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DETERMINANTS AND HEALTH OUTCOMES OF THE NUTRITIONAL STATUS OF WOMEN IN ETHIOPIA

BY:

ESHETU SATA

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FACULTY OF SCIENCE

DEPERTMENT OF STATISTICS

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ACRONYMS

ACC/SCN Administration Committee on Coordination Sub-Committee on Nutrition

BMI Body Mass Index

CED Chronic Energy Deficiency

CSA Central Statistical Agency

DHS Demographic and Health Survey

EDHS Ethiopian Demographic and Health Survey

EHNRI Ethiopian Health and Nutrition Research Institute

ENI Ethiopian Nutrition Institute

FSCB Food Security Coordination Bureau

LBW Low Birth Weight

MOPED Ministry of Planning and Economic Development

SPSS Statistical Package for Social Sciences

UN United Nations

UNICEF United Nations Children's Fund

WFP World Food Programme

WHO World Health Organization

Abstract

Nutrition is an indispensable interface between health status and food security. Poor maternal nutrition is very common in most developing countries. The nutritional status of women is a perceptive indicator of health status and nourishment levels both the mother and their children. The central objective of this study is to analyze the socio-economic, demographic and health related determinants of the nutritional status of women in the reproductive age group both at the national and regional levels. The study is carried out using quantitative data from the 2005 Ethiopian Demographic and Health Survey. Women with body mass index less than 18.5 are considered to be at the risk of acute undernutrition. Univariate analysis, multiple logistic regression and multilevel logistic regression are fitted to determine the factors affecting the nutritional status of women in the reproductive age. The study indicated that 24.8% of women in the reproductive age are undernourished. The bivaraite analysis indicated that region, place of residence, source of drinking water, household economic status, employment status of women, education level of women, age of women, marital status and parity are significantly associated with the nourishment level of women. In the multivariate logistic regression approach region, place of residence, household economic status, employment status of women, age of women and marital status are found to be the determinants of the nutritional status of women at the national level. The multilevel logistic regression implied place of residence, household economic status, employment status of women and source of drinking water are determinates of the nutritional status of women in the reproductive age. Maternal undernutrition is linked with poor health status. Therefore, multisectroral policy interventions must be taken to improve the nutritional status of women both at the national and regional levels.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Nutrition and health are essential components of the quality of life. Nutrition is a pivotal interface between health and food security. Nutritional status is therefore a sensitive indicator of health status and nourishment levels of a population. Nutritional deficits in human beings contribute to illness, low weight and stunted physical and mental development. Nutrition plays a vital role in maintaining good health while undernutrition generates vulnerability to a wide range of diseases and general ill health. Undernutrition and sickness represent the main health problems in developing countries. Undernutrition diminishes the ability of all systems of the body to perform properly, especially for children and women in the reproductive age. The magnitude of women undernutrition and the various social, economic and health indicators of poor prenatal nutrition for women and children provides a convincing justification for assessing nutritional status of women.

In developing countries like Ethiopia the nutrition and health of women throughout their life is affected by complex and interrelated social, cultural, environmental and health service-related factors. Accordingly, nutrition has long been recognized as a fundamental human right, enshrined in key international conventions. Freedom from hunger and undernutrition was declared a basic human right in the 1948 Universal Declaration of Human Rights. In poorly nourished populations, reductions in hunger and improved nutrition convey considerable productivity gains. Such productivity gains are necessary for economic growth. Going beyond the critical role that nutrition plays in economic and human development, good nutritional status is a core stone that affects the health of all people, enabling us to reach our fullest potential as individuals and societies (ACC/SCN, 1992).

Hunger and undernutrition are devastating problems, particularly for the poor. Ethiopia is a country known for its chronic nutrition insecurity and high rate of undernutrition. Ethiopia is known for a long history of food shortfalls and famine emergencies that contribute to high level of undernutrition (Lindet and Tadesse, 1997). According to the study by the Ministry of Planning and Economic Development (MOPED), 50 percent of the Ethiopian population is living below the poverty line and therefore cannot meet the daily minimum nutritional requirement of 2200 calories (MOPED, 1999). Ethiopia's average per capita daily calorie consumption of 2111 is one of the lowest calorie consumptions world wide (Pankhurst and Gebre, 2002). Moreover the FAO/WFP crop and food supply assessment team indicated the average per capita daily calorie consumption is 2000 calories (FAO/WFP, 2005).

Women in the reproductive age group (15-49 years) and children in Ethiopia are vulnerable to the risk of undernutrition. Women in the reproductive age and children are exposed to undernutrition due to low dietary intakes, inequitable distribution of food within the household, improper food storage and preparation, dietary taboos, infectious diseases and care (Woldemariam Girma and Timotiwos Genebo, 2002). Particularly, for women the high nutritional cost of pregnancy and lactation also contribute significantly to their poor nutritional status. Many factors influence women's nutritional status, ranging from her physiological utilization of food and nutrients during pregnancy and lactation through the socio-economic influences on food availability and her energy expenditure, to the cultural and educational conditions that affect her ability to utilize available resources. Undernutrition diminishes women's potential contribution to their family, community and nation. It reduces productivity, decreases income-earning capacity, and increases health care costs. Moreover, the productivity potential of women is critically hampered by undernutrition (Philip and Lipton 1994).

Poor nutritional status of women is directly associated with poor health status of both the mothers and their children. Undernutrition posses a variety of threats to women in the reproductive age. It makes them more susceptible to infections, and leaves them with fewer reserves to recover from illness; it weakens women's ability to successfully carry, deliver and care for their children (Tinker and Post, 1991). Undernutrition plays a key role in maternal mortality. High maternal mortality is a reflection of women's undernutrition, poor health status and high fertility (ACC/SCN, 1990). Maternal undernutrition was found to be the cause for about 80% of the low birth weight (LWB) babies in developing countries due to intrauterine growth retardation (Brems and Berg, 1988). LBW babies have a 30% times greater risk of prenatal mortality than infants of normal birth weight (Tinker and Post, 1991). Poor maternal nutrition is very common in most developing countries. Women that are underweight are more likely to have unsuccessful pregnancies. Food supplementation to underweight women during pregnancy can improve pregnancy outcomes but such programmes are given little priority in most countries (Krasovec and Anderson, 1991).

Improving women's nutrition will have both short term and long term effects on the social and economic well-being of not only the individual but also the community and the nation (ACC/SCN, 1992). Therefore addressing the nutritional status of women is crucial for the improvement of health and food security of the individual as well as the society as a whole. This fact can be strengthened by the reality that in addition to their reproductive roles, women contribute to their nation's economic development by caring for their families and engaging in income generating activities, farming and other productive labour (Lindet and Tadesse, 1997).

The causes of undernutrition are multisectroral and intercorrelated, often operating at many levels. The high prevalence of undernutrition in Ethiopia is attributed to a combination of extreme poverty and poor maternal health. Women are particularly at risk, suffering from social, economic and nutritional deprivations. In Ethiopia nutritional deficit may also be exacerbated in women by chronic seasonal household food insecurity, inadequate quality of the diet consumed, poor nutrient utilization and limited access to health services (Woldemariam Girma, 2001).

1.2 STATEMENT OF THE PROBLEM

Nutritional status and maternal health are related. Poor maternal nutrition is directly associated with mother's resistance to infections or maternal ill health. Poor nutrition contributes to mother's resistance to infections and infections are in turn are factors for poor nutritional status of the mother (UN, 2005). Nutritional deficit (undernutrition) of women in the reproductive age in Ethiopia is a problem insufficiently recognized and inadequately documented and little is known about the risk indicators and determinants of the nutritional status of women in the reproductive age. From the point of view of identifying pre-disposition to maternal malnutrition little is known about risk indicators such as characteristics of socio-economic profile, educational level, place of residence, health related and other factors associated with nourishment levels of women.

Improving maternal nutrition contributes increases women's potential contribution to their family, community and nation. It plays a crucial role in increasing productivity, income-earning capacity, and decreases health care costs. Moreover, the productivity potential of women is critically hampered. Therefore, addressing the problem of the nutritional status of women is vital for the health of both mothers and their children.

Some attempts were made to assess the determinants of the nutritional status of women in Ethiopia (Lindet and Tadesse, 1997; Teller and Yimer, 2000; Woldemariam, 2001; Woldemariam Girma and Timotiwos Genbo, 2002; Fikrewold Haddis 2008). Woldemariam made an attempt to determine the risk factors associated with maternal nutritional status in Southern Nations, Nationalities and Peoples Regional States using limited data. Woldemariam and Timotiwos in 2002 attempted to assess the determinants of the nutritional status of women by considering all women in the reproductive age group (included pregnant and lactating women in the study). Fikrewold, 2008 assesses the levels, differentials and determinants of malnutrition among women in Ethiopia.

The studies described above measure the nutritional status of women by taking into account malnutrition which includes both undernutrition and obesity (which is not a major problem in developing countries like Ethiopia). However, the above studies did not include the health outcomes that result from the poor nutritional status of the women. This paper uses multilevel logistic regression approach to asses the determinants of nutritional status at regional level. Therefore, this study is an attempt to study the nutritional status of women on the basis of undernutrition which is a major problem in developing countries like Ethiopia.

1.3 OBJECTIVE OF THE STUDY

1.3.1 General objective

The general objective of the study is to identify the determinants and health outcomes of the nutritional status of women in Ethiopia.

1.3.2 Specific objectives

- To estimate the level of maternal undernutrition in Ethiopia
- To examine the determinants of the nutritional status of women in the reproductive age group at national level
- To see the level of acute undernutrition by region in particular and in Ethiopia in general
- To assess the health outcomes of poor nutritional status

1.4 SIGNIFICANCE OF THE STUDY

The findings of this study will be useful in many ways. The study could help to find out the factors that determine the nutritional status of women in the reproductive age group and addressing the problem of maternal undernutrition. Besides, the study may indicate various actions to be taken to improve maternal nutrition. The results also serve as an addition to the existing knowledge with regard to maternal nutritional status in Ethiopia. Lastly, the outcome of this research could give baseline information on the problem of nutritional status of women for various government and non-governmental organizations so as to develop programs that improve the nourishment status of women.

1.5 LIMITATIONS OF THE STUDY

- ✓ The study is based on data collected at one point in time (cross-sectional data). Hence, it is difficult to establish casual relationship between exposure variables and the outcome variable (acute undernutrition).
- ✓ The EDHS data lack information on variables such as environmental, workload and cultural factors that affect the nutritional status.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL CONSIDERATIONS OF THE NUTRITIONAL STATUS OF WOMEN

2.1.1 Definitions and basic concepts

Nutrition refers to the intake of food and other essential nutrients for promoting growth and to maintain healthy tissues and organ function.

Malnutrition is a condition that develops when the body does not get the right amount of nutrients it needs to maintain healthy growth or when the body is unable to utilize the food consumed. Malnutrition refers to all deviations from adequate nutrition, including undernutrition (and overnutrition) resulting from inadequacy of food (or excess of food) relative to need (respectively). Malnutrition refers to both undernutrition and overnutrition. Undernutrition is a consequence of consuming too few essential nutrients whereas overnutrition is a result of consuming too many dietary intakes. The terms "malnutrition" and "undernutrition" are often used loosely and interchangeably, although a distinction is, and needs to be, made at all times.

Undernutrition is a type of malnutrition caused by inadequate food intake or body's inability to make use of needed nutrients. Undernutrition is the outcome of insufficient food caused primarily by an inadequate intake of dietary or food energy. Undernutrition refers to a dietary energy intake below the minimum requirement level to maintain the balance between actual energy intake and acceptable levels of energy expenditure.

