements are
     A. *Precise and not accurate*   C. *not precise and not accurate*
     B. *Precise and accurate*   D. *not precise but accurate*

    8.2 The reason for choosing your answer is
    A. *Little variation in reading and close to the actual value*
    B. *Little variation in the reading but far from the actual value*
   C. *Large variation in the reading and far from the actual value*
    D. *Large variation in the reading and close to the actual value*

Q8 is an application question for the analogy used where the center of the concentric circles are taken as target. Students are very confident and at the same time correct in answering 8.1 and 8.2. This result shows misconception is minimal for the shooting target analogy.

Q9. In Ethiopia, the culture of Amharic speaking people is different from Oromipha speaking and Somali people. Using this analogy consider three students **X, Y** and **Z** standing as shown represented by three arrows.

Student **Y** moves as shown with velocity V. How do student **X** and student **Z** describe the movement of student **Y** with respect to each other? (Both **X** and **Z** are faced towards **Y**).

Students' response: *to the right, away from them, different direction, not clear*
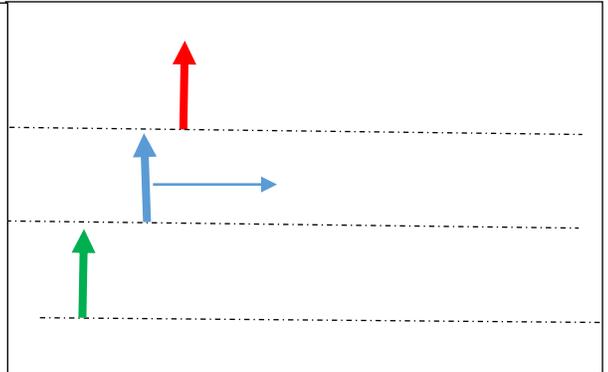
The answer to the question is expected to be: To the right hand side for **Z** and to the left hand side for **X** taking earth as a reference frame. Being critical for each response of the students, only the response 'different direction' is the closest of all to the expected response.

Grade 12 students were provided one structured question that is intended to know whether they understand a quantity in a vibratory motion if the same quantity is explained using circular motion or not. The second interview question asks students how energy flows in a refrigerator using a heat pump analogy. Circular motion which was used as analogy in Q10 is a pre-taught concept. Students are very confident in answering questions 10.1 and 10.2. Misconception is minimized as significant numbers of students are correct in Q10.1 and Q10.2. Students are also confused because they considered points other than number 2 in fig.2 as the displacement of particle P that corresponds to point Z in the analog.

Q10. A particle P is rotating in a circle of radius A=4unit from X to y and then point Z.

10.1) the circular pattern is converted in to a transverse wave as in figure 2. When the particle reaches at point Z, the corresponding displacement on the transverse wave in figure 2 will be

    A. *Point 1*   C. *Point 2*
    B. *Point 4*   D. *point 3*
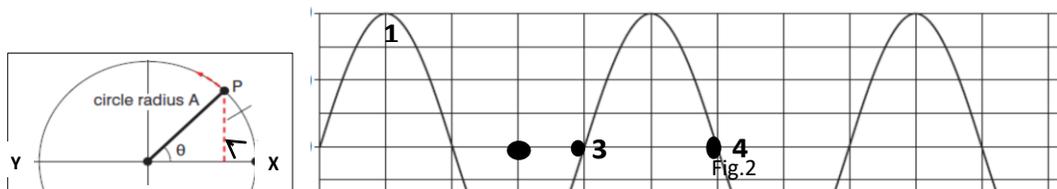
(10.2)Th Fig.1   *choosing your answer is*

    A. *At Z, the particle covers one full cycle*   C) *At Z, the particle covers three-forth cycle*
    B. *At Z, the particle covers Half cycle*   D)*At Z, the particle covers two cycles*

> **Q11.** Based on a heat pump concept, energy in a Refrigerator flows from _____ to ____.

In Q11, Students were expected to answer by stating the flow of energy from colder region to hotter region. Yet it is found that a frequent answer is from higher temperature to lower temperature considering refrigerator as a heat engine. The analogy is not fully understood or it does not change their alternative concept that they had before the analog is presented to them.

The current study using systematically designed interview questions that relate analog and target directly or application of the analog on the target concept revealed that either misconceptions are resulted or alternative conceptions were still held on by the students.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study was aimed at exploring the appropriateness of analogical examples in secondary school physics textbooks and teachers in enhancing conceptual understanding to counter intuitive physics concepts and the resulting misconceptions by secondary school students. Regarding the types of analogies are used by textbooks and physics in teaching abstract physics concepts, most of the analogies used in the general and secondary school physics text books for all grade levels can be categorized under (1) previously learned topics as analogy (2) Students' intuitive knowledge or real-life examples as analogy, (3) Unfamiliar analogies. In some cases, the analog is as unfamiliar to students as the target domain. In this case students' understandings of the base domain therefore also require major restructuring.

Regarding the appropriateness of analogies presented, analogies presented in secondary school physics textbooks lack in identifying explicitly the features and attributes of an analog and then match with them a clearly identified features of a target concept. This was also witnessed in the interview test questions using unshared attributes that lead them to misconceptions. The effectiveness of analogies presented in the textbook would have been cross checked using questions or problems immediately following the content covered in the chapters.

Regarding the appropriateness of analogies in helping students learn abstract physics concepts, it was found that most of the analogies are given inappropriately. One of the problems observed was looking analogies as true descriptions of concept. The study found that in most cases analogies are seen as similar to the target concept or do not tell students that all features of the analogy and the target are similar. However, it should be noted that although analogies are very important tools of learning abstract physics they are not a true representations of the concepts. As a result, unshared attributes between the analog and target are often a cause of misunderstanding when learners attempt to map unshared attributes from the analog to the target because of the fat that every analog breaks down somewhere. The other problem was unfamiliarity of the analog itself or learners in this the analogy would never help learners to understand the target concept. As a result, poor analogical transfer occurred when students enter the learning situation with a weak knowledge base with respect to the target problem domain. In many cases the base domain is unfamiliar to students as the target domain. Regarding the misconceptions that could be held by students due to analogies, it was found that students' held several misconceptions to the fundamental concepts of physics.

Recommendations

While using analogies for teaching abstract physics concepts physics teachers must become familiar with students' difficulties in understanding scientific concepts in order to design meaningful materials to provide meaningful learning. However, in most cases the analogies presented were seen as true descriptions of the target concepts. Therefore, textbook writers should tell students that analogies are representations that help them make abstract concepts more concrete.

The soundness of analogies can be evaluated by inspecting the degree that deep structure relations between the two domains, as opposed to surface similarities, form a basis for the analogical comparison. However, in this study, it was found that surface similarities instead of deep structural similarities were focused. Therefore, in using any analogy, care needs to be taken to ensure that an impression is not conveyed that the analog is a true description of the target concept

The study also found that students held various misconceptions to abstract physics concepts as a result of analogical examples. Therefore, textbook writers should consider their analogical presentations and should also try to develop guidelines in using analogies and to focus on deep structural similarities that surface features, clearly presenting all attributes of both target and analogy and using students generated analogies as a resource.

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