MEKELLE UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS
DEPARTMENT OF ECONOMICS

DETERMINANTS OF CHILD MALNUTRITION
A CASE STUDY IN CENTERALZONE of TIGRAY, NORTHERN ETHIOPIA

By:

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A Thesis

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(Development Policy Analysis Specialization)

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Declaration

This is to certify that this thesis entitled "**Determinants of Child Malnutrition** (A Case Study in Central Zone ofTigray, Northern Ethiopia)"submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science** in **Economics (Development Policy analysis)**, to the College of Business and Economics, Mekelle University, through the Department of Economics, done by Mrs. **AsegedechHagosID**.No. CBE/PS 015/03 is an authentic work carried out by her under my guidance. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

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CERTIFICATION

As member of the Board of Examiners of the Msc. Thesis Open Defense Examination, we certify that we have read evaluated the Thesis prepared by AsegedechHagosand examined the candidate. We recommended that the Thesis be accepted as fulfilling the Thesis requirement for the Master of Science Degree in Economics (Development Policy Analysis).

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List of Abbreviations and Acronyms

BMX Body Mass Index

CDC Center for Disease Control

CSA Central Statistical Authority

EDHS Ethiopia Demographic and Health Survey

FAO Food and Agriculture Organization

HHs Households

HAZ Height-for-age Z-score

MDG Millennium Development Goal

ML Maximum Likelihood

PSNP Participation Safety Net Program

REST Relief Society of Tigray

SD Standard Deviation

TLU Tropical Livestock Unit

UNICEF United Nations Children Fund

VIF Variance Inflation Factor

WB World Bank

WAZWeight-for-age Z-score

WHZ Weight -for -Height Z-score

WHO World Health Organization

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Abstract

The study analyzes the determinants of child malnutrition among under-five children of farming households in Central Zone of Tigray, Northern Ethiopia. A logit model is employed to analyze the determinants of child malnutrition among under-five children using a cross-sectional data.

The results of the analysis shows that the significant determinants of malnutrition are age of household, sex of household, education of household, presence of latrine in the household, use of treated water, sex of child, child age and child birth interval while age of household, family size, oxen ownership are among the insignificant variables. House hold education is highly significant at 1% and negatively associated with child malnutrition suggesting that as household head get educated, become more at ease to adapt and utilize new idea. Then this helps to improve nutritional status of their children. Child birth interval is among the negatively related and significant variable with malnutrition signifying that as birth space increase there may be better caring of children that reduce malnutrition. Finally especial attention should be given to reduce the present high rate of malnutrition in the study area.

Keywords: *Households, Child Malnutrition, Nutritional status.*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Many African countries are endowed with various and plentiful natural and human resource which is favorable for agricultural production particularly the Sub-Saharan Africa. However, the child malnutrition remains one of the most fundamental challenges and biggest health burden of developing countries (WHO, 2000& WHO, 2007). It is a leading factor for under-5 year's child mortality and morbidity in Sub-Saharan Africa.Malnutrition is also the most serious socioeconomic and health problem which contributes to 2.2 million deaths worldwide for children less than five years old [UNICEF, 2005; UNICEF, 2006]. According to Sun movement progress report 2012 malnutrition problem affect for about 180million children under five years age, especially stunting the result of chronic deficiency in nutrition starting from the period of pregnancy to the age of two years and have caused for damaging child physical and mental development.

Recent studies show that malnutrition affects negatively for children of developing countries. According to WHO, 2012, 1 in 6 children were estimated to be underweight in those countries and causes about 55% of all deaths of children under five years of age worldwide (Pelletier et al, 1994). A significant proportion of child morbidity and mortality in developing countries is attributable to child malnutrition (Caulfield *et al*., 2004; Amsalu and Tigabu, 2008), which is preventable if sufficient efforts are made to overcome the problem. For a child born in sub-Saharan Africa, the probability of dying before fifth birth day was 1.9 times higher than in South Asia, 6.3 times higher than in Latin America and the Caribbean, and 24 times higher than in industrialized countries (UNICEF, 2010).

Malnutrition can be categorized in to under nutrition and over nutrition and at this time child under nutrition remains one of Africa's most fundamental challenges for improved economic development due to lack of enough time and capacities of caregivers to provide adequate food and necessary health services for healthy life children's. Hence an

estimated 200 million people on the continent, both children and adults, are undernourished, their numbers having increased by almost 20% since the early 1990s (FAO,2003).

Existing literature revealed that under nutrition affects children's future development; nutritional status hinders the physical and mental development of children. Moreover, it causes for over 28 percent of all deaths in Africa some 2.9 million deaths annually (Ezzati et al., 2003).Studies also shows that being malnourished in the first years of life may influence future intellectual development and health of a child, thus affecting productivity and health status in adult age and future productivity of country (Levinson and Bassett, 2007; Victora et al., 2008).

When a child's natural growth is negatively impacted because his nutritional and caloric needs are consistently unmet, his growth slows and the likelihood of him completing secondary school and obtaining wage-earning employment decreases (Aldermn, Hoddinott, and Kinsey, 2006). Additionally, when women are malnourished as children they may be more likely to experience complications during delivery of their own children and deliver lower birth-weight child (Alderman et al,, 2006; Strauss & Thomas, 1998).

The impact of malnutrition therefore has negative consequence for a population's health and development in short and long period of time. Moreover malnourished children has faced the risk of dying from a disease is two times higher than that of well-nourished children, moderately malnourished are five times as likely to die, and severely malnourished children have a risk that is eight times higher(UNICEF, 1996). Hence child malnutrition remains a major public health problem of the world.