Nutritional status refers to the state (condition) of the body in relation to the consumption and utilization of nutrients which can be assessed by different measures such as height, body mass index and arm circumference.

Nutritional anthropometry is defined as "measurements of the variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition.

Body mass index (BMI) is an index used to measure thinness or obesity for adults. Body mass index is defined as weight in kilogrammes divided by height squared in meters (kg/m^2). A BMI less than 18.5 is used to define thinness or acute undernutrition and a BMI of 25 or above usually indicates overweight or obesity and a BMI from 18.5 to 24.9 is considered to be normal.

2.1.2 Measures of Nutritional Status

There are two possible ways to measure the adequacy of food and nutrition intake among individuals or population groups. The first measure is nutritional intake assessment and the second is anthropometric measure of nutritional status. Nutritional intake assessment measures of nutritional intake estimate the amount of food a person is eating and can be used to assess adequacy of the quantity of dietary energy (and protein) supply. In simple terms, one can categorize people as being well-nourished or undernourished based on whether their intake of food matches their food energy needs or nutrient requirements.

Anthropometric measure of nutritional status (Nutritional anthropometry) is the most frequently used method to assess the nutritional status of individuals or population groups. Measurements of nutritional anthropometry are based on the gross composition of the human body at different age levels and degrees of nutrition. Nutritional anthropometric indicators provide a reflection of the nutritional status of the community and hence complement the information obtained by other approaches. There three commonly used standard measures of the nutritional status of an adult are Mid-upper arm circumference, Height and Body mass index (BMI).

Mid-upper arm circumference (MUAC) is an anthropometric measure of nutritional status that reflects both fat and tissue stores. MUAC is the circumference of the left upper arm, measured at the mid-point between the tip of the shoulder and the tip of the elbow. MUAC is measured in centimetres (mm); MUAC below 160 mm is considered as an indicator of acute undernutrition (ACC/SCN, 1992). MUAC is useful for both screening acute adult undernutrition and for estimating prevalence of undernutrition at a population level. The MUAC measurement requires little equipment and is easy to perform even on the most debilitated individuals. Maternal mid-upper arm circumference can be used as an indicator of maternal nutritional status as MUAC is highly correlated with maternal weight and weight for height (James et al, 1988).

Height is one of the commonly anthropometric measures of nutritional status. The height of women is associated with past socio-economic status and nutrition during childhood and adolescence. A woman's height is used to predict the risk of difficulty in delivery because small stature is often associated with small pelvis size and the potential for obstructed labour. The risk of giving birth to a low birth weight baby is influenced by the mother's nutritional status. The cutoff point for the height at which mothers can be considered at risk varies between populations but normally falls between 140 and 150 centimeters. In DHS surveys a cutoff point of 145 cm is used.

BMI is considered to be the most suitable and objective anthropometric indicator of nutritional status of adults. It was chosen because this anthropometric indicator, derived from measures of weight and height of individuals of both sexes, is consistently and highly correlated with body weight (or energy stores within the body) and is relatively independent of the height of the adult (James et al, 1988). BMI is a simple but objective anthropometric indicator of the nutritional status of the adult population and is closely related to food consumption and the prevalence of inadequacy of food in the community.

Women's undernutrition is highly prevalent in developing countries, resulting in substantial increases in mortality and overall disease burden (Black, et al, 2008). Among the countries in Eastern Africa with BMI data, the situation of chronic energy deficiency (CED) is more severe in Ethiopia. A small-scale study in Kersa sub-district of Oromiya showed that 35 percent of non-pregnant women in the south-western part of the country had a BMI less than 18.5 which is an indicative of poor nutritional status (Zerihun et al, 1997). According to the 2005 EDHS report twenty-seven percent of women were found to be chronically malnourished (BMI less than 18.5). It was found that there is a marked variation between urban and rural women. More women have a BMI less than 18.5 in rural areas (28 percent) than in urban areas (19 percent). Gambela (39 percent) and Tigray (38 percent) have the highest percentage of undernourished women and Addis Ababa has the lowest percentage (15 percent).

In Ethiopia the issues of measuring nutritional status came into appreciation in the early 1960's. In the early 1960's, the Imperial Ethiopian government recognized the importance of identifying the nutritional status of the Ethiopian people by inviting Swedish nutritionists to advice on the problem of nutrition in Ethiopia and the Ethiopian Nutrition Institute (ENI) was established in 1968. Although limited in coverage, surveys were conducted to study the nutritional status of various socio-economic groups (semi-pastoralists, enset-growinig farmers, cereal-based farming households, and urban dwellers) between 1963 and 1968 that included both direct (clinical, laboratory and anthropometric) and indirect (production, mortality rate, disease burden) measurements. In the 1990s, there was a major shift of emphasis and ENI was transformed into Ethiopian

Health and Nutrition Research Institute (EHNRI), with a narrower focus on micronutrient and health-related clinical investigations. In 2003, USAID/Ethiopia introduced the Essential Nutrition Actions (ENA) package as an approach to support the Ethiopian government and its partners in their efforts to improve the nutrition of women and children under two years of age.

In 2004, a new opportunity emerged for developing a comprehensive approach to address malnutrition when the Federal Government agreed to put in place such a strategy as part of the groundwork for the preparation of the second phase of Sustainable Development and Poverty Reduction Program, which is now called the Plan for Accelerated and Sustained Development to End Poverty - 2005/06-2009/10. At that time, the Council of Ministers of the federal government gave the responsibility for coordinating overall nutrition activities in the country to the Ministry of Agriculture and Rural Development (MOARD), and established its initial task as being the development of an NNS. Within MOARD, the Food Security Coordination Bureau (FSCB) was assigned the task of formulating the strategy. In addition the Ethiopian Demographic and Health surveys conducted in 2000 and in 2005 have incorporated indicators of the nutritional status of children and women in the reproductive age group.

2.2 DETERMINANTS OF THE NUTRITIONAL STATUS OF WOMEN

2.2.1 Socio-economic Determinants of the Nutritional Status of Women

Some evidence in developing countries indicate that malnourished individuals with a body mass index (BMI) below 18.5, show a progressive increase in mortality rates as well as increased risk of illness (Rotimi et al, 1999). For social and biological reasons, women of the reproductive age are amongst the most vulnerable to malnutrition. Increased prenatal and neonatal mortality, a higher risk of low birth weight babies, stillbirths, and miscarriage are some of the consequences of malnutrition in women (Krasovec and Anderson, 1991). Some of the socioeconomic factors explaining women's nutrition according to studies done in different places are reviewed below.

Household Economic Status

Several studies indicated that household economic status is an important determinant of women undernutrition. The economic status of a household is an indicator of access to adequate food supplies, use of health services, availability of improved water sources, and sanitation facilities, which are prime determinants of child and maternal nutritional status (UNICEF, 1990). A study on the determinates of nutritional status of women (Woldemariam and Timotiwos, 2002) indicated that as compared with women living in households with medium or higher economic status, women living in very poor and poor households were about 1.7 and 1.3 times more likely to be undernourished, respectively. A study of most of the DHS surveys conducted in developing countries (Loaiza, 1997) and a study in Southern Nations and Nationalities and Peoples Region of Ethiopia (Teller and Yimer, 2000) showed that women from low economic status households were the most affected by undernutrition.

Women's Employment and Control over Income

Women's employment increases household income, with consequent benefits to the household nutrition in general and the woman's nutritional status in particular. Employment may increase women's status and power, and may bolster a woman's preference to spend her earnings on health and nutrition. Though employed, women without control over their income and decision-making authority within the household are deprived of economic and social power and the ability to take actions that will benefit their own well-being. Studies in Africa have indicated that, at similar levels of income, households in which women have a greater control over their income are more likely to be food secure (Kennedy and Haddad, 1991).

Place of Residence

A study in SNNPR showed that the risk of maternal undernutrition in rural area is 1.64 times higher as compared to the urban areas (Woldemariam Girma, 2001). A comparative study on maternal nutritional status in 16 of the 18 DHS conducted countries (Loaiza, 1997) and a study in the SNNPR of Ethiopia (Teller and Yimer, 2000) showed that rural women are more likely to suffer from chronic energy deficiency than women in urban areas. Higher rates of rural malnutrition were also reported by local studies in Ethiopia (Zerihun et al., 1997; Ferro-Luzzi et al., 1990).

Education of Women

Education may enable women to make independent decisions, to be accepted by other household members, and to have greater access to household resources that are important to nutritional status. Women who receive even a minimal basic education have a higher level of awareness than those who are illiterate about the need to utilize available resources for the improvement of the nutritional for themselves and their families. This has an effect on their own nutritional status and that of their children and families (ACC/SCN, 1990). A comparative study on maternal malnutrition in ten Sub-Saharan African countries (Loaiza, 1997) and a study in the SNNPR of Ethiopia (Teller and Yimer, 2000) showed that the higher the level of education, the lower the proportion of undernourished women.

2.2.2 Demographic Determinants of the Nutritional Status of Women

Age of Women and Parity

Women's age and parity are important factors that affect maternal depletion, especially in high fertility countries (Zerihun et al, 1997, as cited in Winkvisit, 1992). A study on the determinates of nutritional of women (Woldemariam and Timotiwos, 2002) showed that women in the youngest age group (15-19) and the oldest age group (35-49) were about 1.6 times more likely to be under nourished as compared with women in the age group 20-24. Local studies in Ethiopia showed that women in the youngest reproductive age group (15-19) and women in the oldest reproductive age group surveyed (45-49) are the most affected by undernutrition (Teller and Yimer, 2000). A small scale study conducted in the southern Shewa and Zigwa Boto showed that women undernutrition rises markedly from age 35 onwards (Zerihun et al, 1997). DHS Studies in some Sub-Saharan African countries (Loaiza, 1997) showed differential in the magnitude of Chronic Energy Deficiency (CED) among women at different ages during their reproductive years. Studies in Burkina Faso, Ghana, Malawi, Namibia, Niger, Senegal and Zambia showed a greater proportion of mothers aged 15 to 19 and 40 to 49 exhibits CED. The percentages are particularly high in Namibia, Niger and Senegal (Loaiza, 1997). The high level of CED at younger ages (15-19) is likely due to the competing demand for nutrient between the mother and the fetus, while old age undernutrition may be due to maternal depletion associated with high parity.

Marital Status of Women

Marital status of women is associated with household headship and other social and economic status of the women that affect their nutritional status. Nutritional and social securities could be endangered by a negative change in marital status. A study on the determinates of nutritional of women (Woldemariam and

Timotiwos, 2002) indicated that at the national level, never-married women were about 1.9 times more likely to be undernourished than currently married women, and the difference was statistically significant. A study in the SNNPR of Ethiopia (Teller and Yimer, 2000) showed that women's malnutrition is significantly associated with marital status indicating that compared to married women malnutrition is higher among unmarried rural and divorced/separated urban women compared to married ones.

2.2.3 Health related Determinants of the Nutritional Status of Women

Health services are necessary components of any strategy to improve women nutritional status. One major factor affecting women's nutrition is morbidity and it is an immediate cause of malnutrition since it affects the dietary intake of the person. The synergistic relationship between health and nutritional status is evident in several ways. Undernutrition increases individual's vulnerability to disease and heightens the severity of the disease. At the same time, disease often undermines nutritional status (WHO, 2000). Access to health care, source of water supply and sanitation are basic components of health service for improving nutritional status. Access to health care services and the health sector intervention with regard to nutrition are important packages of improving nutritional status. The proportion of the population with access to safe drinking water source is an indicator of a country's social development. This proportion determines the magnitude of water-related diseases that are likely to affect nutritional status (WHO Africa Regional Office, 2000). Unfavourable health environment caused by inadequate water and sanitation can increase the probability of infectious diseases and indirectly cause certain types of undernutrition (UNICEF, 1990; Engle, 1992). A comparative study in some developing countries (Sommerfelt, et al., 1994) and in Jimma, Ethiopia (Getaneh, et al., 1998) showed that unprotected water source and non-availability of latrine were associated with low child stature.

2.3 HEALTH OUTCOMES OF POOR NUTRITIONAL STATUS OF WOMEN

Undernutrition plays a key role in maternal mortality, just as in infant and child death. High maternal mortality is a reflection of women's undernutrition, poor health status and high fertility (ACC/SCN, 1990). The magnitude of women undernutrition and the enormous social, economic, health indicators of poor prenatal nutrition for women and children provides a convincing justification for stronger action to be taken to improve nutritional status of women. Because of both the reproductive consequences and the long term effects of childhood malnutrition on adult physical and intellectual productivity, as well as the widespread impact of women's health and nutrition on child survival, women's productivity, family welfare, and poverty reduction in the community as a whole, securing adequate nutrition of women, particularly before and during pregnancy, is a socially and economically important goal for developing countries.

Good maternal nutrition is important for both the health and reproductive performance of women and the health, survival, and development of their children. Undernutrition in women is not conspicuous and remains to a large extent uncounted and unreported; thus, insufficient attention has been given to its extent, causes and consequences (Tinker, Koblinsky, 2004). As a result, inadequate resources and efforts have been allocated to improving women's nutrition compared with other nutrition and public health actions. This lack of emphasis on human nutrition related programs and the increased opportunities for policies and programs that can be implemented through existing health care systems, which are expanding and providing better coverage, particularly in prenatal care, in most developing countries.

2.4 ANALYTICAL FRAMEWORK

The analytical framework for this study is adopted from the global conceptual framework (UNICEF, 1998). The global conceptual framework for the causes of undernutrition presents a functional comprehensive understanding of how undernutrition is an outcome of multisectroral problems that can be examined in terms of immediate, underlying and basic causes. In the framework, undernutrition is viewed as one important demonstration of a problem that reaches across multiple sectors and social, political, economic, and cultural institutions. As such, the objective is not only to eliminate the manifestation but also to address the problem itself. In the conceptual framework, the immediate causes of undernutrition are the jointly underlining conditions of inadequate dietary intake and infectious diseases; whereas the extent to which the underlying determinants are expressed is an issue of availability food resources, access to these resources and the presence healthy environment with clean water and adequate sanitation, all of which contribute to determining the nutritional status of an individual. The basic causes are linked with the availability of nutritional resources at the household level which are themselves functions of how society is organized in terms of economic structure. Based on the conceptual framework and literature review the analytical framework for this study is described in figure 2.1.

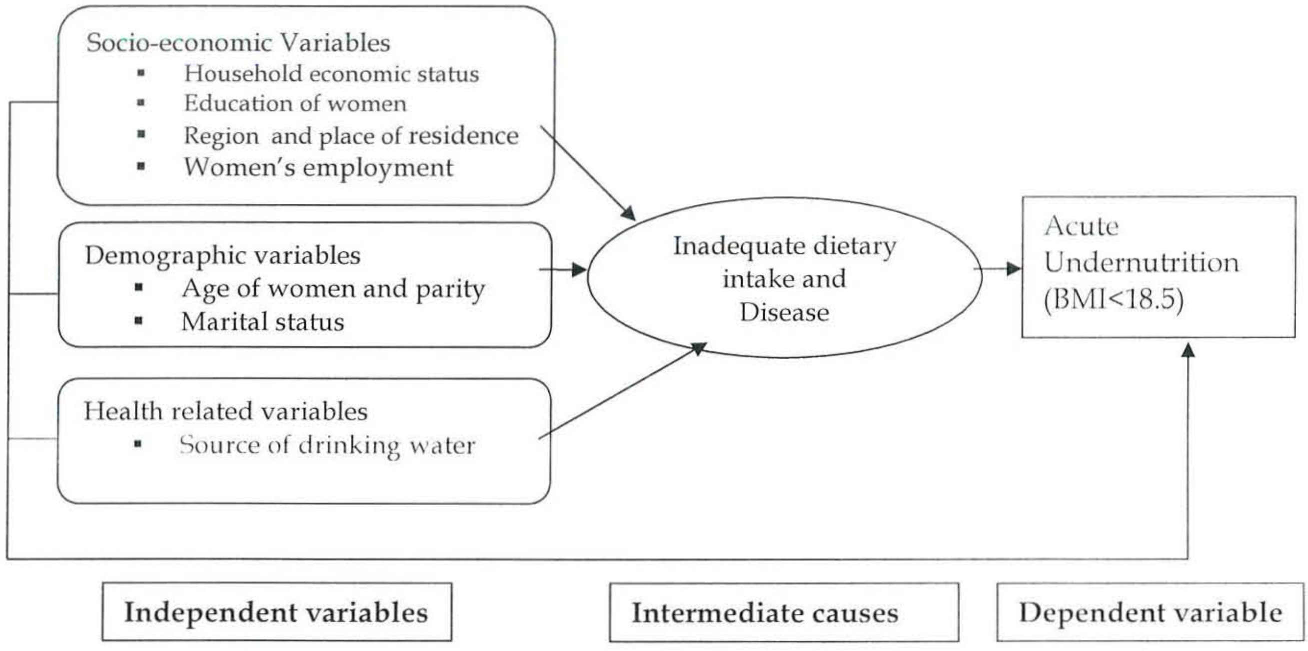

Figure 2.1: Analytical framework for the determinants of the nutritional status of women.

Description of the framework

The analytical framework demonstrates that household economic status, education of women, region, place of residence, marital status, women's employment, source of drinking water, age of women and parity are the basic determinants of maternal undernutrition. Moreover, the framework also reveals that maternal undernutrition could result from inadequate dietary intake and disease which are the direct outcomes of the basic socioeconomic, demographic and health factor problems.

2.5 HYPOTHESES

The hypotheses to be tested in this study are:

1. Rural women are at high risk of undernutrition than urban women.
2. Poor household economic status is associated with higher incidence of maternal undernutrition
3. Unemployed women are highly affected by acute undernutrition.
4. Women in the age groups 15-19 and 35-49 are at high risk of undernutrition.
5. Never-married women are at high risk of undernutrition than married women.

CHAPTER THREE

DATA AND METHODOLGY

3.1 THE DATA

3.1.1 Source of Data

This study uses quantitative data obtained from the 2005 Ethiopian Demographic and Health Surveys (EDHS). This survey is the second national demographic and health survey conducted by Central Statistical Agency (CSA) in collaboration with ORC Macro. The 2005 EDHS data were collected with the prime objective of generating health and demographic information on family planning, fertility levels and determinants, fertility preferences, infant, child, adult and maternal mortality, maternal and child health, child and maternal nutrition, malaria, women's empowerment, and knowledge of HIV/AIDS along with other household characteristics in the nine regions and two administrative regions both in rural and urban areas (CSA and ORC Macro, 2006). The study used data from the 2005 EDHS with reference to a total of 14,070 women in the reproductive age group 15-49 years.

3.1.2 Data Quality

Age data are important demographic characteristics of women. The quality of the age data is vital in ensuring the accuracy of estimates. A look at the single year age data for women shows that there is a clustering at ages ending in "0" and "5" (Figure 3.1). This is indicates that there is age heaping or age/digit preference.

Therefore, it is necessary to evaluate the quality of age data before analysis. To overcome the problem of the heaping of age in the digits ending with "0" and "5" it would be better to use a five year age group categories than a single age.

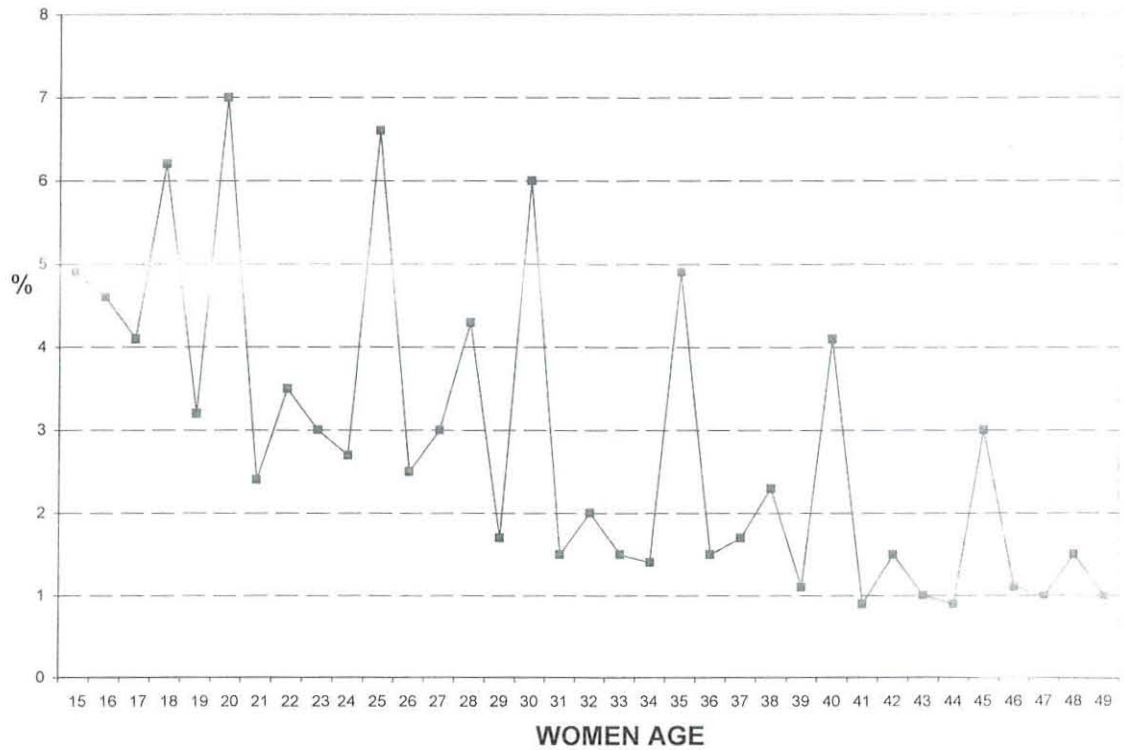

Figure 3.1 Percentage distributions of women by age

3.2 VARIABLES IN THE STUDY

The dependent variable is a dichotomous random variable "Acute Undernutrition" (it takes the value 1 if the BMI of the women is less than 18.5, and 0 otherwise) and is denoted by (UNDERNUTR). The factors and variables that influence the prediction of acute undernutrition included in the study are region, place of residence, education level of women, household economic status, employment status of women, age of women, marital status, parity and source of drinking water. The description and coding of the dependent variables are given in the Table 3.1.

Table 3.1 Description and Coding of the Factors and Influential Variables

No.	Description and Name	Categories
1	Region (REGION)	(1) Tigray (2) Afar (3) Amhara (4) Oromiya (5) Somali (6) Ben-Gumuz (7) SNNP (8) Gambela (9) Hareri (10) Addis Ababa (11)Dire Dawa
2	Place of residence (PLACE_RESI)	(1) Urban (2) Rural
3	Source of drinking water (DRINK_WATER)	(0) Unprotected (1) Protected
4	Household economic status (HOUSECON_STAT)	(1) very poor (2) poor (3) medium or above
5	Education level of women (EDUC_WOMEN)	(0) no education (1) primary (2) secondary and above
6	Marital status (MARITAL_STAT)	(0) never married (1) married/living together (2) divorced/widowed
7	Employment of women (EMPLOY_WOMEN)	(0) unemployed (1) employed
8	Age group (AGE_WOMEN)	(0) 15-19 (1) 20-24 (2) 25-29 (3) 30-34 (4) 35-49
9	Parity (PAR)	(0) no children (1) one child (2) 2-3 children (3) 4-5 children (4) 6 or more children

3.3 METHODOLOGY

To meet the general and specific objectives of the study univariate analysis, multiple logistic regression and multilevel logistic regression are used.

3.3.1 The Logistic Regression

Logistic regression model describes the relationship between a dichotomous response variable and a set of explanatory variables and factors. The explanatory variables/factors could be continuous and/or categorical. The logistic regression uses maximum likelihood procedure for estimating the parameters after transforming the response variable to logit variable (the natural log of the odds of the dependent variable).

Let Y be a dichotomous random variable denoting the outcome of an experiment, and let X=(X_1, X_2,..., Xp) be a collection of p influential variables. Let the conditional probability that the outcome is present be denoted by $P(Y=1/X)=p(x)$. Then the logit of the multiple logistic regression is given by the equation $f(X)=\beta_0+\beta_1X_1+\beta_2X_2+...+\beta_pX_p$ and the odds in favour of success for the multiple logistic regression will be $\ln\left(\frac{p}{1-p}\right)=\ln\left[e^{f(X)}\right]$.

This implies that $p(x)$ will have the form $p(x)=\frac{\exp(\beta_0+\beta_1X_1+...+\beta_pX_p)}{1+\exp(\beta_0+\beta_1X_1+...+\beta_pX_p)}$

If the X_j are varied and n values $Y_1, Y_2, \ldots, Y_n$ of Y are observed we write

$$p_i(x) = \frac{\exp(\beta_0 + \beta_1 X_{i1} + \ldots + \beta_p X_{iP})}{1 + \exp(\beta_0 + \beta_1 X_{i1} + \ldots + \beta_p X_{iP})}$$

The logistic regression problem is concerned with obtaining an estimate of the vector of parameters $\beta = (\beta_0, \beta_1, \ldots \beta_p)$.

The method used to obtaining the estimates $\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_p$ for $\beta_0, \beta_1, \ldots, \beta_p$ is the maximum likelihood method. In order to apply this method we must first construct a likelihood function; the maximum likelihood estimators of the parameter are obtained by choosing those values which maximize this function.

Estimation of $\beta_0, \beta_1, \ldots, \beta_p$

If Y is coded as zero or one then for those pairs (X_i, Y_i), where y_i=1 the contribution to the likelihood is $p(x_i)$, for those pairs where y_i=0 the contribution to the likelihood function is 1- $p(x_i)$. Since the observations are assumed to be independent, the likelihood function is given by $l(\beta) = \prod_{i=1}^{n} [p(x_i)]^{y_i} [1 - p(x_i)]^{1-y_i}$.

The natural logarithm of this equation is called the log-likelihood and it is given by $L(\beta) = \ln(l(\beta)) = \sum_{i=1}^{n} \{y_i \ln[p(x_i) + (1 - y_i)\ln[1 - p(x_i)]\}$

To obtain the estimator $\hat{\beta}$, the value that maximizes the likelihood function we differentiate $L(\beta)$ with respect to the components of β and set the resulting equations zero. For the logistic regression these equations are not linear in the $\beta's$. Therefore iterative methods like Newton-Raphson are employed to find the solution for the equations.

Parameter Variances and Covariances

Let $\sum \hat{I}(\hat{\beta}) = X'VX$ where $\hat{I}(\hat{\beta})$ is the fisher's information matrix, X is the $n \times p$ regression matrix (X is a matrix of 1s and the predictor data matrix) and V is an $n \times n$ diagonal matrix with i^{th} diagonal term $\hat{p}_i(1-\hat{p}_i)$.

That is, the matrix X is $X = \begin{bmatrix} 1 & X_{11} & \ldots & X_{1.p-1} \\ 1 & X_{21} & \ldots & X_{2.p-1} \\ . & . & . & . \\ 1 & X_{n1} & . & X_{n.p-1} \end{bmatrix}$ and the matrix V is

$$V = \begin{bmatrix} \hat{p}_1(1-\hat{p}_1) & 0 & . & . & . & 0 \\ 0 & \hat{p}_2(1-\hat{p}_2) & . & . & . & 0 \\ . & . & . & . & . & . \\ 0 & 0 & & & & \hat{p}_n(1-\hat{p}_n) \end{bmatrix}.$$

Denote $\sum(\hat{\beta}) = \hat{I}^{-1}(\hat{\beta})$. The estimate of the variance of $\hat{\beta}_j = \hat{\sigma}^2(\hat{\beta})$ is the j^{th} diagonal term of the matrix $\sum(\hat{\beta})$ and the off-diagonal terms are the covariance estimates $\sigma(\hat{\beta}_j, \hat{\beta}_u)$ *for* $\hat{\beta}_j$ *and* $\hat{\beta}_u$.

Model selection

In logistic regression there are different methods of model selection (forward entry method, backward removal and forward stepwise). The Forward Stepwise Likelihood Ratio is a family of the forward stepwise method. The Forward Stepwise Likelihood Ratio is the most appropriate for designs with a single dependent variable (Merenda, et al 1980). The forward stepwise method employs a combination of the procedures used in the forward entry and backward removal methods. At the initial step the procedures for forward entry are performed. At any subsequent steps where two or more effects have been selected for entry into the model, forward entry is performed if possible, and backward removal is performed if possible, until neither procedure can be performed nor stepping is terminated. Stepping is also terminated if the maximum number of steps is reached.

Goodness of fit of the model

There are several measures to determine the goodness of fit of a logistic regression model. These measures include the likelihood ratio (G^2) statistic, Pearson statistic (χ^2), and the Hosmer-Lemeshew statistic (HL).

The Likelihood Ratio Test statistics (G^2) is defined as $G^2 = 2\sum[(observed)\log\left(\frac{observed}{fitted}\right)] = -2\ln\left(\frac{L_r}{L_f}\right)$ where L_r is the likelihood of the restricted model and L_f the likelihood of the full model. If the G^2 is significant, the variable is considered to be a significant predictor in the equation (Agresti, 1996).

The Pearson χ^2 statistic is given by $\chi^2 = \sum\left[\frac{(O_j - m_j p_j)^2}{m_j p_j (1 - p_j)}\right]$ where O_j is the number of observed observations in group j, p_j is the model's predicted value (fitted probabilities), m_j is the number of subjects with $X=X_j$ and $\sum m_i = n$.

The Hosmer-Lemeshow (1989) goodness of fit statistic is given by $HL = \sum_{j=1}^{G} \frac{(O_j - n_j \bar{p}_j)^2}{n\bar{p}_j(1-\bar{p}_j)}$ where G is the number of observations in the j[th] group, $\bar{p}_j = \sum_{i=1}^{n_j} \frac{m_j \bar{p}_j}{n_j}$, n_j is the number of covariate patterns in the k[th] group. If the Hosmer-Lemeshow goodness-of-fit test statistic is greater than 0.05, we will not reject the null hypothesis that there is no difference between observed and model predicted values.

Significance of the model estimates

The Wald test is employed as a diagnostic check to test the significance of individual model estimates $\hat{\beta}_j$ where j= 0, 1,... ,p. The Wald statistic (W) is the squared ratio of the unstanderized logit coefficient to its standard error, that is,

$$W = \frac{\hat{\beta}_j^{\,2}}{\hat{\sigma}^2(\hat{\beta}_j)}.$$

Adequacy of the fitted model

The fitted model may be inadequate because of particular observations, outliers or influential values. These observations may affect the conclusion to be drawn from the analysis. Thus, detection and treatment of such observations should be part of the model adequacy check. Detection and treatment of outliers, influence diagnostics and multicollinearity diagnostics are some of the statistical techniques that are used to examine the adequacy of a fitted model. Standardized residuals are used in identifying outliers whereas Cook's distance, the leverage statistic and DfBeta are used to detect influential cases. The strategy for evaluating the impact of outliers and influential cases on logistic regression model is first to run a baseline model including all cases and secondly to run a model omitting outliers and influential cases. If the model without the outliers and influential cases has a classification accuracy rate that is better than the baseline model, we will interpret the revised model. If the accuracy rate of the revised model without outliers and influential cases is less than 2% more accurate (i.e. the difference between the accuracy rates of the two models is less than 2%), we will interpret the baseline model (Gujarati, 1995; Merenda, et al., 1980).

There are no direct measures for detecting multicollinearity for logistic regression. Tolerance values and VIF are useful tools in detecting multicollinearity. Tolerance values less than 0.1 and VIF values greater than 10 indicate the presence of multicollinearity.

3.3.2 The Multilevel Logistic Model

Introduction to Multilevel Analysis

Multilevel or hierarchically structured data are common in certain areas of research. For example, school education provides a system in which individuals are subject to the influences of hierarchal groups. Pupils or students learn in classes; classes are taught within schools; and schools may be administered within school boards. The units in such a system lie at four different levels of a hierarchy. These are pupils at level 1, classes at level 2, schools at level 3 and school boards to level 4. In household surveys, the level 1 units are individual people; the level 2 units could be households, districts or regions. In multilevel data structure units at one level are recognized as being grouped, or nested, within units at the next higher level. The existence of such data hierarchies is neither accidental nor ignorable. To ignore this relationship risks neglecting the importance of group effects, and may also render invalid many of the traditional statistical analysis techniques used for studying data relationships (Goldstein, 2003).

The statistical analysis that deals with multilevel or hierarchical data is called multilevel statistical analysis. Multilevel statistical analysis is useful in controlling nested sources of variability (Hox, 1995). Multilevel logistic regression belongs to the family of multilevel analysis. The multilevel logistic regression model could be a single-level, two-level and so on. In this study the two-level logistic regression is considered. The basic data structure of the two-level logistic regression is a collection of N groups (units at level two) and within the *k* groups (*k*=1, 2, . . ., N) there are a random sample of n_k level-one units (individuals). The dichotomous outcome variable for individual i in group j, is denoted by Y_{ij}. The outcome variable takes values of either 0 or 1 which represent 'failure' and 'success', respectively. Suppose the success probability in group j is denoted by p_j. Then, Y_{ij} can be expressed as the sum of the probability in group j, p_j plus a residual, ε_{ij}. That is, $Y_{ij} = p_j + \varepsilon_{ij}$ where $E(\varepsilon_{ij}) = 0$ and variance $Var(\varepsilon_{ij}) = p_j(1 - p_j)$. There are different types of the two-level logistic regression models. These are the null (empty) logistic regression model (a model without explanatory variables), the random intercept logistic regression model and the random coefficients logistic regression model. Goldstein (2003) and Snijders and Bosker (1999) give detailed discussions on these models. Since the two-level random intercept logistic regression model allows the overall probability of the first level units to vary across level two units, in this paper the proposed model is the two-level random intercept logistic regression model.

The two-level Random Intercept Model

The two-level random intercept model takes the form (Goldstein, 2003)

$$\log it(p_{ij}) = \log(\frac{p_{ij}}{1 - p_{ij}}) = \beta_{0ij} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \ldots + \beta_k x_{kij}$$
$$where\ \beta_{0ij} = \beta_0 + \upsilon_{0j} + \varepsilon_{0ij}$$
$$\mathrm{var}(\varepsilon_{0ij}) = \sigma_0^{\ 2},\ \mathrm{cov}(\varepsilon_{0ij}, \upsilon_{oj}) = 0$$

In this model p_{ij} is the probability of having a positive (success) event for the i^{th} individual in the j^{th} cluster, βs are parameters of the model Xs are regressors, υ_{oj} is the effect of group j on the log odds of a positive event or a level 2 residual, and ε_{oij} is a level 1 residual. In the model, both υ_{oj} and ε_{oij} are random quantities (they form the random part of the model), whose means are equal to zero. We assume that, being at different levels, υ_{oj} and ε_{oij} are uncorrelated and we further make the standard assumption that they follow a normal distribution (Rasbash et al, 2004). The random effect υ_{0j} follow a normal distribution with mean zero and variance $\sigma_0^{\ 2}$, which for a random intercept model consists of a single term which is the variance of υ_{0j} (Rasbash et al, 2004; Hox, 1995). The set of explanatory variables $\beta_1 x_{1ij} + \beta_2 x_{2ij} + ... + \beta_k x_{kij}$, are fixed and need to be estimated. The Variance precision factor (VPF), a useful measure that is used to evaluate the extent of level 2 variation that is due to unobserved factors operating at cluster level, is computed as $\rho = \dfrac{\sigma_0^{\ 2}}{\sigma_0^{\ 2} + \dfrac{\pi^2}{3}}$ where $\sigma_0^{\ 2}$ is the variance of υ_{oj} and $\dfrac{\pi^2}{3}$ is the variance for the logistic distribution.

The MLwiN version 2.02 software is used to estimate the parameters of the multilevel models. Two approximate estimation procedures are available in MLwiN to fit multilevel models to discrete response data: marginal quasi-likelihood (MQL) and predictive quasi-likelihood (PQL). The MQL procedure tends to underestimate the values of both the fixed effects (the set of explanatory variables) and random efects of the model, especially when the sample taken from each cluster is small. In addition, greater accuracy can be observed if the second order Taylor series approximation, rather than the first order, is used (Goldstein, 2003). Therefore, the PQL2 procedure is used to estimate the parameters of the models in this thesis. The coefficients in the model can be described as the log odds for a given category of a variable over the odds for the base category of the same variable. To ease interpretation, results are expressed in terms of odds ratios, which are calculated by exponentiating the parameter estimates. A ratio greater than unity implies that an individual in a given category would be more likely to experience the event compared with a counterpart in the base category. A ratio lower than unity signals that an individual in the given category is less likely to experience the event compared with a counterpart in the base category (Neter et al,1996).

For the two-level random intercept logistic model the likelihood value is unavailable, alternatively the joint chi-square (Wald test) is used to asses the goodness of fit of the model. There are no diagnostic checking methods for the two-level random intercept logistic model. Rasbash, 2005 and Hox, 1995 used the standardized residual and to examine model diagnostics. A standardized residual value greater than +2 or less than -2 and indicates an outlier.

CHAPTER FOUR

RESULTS

The response variable considered in this study is binary assuming two outcomes (0=nourished, 1=undernourished), which are indicators of the nutritional status of women. The purpose of this chapter is to analyze the effect of the different socio-economic, demographic and health related determinants of the nutritional status of women in Ethiopia using the data from the 2005 EDHS. Descriptive, univarite, multiple logistic regression and multilevel logistic regression methods are used to measure the effects of the determinants of malnourishment. The data are analyzed using the Statistical Package for Social Sciences (SPSS) version 15.0 and MLwiN version 2.02. The descriptive part provides percentages of undernourished individuals. The Pearson chi-square test is used to assess the association between variables in the univariate analysis. The multiple logistic regression analysis is employed to assess the determinants of nutritional status at the national level. Finally, multilevel logistic regression is used to assess factors affecting the nutritional status of women at the regional level.

4.1 DESCRIPTIVE STATISTICS AND UNIVARIATE ANALYSIS

Descriptive Statistics

From the 2005 EDHS report about 27 percent women have a BMI less than 18.5, which is greater than the Sub-Saharan average prevalence of 17 percent during the period 2002-2006 as shown in Figure 4.1 below (Macro international, 2008).

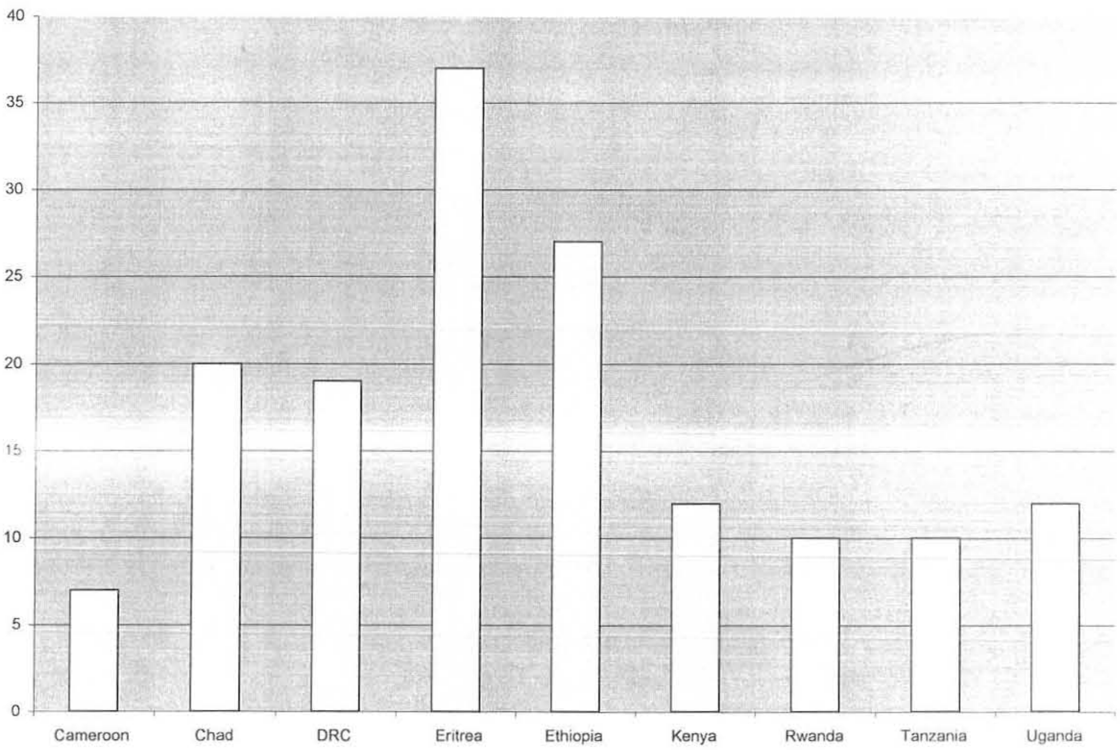

Figure 4.1: Undernutrition among women in selected Sub-Saharan African countries

Table 4.1 displays the percentage distribution of undernourished women along with the socio-economic, health-related and demographic variables. With regard to place of residence and region the results from Table 4.1 indicate that the proportion of undernourished women is higher in rural areas than in urban areas. The highest prevalence of undernutrition in women is observed in Gambela (37.5%) and the lowest in Addis Ababa (15.4%). Educated women (secondary and above) have a better nutritional status with 17.8 percent undernourished which is lower than women with primary education or no education. The findings show that women who use protected source of drinking water have a better nutritional status (21.2%). As to the socio-economic factors household economic status and employment status women very medium or above economic status (19.8%) and women employed in non-agricultural activities (18.2%) have better nutritional status, respectively. Concerning demographic variables, the level of undernutrition is highest for never married women (27.3%), women in the youngest age group 15-19 years (30.4%) and women with higher parity (6^+) women (27.4%).

Univarite Findings

To determine the factors that are strongly associated with the nutritional status of women, a preliminary univariate analysis based on chi-square test is employed. The findings of the univariate analysis are displayed in Table 4.1. From the results the socio-economic variables Region (REGION), Place of Residence (PLACE_RESI), Education of level women (EDUC_WOMEN), Household economic status (HOUSECON_STAT) and Employment status of women (EMPLOY_WOMEN) are found to be strongly associated with nutritional status of the women. Besides the health related factors such as source of drinking water (DRINK_WATER) is also found to be associated with level of nutritional status of women. Finally, the demographic factors marital status (MARITAL_STAT), age of women (AGE_WOMEN) and parity (PAR) are also found to be significantly associated with nutritional status of women.

Table 4.1 Percentage distribution and chi-square values of the nutritional status of women

Background characteristics	Percent undernourished (BMI <18.5)	Pearson chi-square value	P-value
Region		127.748	0.000***
Tigray	34.4		
Afar	28.1		
Amhara	25.1		
Oromiya	21.9		
Somali	29.4		
Ben-Gumuz	28.8		
SNNP	23.0		
Gambela	37.5		
Hareri	19.3		
Addis Ababa	15.4		
Dire Dawa	23.5		
Place of Residence		79.843	0.000***
Urban	17.7		
Rural	27.8		
Education of women		40.377	0.000***
No education	26.5		
Primary	25.8		
Secondary and above	17.8		
Source of drinking water		27.942	0.000***
Unprotected	27.6		
Protected	21.2		
Household economic status		89.878	0.000***
Very poor	30.6		
Poor	29.0		
Medium or above	19.8		
Women employment status		50.524	0.000***
Not employed	30.1		
Employed in agriculture	25.8		
Employed in non-agriculture	18.2		
Age of women		54.840	0.000***
15-19	30.4		
20-24	20.3		

25-29 30-34 35-49	20.8 23.2 26.2		
Marital status Never married Married/living together Divorced/widowed/separated	 27.3 23.3 26.6	12.427	0.002***
Parity 0 1 2-3 4-5 6+	 25.9 21.1 22.9 23.5 27.4	16.085	0.003***

** Significant at 0.05 level of significance

The univariate analysis gives indications to select variables for the multivariate analysis. The independent variables with p-values < 0.05 are included in the multivariate analysis. Accordingly Region (REGION), Place of Residence (PLACE_RESI), Education level of women (EDUC_WOMEN), Source of drinking water (DRINK_WATER), Household economic status (HOUSECON_STAT), Employment of women (EMPLOY_WOMEN), Marital status (MARITAL_STAT), Age of women (AGE_WOMEN) and Parity (PAR) are the variables to be included in the multiple analysis.

4.2 DETERMINANTS OF THE NUTRITIONAL STATUS OF WOMEN AT NATIONAL LEVEL: A MULTIPLE LOGISTIC REGRESSION APPROACH

One main problem with univariate analysis is that it does not take into account the possibility that a collection of variables, each of which is weakly associated with the outcome, can become an important predictor of the outcome when taken together (Hosmer and Lemeshow, 1989). To overcome this drawback a multiple logistic regression approach should be employed. Multiple logistic regression analyses is done using the significant variables in the univariate analysis. Fitting a model to a set of data first demands estimating the unknown parameters in the model. The logistic regression "FORWARD STEPWISE (LIKELIHOODRATIO)" was used to select significant variables/factors. The stepwise proceeds by entering REGION in step 1: MARITAL_STAT in step 2, PLACE_RESI in step 3: AGE_WOMEN in step 4: HOUSECON_ECON in step 5, EMPLOY_WOMEN in step 6. The likelihood ratio test criterion is used to select and remove variables at each step of the procedures. The 0.05 level of significance is used for entry of variables. The final (optimal) logistic regression model given in Table 4.2. The findings of the logistic regression model indicates that the nutritional status of women (undernourished, nourished) is affected by many variables. From Table 4.2, at the national level, the most important risk factors of undernutrition were found to be region, place of residence, household economic status, employment status of women, age of women and marital status. On the other hand, education of women, source of drinking water and parity were not significant determinants of the nutritional status of women in the multivariate set up.

Table 4.2 Variables in the final model and estimates

Covariates	$\hat{\beta}$	S.E.	Wald	DF	Sig.	Exp($\hat{\beta}$)
REGION			77.161	10	0.000	
Tigray	0.769	0.163	22.212	1	0.000	2.158
Afar	0.512	0.185	7.637	1	0.006	1.668
Amhara	0.260	0.165	2.496	1	0.114	1.297
Oromiya	0.017	0.161	0.011	1	0.915	1.017
Somali	0.541	0.183	8.710	1	0.003	1.717
Ben-Gumuz	0.596	0.182	10.670	1	0.001	1.814
SNNP	0.198	0.159	1.544	1	0.214	1.219
Gambela	1.067	0.175	37.244	1	0.000	2.906
Hareri	0.204	0.175	1.358	1	0.244	1.226
Dire Dawa	0.314	0.167	3.556	1	0.059	1.369
Addis Ababa (Ref.)	-	-	-	-	-	1.00
HOUSECON_STAT			8.936	2	0.011	
Very poor	0.284	0.116	6.043	1	0.014	1.328
Poor	0.276	0.100	7.678	1	0.006	1.318
Medium or above	-	-	-	-	-	-
EMPLOY_WOMEN			7.940	2	0.019	
Unemployed	0.253	0.092	7.632	1	0.006	1.288
Employed in Agri.	0.275	0.134	4.187	1	0.041	1.317
Employed in non-Agri. (Ref.)						

AGE_WOMEN			15.191	4	0.004	
15-19	0.223	0.095	5.505	1	0.019	1.249
20-24 (Ref.)	-	-	-	-	-	1.00
25-29	0.043	0.118	0.136	1	0.712	1.044
30-34	-0.189	0.106	3.202	1	0.074	0.827
35-49	0.212	0.096	4.857	1	0.028	1.236
PLACE_RESI						
Rural	0.274	0.115	5.673	1	0.017	1.315
Urban (Ref.)	-	-	-	-	-	-
MARITAL_STAT			26.876	2	0.000	
Never married	0.423	0.172	6.072	1	0.014	1.526
Married/living tog. (Ref.)	-	-	-	-	-	-
Divorced/separated	0.128	0.134	0.908	1	0.341	1.137
Constant	-1.764	0.146	145.505	1	0.000	0.171

4.2.1 Interpretation of the results of the Logistic Regression Model

The effect of each covariate is interpreted using the estimated odds ratio. Region is one of the important socioeconomic factors affecting the nutritional status of women. As compared to women living in Addis Ababa (reference category), women living in Tigray, Afar, Somali, Benshangul-Gumuz and Gambela are found to be 2.16, 1.67, 1.71, 1.81 and 2.91 times more likely to be undernourished, respectively. Women who reside in rural areas were about 1.32 times more likely to be undernourished than women in urban areas (reference category). As compared with women residing in households with medium or above economic status (reference category), those women residing in very poor and poor households are about 1.33 and 1.32 times more likely to be undernourished, respectively. Unemployed women and women employed in agriculture are about 1.29 and 1.32 times more likely to be undernourished than women employed in non-agriculture (reference category). Age of women and marital status are important demographic factors affecting nutritional status of women. Women in the youngest age group 15-19 and women in the oldest age group 35-49 were about 1.25 and 1.24 times more likely to be undernourished as compared with women in the age group 20-24 (reference category). Finally, never-married women are about 1.53 times more likely to be undernourished than married/living together women (reference category).

4.2.2 Assessing the Goodness of fit of the model

After fitting a model to a set of data, the next step is to check the goodness-of-fit of our model. The test of goodness-of-fit can be checked by the extent to which the fitted values of the response variable under the model agreed with the observed values. Some of the goodness of fit tests described in the previous chapter are discussed below.

The Likelihood Ratio Test

The likelihood ratio test is based on comparing the $-2LL_r$ for the restricted model (initial model) and $-2LL_f$ for the full model and (the model chi-square test). That is, initial chi-square is -2LL for the model, which accepts the null hypothesis that all the β coefficients are zero. This implies that none of the predictor variables/factors is linearly related to the log odds of the response variable. The model chi-square thus tests the null hypothesis that all population logistic regression coefficients except the constant are zero. Model chi-square measures the improvement in the fit that the explanatory variables make compared to the restricted model. Model chi -square is a likelihood ratio test, which reflects the difference between the error of not knowing the independent variables (initial chi-square) and error when the independent variables are included in the model (deviance). As can be seen from Table 4.4 the $-2LL_r$ for the restricted model is 5617.269. For the full model $-2LL_f$ is found to be 5383.869, which imply a model chi-square of 233.400 with p-value 0.000. Since the p (model chi-square) is <0.05 the null hypothesis thus rejected implying a good fit of the model.

Table 4.3 -2log likelihood for the initial model

Iteration	-2 Log likelihood	Coefficients Constant
1	5629.080	-1.037
2	5617.277	-1.146
3	5617.269	-1.149
4	5617.269	-1.149

Constant is included in the model.
Initial -2 Log Likelihood: 5617.269
Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer - Lemeshow Test

The Hosmer-Lemeshow test is another test of goodness of fit of the model. The hypothesis to be tested is the model fits the data (null hypothesis) against the model does not fit the data (alternative). The values of Hosmer-Lemeshow statistic and its contingency table for the final step computed using SPSS are given below.

Table 4.4 Hosmer-Lemeshow test

Chi-square	Df	Sig.
3.637	8	0.888

Table 4.5 Results of contingency table for Hosmer-Lemeshow test

	acute undernutrition = nourished		acute undernutrition = undernourished		Total
	Observed	Expected	Observed	Expected	Observed
1	436	433.682	53	55.318	489
2	435	430.202	69	73.798	504
3	407	412.673	90	84.327	497
4	409	406.972	95	97.028	504
5	395	402.697	115	107.303	510
6	388	391.071	123	119.929	511
7	382	377.097	130	134.903	512
8	359	360.813	154	152.187	513
9	350	338.481	159	170.519	509
10	303	310.311	237	229.689	540

The result of the Hosmer-Lemeshow test indicates that the null hypothesis should not be rejected meaning that the model fits the data.

Classification table, Cox and Snell R Square and Nagelkerke R Square

A classification table displays the tabulated cross-classifications of the observed category by the model-predicted category on the dependent variable and it is one way of assessing the goodness of fit of a model (Hosmer and Lemeshow, 1989). The values of the Cox and Snell R Square, Nagelkerke R Square (Annex I) and the classification table are given below and all of them indicated that the model is good fit.

Table 4.6 Classification tables

Classification Table

Observed		Predicted		
		acute undernutrition		Percentage Correct
		Nourished	Undernourished	
Acute undernutrition	Nourished	3827	37	99.042
	Undernourished	1200	25	53.041
Overall percentage				75.693

4.2.3 Model Diagnostics

In addition to the examination of the goodness of fit of the model, it is also useful to examine outliers and influential cases. Standardized residuals are used in identifying outliers whereas Cook's distance, the leverage statistic and DfBeta are used to detect influential cases. The strategy for evaluating the impact of outliers and influential cases on our logistic regression model is first to run a baseline model including all cases and secondly to run a model omitting outliers and influential cases. If the model excluding outliers and influential cases has a classification accuracy rate that is better than the baseline model, interpretation will be made the revised model. If the accuracy rate of the revised model without outliers and influential cases is less than 2% more accurate, then we conclude that there are no outliers and influential cases implying that the model fits the data (Gujarati, 1995; Merenda, et al 1980). Table 4.9 gives classification accuracy for all cases and table 4.10 gives classification accuracy after omitting outliers and influential cases.

Table 4.7 Classification accuracy for all cases

Classification Table

Observed		Predicted		
		acute undernutrition		Percentage Correct
		Nourished	Undernourished	
Acute undernutrition	Nourished	3827	37	99.042
	Undernourished	1200	25	53.041
Overall percentage				75.693

Table 4.8 Classification accuracy after omitting outlier and influential cases

Classification Table

Observed		Predicted		
		acute undernutrition		Percentage Correct
		Nourished	Undernourished	
Acute undernutrition	Nourished	3816	48	98.758
	Undernourished	1172	42	53.460
Overall percentage				75.975

Prior to the removal of outliers and influential cases, the overall accuracy rate of the logistic regression model was 75.693%. After removing outliers and influential cases, the overall accuracy rate of the logistic regression model was found to be 75.975%. The logistic regression omitting outliers and influential cases was less than two percent more accurate in classifying cases than the logistic regression with all cases. This implies that there are no outliers and influential cases.

Annex 3 shows that the tolerance values are all greater than 0.1 and the VIF values are all less than 10 implying that there is no multicollinearity.

4.3 DETERMINANTS OF THE NUTRITIONAL STATUS OF WOMEN AT REGIONAL LEVELS: A MULTILEVEL LOGISTIC REGRESSION APPROACH

The multiple logistic regression analysis of the determinants of nutritional status of women at the national level revealed that there is a difference in the nutritional status of women among the regions. To assess the determinants of nutritional status at the regional level the two-level random intercept logistic regression model was employed using MLwiN software. In this model a region is used as second level (level two) unit and women as first level unit. The MLwiN software gives best estimates when the number of explanatory variables is few (Rasbash et al, 2004). In the study of contraceptive use in which districts are level 2 units and women level 1 units Rasbash used five explanatory variables (Rasbash et al, 2004). The study done by Hox on education data schools are level 2 and students are level 1 used six explanatory variables (Hox, 1995). In this study only six of the nine explanatory variables are used in the logistic regression analysis. The explanatory variables considered in the multilevel analysis are: education of women, source of drinking water, household economic status, employment status of women, place of residence and marital status.

The binary response Y_{ij} which equals 1 if woman i in region j is undernourished, and 0 otherwise. The random effect υ_{0j} follow a normal distribution with mean zero and variance σ_0^2, which for a random intercept model consists of a single term which is $\text{var}(\upsilon_{0j})$ (Rasbash et al, 2004; Hox, 1995). The intra-cluster correlation is a useful measure to evaluate the extent of level 2 variations that is due to unobserved factors. In multilevel analysis the fitted multilevel model gives an equation of the parameter estimates of each category along with their standard errors in brackets. Note that if the explanatory variables were declared to be categorical, MLwiN automatically enters dummy variables. Using the MLwiN version 2.02 and PQL2 estimation procedure the variables in the final model are given in Table 4.11.

Table 4.9 Variables in the Final Model for the Two-level Random Intercept Logistic Regression Model

	Estimate	S. E.	Z-value	Odds ratio [95% CI]
Household Economic Status				
Very poor	0.414	0.105	3.943**	1.513 [1.231, 1.860]
Poor	0.411	0.107	3.841**	1.508 [1.223, 1.816]
Medium or above (Ref.)	-	-	-	1.00
Employment status of Women				
Unemployed	0.235	0.099	2.374**	1.265 [1.042, 1.536]
Employed in Agric.	0.305	0.127	2.402**	1.357 [1.059, 1.740]
Employed in non-agriculture (Ref.)	-	-	-	1.00
Drinking water				
Unprotected	0.565	0.122	4.631**	1.759 [1.386, 2.233]
Protected (Ref.)	-	-	-	1.00
Marital status				
Never-married	0.419	0.168	2.494**	1.521 [1.093, 2.144]
Married/living together (Ref.)	-	-	-	1.00

Random part				
Intercept	-1.739**	0.131		0.176
Intra-cluster variance	0.225**	0.067		
Intra-cluster correlation(VPF)	0.064			
Deviance-based chi-square			176.011	

** Significant at 0.05 level of significance

The intra-cluster variance (variance precision factor), which represents the variance due to unobserved factors operating at cluster level, is significant (Table 4.11). The intra-cluster correlation is 0.064 (Table 4.11) indicating that 6.4% of the variation in the nutritional status of women is the result of unobserved level two factor.

4.3.1 Interpretations of the two-level random intercept logistic regression model

The results are interpreted using the odds ratio in a similar approach as multiple logistic regression approach. From Table 4.11 at the regional level the most important determinants of undernutrition were found to be Household economic status, Employment status of women, Source of drinking water, and Marital status of women. The effect of each covariate is interpreted using the estimated odds ratio. From the multilevel analysis at regional level, as compared to women residing in households with medium or above economic status (reference category), women residing in very poor and poor households are both about 1.51 times more likely to be undernourished. Unemployed women and women employed in agriculture are respectively about 1.27 and 1.36 times more likely to be undernourished than women employed in non-agriculture.

Source of drinking water is an important health related factor in determining nutritional status of women. Women with unprotected source of drinking water are about 1.76 times more likely to be undernourished than women with protected source of drinking water. The finding also showed that never-married women are 1.52 times more likely to be undernourished as compared to married/living together women (reference category).

4.3.2 Model Diagnostics

For the two-level random intercept logistic model the likelihood value is unavailable. Alternatively the joint chi-square (Wald test) is used to asses the goodness of fit of the model. The deviance based chi-square value is 176.01 implying that the model fits the data very well. For our model the minimum and maximum values of the standardized residuals are -1.054 and 1.882 implying that there are no outliers.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION

The study has demonstrated that at the national level there is a considerably high level of undernutrition (24.8%) which is higher than the level in the Sub-Saharan African countries. The study has shown that region, place of residence, household economic status, employment status of women, source of drinking water, age of women and marital status are the basic determinants of the nutritional status of women. The findings are consistent with other studies undertaken on nutritional status of women (Lindet and Tadesse, 1997; Teller and Yimer, 2000; Woldemariam, 2001; Woldemariam and Timotiwos, 2002).

The results of the study revealed that there are substantial regional differences in the nutritional status of women. Both the descriptive analysis and multivariate analysis revealed that women residing in Tigray, Afar, Somali, Benshangul-Gumuz and Gambela are at high risk of maternal undernutrition. The higher level of undernutrition in the regions could be due to high level of food insecurity in the households, unproductive soil, the low level of development in the regions, high level of malaria infection which significantly affects dietary intake and recurring droughts in the regions. Perhaps the other reason for the low level of undernutrition the regions could be that most of the areas in the regions are lowlands and the rural populations of these regions are mostly pastorals which may result in limited dietary intake from crop products. This result is consistent with other studies which assert that living in the lowlands are more malnourished compared to women living in the highlands (Tsegaye D., et al, 2003).

The results of the study have also depicted that there is difference in women's nutritional status among rural and urban dwellers. Several DHS studies (Lozia, 1997) in Sub-Saharan countries have revealed similar trends in difference of maternal undernutrition in urban and rural residences. The higher level of undernutrition in the rural areas could be explained by the insufficient knowledge about nutrition and dietary intake, limited access and utilization to health services and little exposure to better dietary accesses and practices.

Household economic status is an important socioeconomic variable which is found to be the determinant of maternal undernutrition. According to the findings of this study, women with very poor or poor household economic status are at high risk of undernutrition as compared to women residing in medium or above household economic status. This could be due to the fact that households with better economic status are most likely to be food secured and hence have access to adequate dietary intake which is reflected by improved nutritional status.

Employment status of women is another important socioeconomic factor that affects maternal undernutrition. This study has also revealed that unemployed women and women employed in agriculture are at high risk of undernutrition as compared to women employed in non-agriculture. This could be explained by the fact that employment of women could provide an additional income that can increase spending on food and nutrition and improve food security of the household resulting in sufficient dietary intake and hence enhanced women nutritional status. The finding is consistent with a study by UNCIEF Ethiopia. It was found that unemployed women are at high risk of undernutrition, even in households with a relatively better socioeconomic status (UNICEF Ethiopia, 2003).

Source of drinking water is a health related factor that explains women's nutritional status. The result of the study has shown that at regional level women with protected source of drinking water have better nutritional status than women with unprotected source of drinking water. This result is consistent with results of other studies. Source of drinking water of the family, sanitary conditions, behavioral factors related to sanitation, represent the underlying (or proximate) factors of undernutrition (Murray and Lopez, 1997).

Age of women and marital status are also important demographic factors affecting nutritional status. The results showed that women in the adolescent reproductive age group (15-19 years) and women in the oldest age group (35-49 years) are at higher risk of undernutrition. The high risk of maternal undernutrition in the youngest age group (15-19 years) could be due to high requirement of adequate nutrient demand for fast adolscent growth, lack of knowledge and lack of decision autonomy about their nutritional status and in some cases for women who give birth in their early ages. The need for high adequate dietary intake for child growth and pregnancy may lead to sever undernutrition. This finding is consistent with a number of studies, which indicate rates of low maternal undernutrition are higher in the young, physiological immature adolescent than in matured women (Worthington-Roberts et al., 1985). The higher risk of undernutrition in the oldest age group (35-49 years) may be due to the cumulative effects of lifetime nutritional deficiency and closely spaced births. The study also indicated that never-married women were more likely to be undernourished as compared to married women.

Women's education is also an important factor which reduces the risk of undernutrition among women. Although the result of the multiple logistic regression analysis does not show a significant association between women education and the risk of undernutrition, the results of the descriptive analysis revealed that women with no education are at a higher risk of undernutrition than women who have primary or higher education. The same result of association was observed with other literatures (Hindin, 2005; Teller, 2000).

5.2 CONCLUSION

Undernutrition is considered as one of the major health problems affecting women in the reproductive age group (15-49 years) in developing countries like Ethiopia. Drought and food shortages chronically affect a considerable proportion of the country's population. In addition to prevailing food shortages, poor household economic status, inadequate maternal health care practices, distribution of food within households and inappropriate nutritional practices make women vulnerable to nutritional problems. The fact that these problems are, in turn, most often complicated with infections and other diseases that result from lack of adequate water and proper sanitation. Multisectroral interventions have to be made to alleviate overall nutritional problems of women at national as well as regional levels. This study found evidence that socioeconomic, health related and demographic factors have significant influences on the nutritional status women. Region of residence, household economic status, woman's employment status, place of residence, woman's age and marital status are important determinants of undernutrition among reproductive age women at national level. Besides, source of drinking water is found to be a determinant of the nutritional status of women at the regional level. Women in Tigray, Afar, Somali, Benishangul-Gumuz and Gambela regions were found to be at higher level of undernutrition. The study also indicated that women in households with low economic status and unemployed women are exposed to undernutrition.

There may be other variables/factors other than the variables/factors considered in this study that could affect the nutritional status of women. These factors include access to health services, within-household food distribution and workload (water and fuel collection, household chores). Therefore, further studies including access to health services, socio-cultural practices, within-household food distribution, women's workload, seasonal food insecurity, and other related factors are suggested.

5.3 RECOMMENDATION

To improve the poor nutritional status of women in the reproductive age in Ethiopia the following recommendations are forwarded.

- ✓ Actions should be taken to improve household food security, adequate dietary intake, appropriate distribution of food within household, access to health facility and better sanitation.
- ✓ Awareness needs to be created, particularly among household decision-makers and women themselves, to highlight the harmful effects of maternal undernutrition and the importance of good quality food for the women, their children and the family.

- ✓ Practical health facility-based programs and guidelines for nutritional assessment for households and the community must be developed.
- ✓ Organizational commitments for the placement of maternal nutrition in national policies and programs should be strengthened.
- ✓ Increase employment opportunities to women by giving more attention to unemployed women living in urban areas of the country.
- ✓ Activities that improve the access to healthy drinking water source and better sanitation should be strengthened.
- ✓ Nutrition education should be given to households decision-makers particularly for women in the reproductive age.
- ✓ Further studies that include other factors like environmental, workload and cultural factors that affect the nutritional status of women are recommended.

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Annexes

Annex 1: SPSS OUTPUT

Dependent Variable Encoding

Original Value	Internal Value
nourished	0
undernourished	1

Iteration History(a,b,c)

Iteration		-2 Log likelihood	Coefficients
		Constant	Constant
Step 0	1	5629.080	-1.037
	2	5617.277	-1.146
	3	5617.269	-1.149
	4	5617.269	-1.149

a Constant is included in the model.
b Initial -2 Log Likelihood: 5617.269
c Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table(a,b)

Observed			Predicted		
			acute undernutrition		Percentage Correct
			nourished	undernourished	nourished
Step 0	acute undernutrition	nourished	3864	0	100.0
		undernourished	1225	0	.0
	Overall Percentage				75.9

a Constant is included in the model.
b The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.149	.033	1227.442	1	.000	.317

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	131.912	10	.000
	Block	131.912	10	.000
	Model	131.912	10	.000
Step 2	Step	33.635	2	.000
	Block	165.547	12	.000
	Model	165.547	12	.000

Step 3	Step	33.026	1	.000
	Block	198.573	13	.000
	Model	198.573	13	.000
Step 4	Step	16.568	4	.002
	Block	215.141	17	.000
	Model	215.141	17	.000
Step 5	Step	10.163	2	.006
	Block	225.304	19	.000
	Model	225.304	19	.000
Step 6	Step	8.095	2	.017
	Block	233.400	21	.000
	Model	233.400	21	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	5485.356(a)	.256	.383
2	5451.722(a)	.320	.479
3	5418.695(a)	.383	.573
4	5402.128(a)	.414	.619
5	5391.965(a)	.433	.648
6	5383.869(a)	.448	.671

a Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.000	8	1.000
2	7.343	8	.500
3	8.891	7	.261
4	13.411	8	.098
5	4.102	8	.848
6	3.637	8	.888

Contingency Table for Hosmer and Lemeshow Test

		acute undernutrition = nourished		acute undernutrition = undernourished		Total
		Observed	Expected	Observed	Expected	Observed
Step 1	1	668	668.000	119	119.000	787
	2	292	292.000	64	64.000	356
	3	517	517.000	125	125.000	642
	4	273	273.000	74	74.000	347
	5	533	533.000	156	156.000	689
	6	436	436.000	134	134.000	570
	7	450	450.000	184	184.000	634

	8	218	218.000	91	91.000	309
	9	291	291.000	155	155.000	446
	10	186	186.000	123	123.000	309
Step 2	1	465	456.507	63	71.493	528
	2	323	327.283	71	66.717	394
	3	360	370.161	86	75.839	446
	4	513	515.952	126	123.048	639
	5	436	431.404	112	116.596	548
	6	397	388.958	120	128.042	517
	7	348	350.369	132	129.631	480
	8	393	397.216	158	153.784	551
	9	290	276.215	118	131.785	408
	10	339	349.933	239	228.067	578
Step 3	1	436	424.974	46	57.026	482
	2	571	576.140	119	113.860	690
	3	421	418.631	90	92.369	511
	4	514	536.633	157	134.367	671
	5	391	387.086	106	109.914	497
	6	447	443.872	159	162.128	606
	7	376	366.356	138	147.644	514
	8	388	385.633	178	180.367	566
	9	320	324.675	232	227.325	552
Step 4	1	487	490.297	71	67.703	558
	2	415	414.866	75	75.134	490
	3	412	391.148	63	83.852	475
	4	384	402.024	114	95.976	498
	5	363	354.342	85	93.658	448
	6	382	394.357	131	118.643	513
	7	385	383.860	135	136.140	520
	8	347	346.351	145	145.649	492
	9	318	318.036	153	152.964	471
	10	371	368.718	253	255.282	624
Step 5	1	428	419.946	48	56.054	476
	2	446	450.282	83	78.718	529
	3	425	423.999	87	88.001	512
	4	398	401.875	99	95.125	497
	5	395	395.577	105	104.423	500
	6	378	383.030	122	116.970	500
	7	377	377.310	135	134.690	512
	8	371	368.106	152	154.894	523
	9	340	328.276	153	164.724	493
	10	306	315.599	241	231.401	547
Step 6	1	436	433.682	53	55.318	489
	2	435	430.202	69	73.798	504
	3	407	412.673	90	84.327	497
	4	409	406.972	95	97.028	504
	5	395	402.697	115	107.303	510

6	388	391.071	123	119.929	511
7	382	377.097	130	134.903	512
8	359	360.813	154	152.187	513
9	350	338.481	159	170.519	509
10	303	310.311	237	229.689	540

Classification Table(a)

Observed			Predicted		
			acute undernutrition		Percentage Correct
			nourished	undernourished	Nourished
Step 1	acute undernutrition	Nourished	3864	0	100.0
		Undernourished	1225	0	50.7
	Overall Percentage				75.9
Step 2	acute undernutrition	Nourished	3864	0	100.0
		Undernourished	1225	0	51.0
	Overall Percentage				75.9
Step 3	acute undernutrition	Nourished	3835	29	99.2
		Undernourished	1215	10	51.8
	Overall Percentage				75.6
Step 4	acute undernutrition	Nourished	3845	19	99.5
		Undernourished	1217	8	52.1
	Overall Percentage				75.7
Step 5	acute undernutrition	Nourished	3835	29	99.2
		Undernourished	1207	18	52.7
	Overall Percentage				75.7
Step 6	acute undernutrition	Nourished	3827	37	99.0
		Undernourished	1200	25	53.0
	Overall Percentage				75.7

a The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	REGION			129.953	10	.000	
	REGION(1)	1.095	.141	60.622	1	.000	2.990
	REGION(2)	.811	.160	25.659	1	.000	2.250
	REGION(3)	.545	.140	15.131	1	.000	1.725
	REGION(4)	.305	.141	4.703	1	.030	1.357
	REGION(5)	.850	.158	29.097	1	.000	2.339
	REGION(6)	.852	.160	28.462	1	.000	2.343
	REGION(7)	.496	.135	13.554	1	.000	1.643
	REGION(8)	1.312	.153	73.496	1	.000	3.712
	REGION(9)	.207	.170	1.484	1	.223	1.230
	REGION(10)	.420	.165	6.507	1	.011	1.522

	Constant	-1.725	.100	300.614	1	.000	.178
Step 2(b)	REGION			151.792	10	.000	
	REGION(1)	1.246	.144	74.921	1	.000	3.478
	REGION(2)	1.021	.165	38.338	1	.000	2.777
	REGION(3)	.710	.144	24.278	1	.000	2.034
	REGION(4)	.440	.143	9.457	1	.002	1.553
	REGION(5)	1.051	.162	42.027	1	.000	2.860
	REGION(6)	1.055	.164	41.265	1	.000	2.872
	REGION(7)	.629	.137	21.017	1	.000	1.876
	REGION(8)	1.495	.157	90.104	1	.000	4.458
	REGION(9)	.308	.172	3.218	1	.073	1.360
	REGION(10)	.514	.166	9.569	1	.002	1.672
	MARITAL_STAT			33.763	2	.000	
	MARITAL_STAT(1)	.293	.103	8.057	1	.005	.746
	MARITAL_STAT(2)	.152	.112	1.859	1	.173	1.164
	Constant	-1.738	.134	168.090	1	.000	.176
Step 3(c)	REGION			93.799	10	.000	
	REGION(1)	.868	.160	29.518	1	.000	2.383
	REGION(2)	.649	.179	13.184	1	.000	1.914
	REGION(3)	.310	.162	3.681	1	.055	1.364
	REGION(4)	.067	.159	.175	1	.676	1.069
	REGION(5)	.674	.177	14.580	1	.000	1.962
	REGION(6)	.656	.180	13.323	1	.000	1.927
	REGION(7)	.205	.157	1.698	1	.193	1.228
	REGION(8)	1.106	.173	40.920	1	.000	3.022
	REGION(9)	.185	.174	1.128	1	.288	1.203
	REGION(10)	.435	.167	6.736	1	.009	1.544
	PLACE_RESI(1)	.535	.095	31.722	1	.000	1.707
	MARITAL_STAT			46.420	2	.000	
	MARITAL_STAT(1)	.366	.105	12.241	1	.000	.693
	MARITAL_STAT(2)	.168	.112	2.225	1	.136	1.182
	Constant	-1.744	.135	167.885	1	.000	.175
Step 4(d)	REGION			93.210	10	.000	
	REGION(1)	.846	.161	27.784	1	.000	2.331
	REGION(2)	.625	.179	12.150	1	.000	1.869
	REGION(3)	.288	.163	3.133	1	.077	1.333
	REGION(4)	.050	.160	.098	1	.754	1.051
	REGION(5)	.656	.177	13.787	1	.000	1.928
	REGION(6)	.635	.181	12.361	1	.000	1.887
	REGION(7)	.197	.158	1.552	1	.213	1.217
	REGION(8)	1.110	.173	40.999	1	.000	3.035
	REGION(9)	.177	.174	1.025	1	.311	1.193
	REGION(10)	.419	.168	6.251	1	.012	1.521
	AGE_WOMEN			16.276	4	.003	
	AGE_WOMEN(1)	.311	.110	8.022	1	.005	.733
	AGE_WOMEN(2)	.079	.116	.462	1	.497	1.082
	AGE_WOMEN(3)	-.191	.106	3.266	1	.071	.826

	AGE_WOMEN(4)	-.114	.118	.924	1	.337	.893
	PLACE_RESI(1)	.508	.095	28.380	1	.000	1.662
	MARITAL_STAT			23.580	2	.000	
	MARITAL_STAT(1)	.329	.106	9.684	1	.002	.720
	MARITAL_STAT(2)	.118	.133	.789	1	.374	1.126
	Constant	-1.639	.139	138.765	1	.000	.194
Step 5(e)	REGION			78.584	10	.000	
	REGION(1)	.790	.162	23.794	1	.000	2.204
	REGION(2)	.546	.184	8.795	1	.003	1.727
	REGION(3)	.291	.163	3.176	1	.075	1.338
	REGION(4)	.036	.160	.050	1	.823	1.036
	REGION(5)	.563	.182	9.549	1	.002	1.755
	REGION(6)	.626	.181	11.927	1	.001	1.871
	REGION(7)	.200	.159	1.587	1	.208	1.222
	REGION(8)	1.076	.174	38.069	1	.000	2.934
	REGION(9)	.202	.174	1.335	1	.248	1.223
	REGION(10)	.413	.168	6.047	1	.014	1.511
	HOUSECON_STAT			10.003	2	.007	
	HOUSECON_STAT(1)	.305	.115	7.018	1	.008	1.357
	HOUSECON_STAT(2)	.289	.100	8.389	1	.004	1.335
	AGE_WOMEN			16.220	4	.003	
	AGE_WOMEN(1)	.315	.110	8.207	1	.004	.730
	AGE_WOMEN(2)	.074	.117	.400	1	.527	1.077
	AGE_WOMEN(3)	-.190	.106	3.238	1	.072	.827
	AGE_WOMEN(4)	-.117	.118	.975	1	.324	.890
	PLACE_RESI(1)	.321	.113	8.072	1	.004	1.379
	MARITAL_STAT			24.247	2	.000	
	MARITAL_STAT(1)	.320	.106	9.134	1	.003	.726
	MARITAL_STAT(2)	.142	.134	1.130	1	.288	1.153
	Constant	-1.650	.139	139.971	1	.000	.192
Step 6(f)	REGION			77.161	10	.000	
	REGION(1)	.769	.163	22.212	1	.000	2.158
	REGION(2)	.512	.185	7.637	1	.006	1.668
	REGION(3)	.260	.165	2.496	1	.114	1.297
	REGION(4)	.017	.161	.011	1	.915	1.017
	REGION(5)	.541	.183	8.710	1	.003	1.717
	REGION(6)	.596	.182	10.670	1	.001	1.814
	REGION(7)	.198	.159	1.544	1	.214	1.219
	REGION(8)	1.067	.175	37.244	1	.000	2.906
	REGION(9)	.204	.175	1.358	1	.244	1.226
	REGION(10)	.314	.167	3.556	1	.059	1.369
	HOUSECON_STAT			8.936	2	.011	
	HOUSECON_STAT(1)	.284	.116	6.043	1	.014	1.328
	HOUSECON_STAT(2)	.276	.100	7.678	1	.006	1.318
	EMPLOY_WOMEN			7.940	2	.019	
	EMPLOY_WOMEN(1)	.253	.092	7.632	1	.006	1.288
	EMPLOY_WOMEN(2)	.275	.134	4.187	1	.041	1.317

AGE_WOMEN			15.191	4	.004	
AGE_WOMEN(1)	.223	.095	5.505	1	.019	1.249
AGE_WOMEN(2)	.043	.118	.136	1	.712	1.044
AGE_WOMEN(3)	-.189	.106	3.202	1	.074	.827
AGE_WOMEN(4)	.212	.096	.892	1	.345	1.236
PLACE_RESI(1)	.274	.115	4.857	1	.028	1.315
MARITAL_STAT			26.876	2	.000	
MARITAL_STAT(1)	.423	.172	6.072	1	.014	1.526
MARITAL_STAT(2)	.128	.134	.908	1	.341	1.137
Constant	-1.764	.146	145.505	1	.000	.171

a Variable(s) entered on step 1: REGION.
b Variable(s) entered on step 2: MARITAL_STAT.
c Variable(s) entered on step 3: PLACE_RESI.
d Variable(s) entered on step 4: AGE_WOMEN.
e Variable(s) entered on step 5: HOUSECON_STAT.
f Variable(s) entered on step 6: EMPLOY_WOMEN.

Annex 2: Output for the two-level random intercept multilevel logistic regression

$$\mathrm{UNDERNUTR}_{ij} \sim Binomial(denom_{ij}, \Pi_{ij})$$

$$\begin{aligned}\log it(\Pi_{ij}) = \beta_{0j} cons &+ 0.015(0.140) EDUC\_WOMEN(1) + 0.069(0.138) EDUC\_WOMEN(2) + \\ &0.565(0.122) DRINK\_WATER + 0.411(0.107) HOUSECON\_STAT(1) + \\ &0.414(0.105) HOUSECON\_STAT(2) + 0.235(0.099) EMPLOY\_WOMEN(1) + \\ &0.305(0.127) EMPLOY\_WOMEN(2) + -0.090(0.162) PLACE\_RESI + 0.419(0.106) \\ &MARITAL\_STAT(1) + 0.114(0.118) MARITAL\_STAT(2)\end{aligned}$$

$$\beta_{0j} = -1.731(0.131) \quad + \upsilon_{0j}$$

$$\upsilon_{0j} = N(0, \sigma_0^2) \; : \; \sigma_0^2 = [0.225(0.067)]$$

Annex 3: Tolerance and VIF values

	Collinearity Statistics	
	Tolerance	VIF
Constant	-	-
Region	0.650	1.538
Educational level	0.534	1.873
Source of water	0.266	3.763
Household economic status	0.557	1.797
Employment status of women	0.915	1.093
Parity	0.444	2.252
Age of women	0.499	2.004
Place of residence	0.247	4.041
Marital status	0.878	1.139

Declaration

I declare that this thesis is my original work and has not been presented for a degree in any university. All the sources of the materials in this thesis are duly acknowledged.

Name: Eshetu Sata

Signature: [signature]

Date: July 2, 2009

Place: Addis Ababa

This thesis has been submitted for examination with my approval as a University advisor.

Name: Eshetu Wencheko

Signature: [signature]

Date: 02/07/09

Place: Addis Abeba