Malnutrition in the Ethiopian context has been described as a long-term year round phenomenon due to chronic inadequacies in food intake combined with high levels of illness (National Nutrition Policy Draft, 2003). Child malnutrition in Ethiopia is one of the most serious public health problem and the highest in the world (Alemu M, NicolaJ,

BeleleT, 2005); especially the prevalence of child stunted malnutrition is the highest in the world. This chronic malnutrition is an obstacle to economic development of the country.

Ethiopia is the second most populous country in Africa, at nearly 84 million. According to Central Statistics Authority (2012) Population projection Ethiopia Census 2007 approximately 14% are children under five years of age. These children and their mothers suffer disproportionately from the poor health and nutrition situation in the country and cause for about 57% of child deaths in Ethiopia (SCUK, 2009).The prevalence of child malnutrition at national level about 44%stunted, 29% underweight and 10% children were wasted and for Tigray region indicated that 51%,35%,10.3% stunted,underweight and wasted respectively. The figure shows that national as well as regional prevalence of malnutrition is higher as compared to the sub-Saharan countries. Thus, understanding the cause and consequence of malnutrition and its relationship to economic development is helpful to solve the problem of malnutrition.

1.2 Statement of the Problem

Ethiopia for the last decade has been registered double digit economic growth (CSA2011) and Poverty has declined substantially between 1999/2000 and 2010/11. The national proportion of people living below the poverty line declined from 45.5% in 1999/2000 to 38.7% in 2010/11 and for Tigray region also reduced from 61.4% to 31.8%. Despite economic growth and the substantial decline of poverty from year to year, child malnutrition[1]is still at high level and continues to be a major public health problem of the country(Christiansen and Alderman, 2004). According to Ethiopia Demographic and Health Survey, 2011 the national levels of stunted, wasted and underweight were 44%,

[1]The country has achieved a remarkable progress in reducing child malnutrition over the past eleven years from 2000 to 2011. i.e. Stunted (58% to 44%), underweight (41% to 33%), and wasting (12% to 10%).Under-five mortality has also declined significantly from 166 in 2000/01 to 88 per 1000 live births in 2010/11 [EDHS,2011].

10% and 29% of the under five children respectively. The figures are the highest among the world even compared with the sub-Saharan countries 34% (FAO,2009). The Ethiopia Demographic and Health Survey, 2011 also revealed that 35.1% of childrenwere underweight (with 9.8% severe underweight), 10.3% of the children were wasted (with 3% severely wasted) and 51.4% of the children were stunted (with 22.4% were severely stunted) whichshowthe prevalence of malnutrition in Tigray is above the national average level.

Even though the secondary sources cited above shows that economic growth is registered in Ethiopia as well as in Tigray and significant reductions in poverty, malnutrition status particularly under nutrition does not show sound improvement in the country and in the study area. Thus, this research paper is supposed to fill the gap in identifying the status of malnutrition, examine the factors influencing malnutrition status as well as identify the major problems that cause child malnutrition. Besides, the study will be helpful by shedding light on intervention areas that need to be pursued by policy makers.

1.3 Research Questions

The following research questions will comprise.

- What is the prevalence of malnutrition among the 6-59 months age of children?
- What factors contribute directly to malnutrition at household level?
- What are the possibilities of improving malnutrition in Central Zone of Tigray ?

1.4 Objectives of the Study

Using data collected by REST (2013) to assess the Impact of safety net program on household livelihood, this analysis seeks to deepen the understanding of determinants of nutritional status of children 6 to59 months old in rural households of the Central Zone of Tigray. The study has the following specific objectives:-

- to measure the prevalence of malnutrition (stunting) among 6months to 59 months age groups in the study area and compare with national average.
- to identify determinants of child malnutrition at household level.

- to give recommendations that improve malnutrition situation of the households in the Central Zone of Tigray.

1.5 Hypotheses of the Study

In line with the theme of the thesis, the following research hypothesis are outlined which are going to be evaluated by making use of econometric analysis.

- Household headed education has a negative impact in child malnutrition.
- Household headed by male has a negative impact on child malnutrition.

1.6 Significance of the Study

Children suffering from malnutrition deserve serious attention not only for keeping them in good health but also on the account that the future world will be in vain without them. The prevalence of malnutrition in Tigray is high (Stunted was 51%, EDHS, 2011) and data on nutritional status of children will help for decision makers.Nutritional indices in the case of children are sensitive indicators and signal serious problems that might require an immediate reaction. The study has provided data on the anthropometric measurements for children aged 6-59 months that are used to calculate nutritional indices. In general good nutritional status improves the health status of the people; theireconomic performance helps to achieve most of MDGs by reducingmaternal and child death rates.Therefore, doing a research, by identifying the determinants of child malnutrition, hopes to provide necessary analytical insights for targeting other zones of the region which might have similar situation to the study area. Moreover, research findings could serve as one source material in the area of malnutrition, other research development planner, and policy makers might also find the research result as an input.

1.7 Scope of the Study

Three different forms of malnutrition are identified, depending on the indicator that is stunting, wasting and underweight: In general, while underweight or wasting may be driven by short-term factors like illnesses or food intake fluctuations throughout the year, stunting is considered a more precise indicator of long-term malnutrition. For this reason,

stunting is also indicated by the WHO as a reliable measure of deprivation (WHO, 1986), and most of the relevant literature on child malnutrition focused on stunting more than on wasting or underweight.

Hence,the study is limited to child under nutrition (stunting) which is the most phenomenon problem in Ethiopia (EDHS,2011) and particularly in Tigray and taking stunting as main malnutrition indicator, while presenting descriptive statistics for all the others.

1.8 Thesis Organization

Chapteronemainly focuses with familiarizing the research topic and research gap of the theme as well as with the definition of the main objective of the research.Chaptertwo deals with the definition and empirical review of related literature on which the hypotheses of the thesis built on.The thesis continues with chapter three which basically focuses on the overview of the study areas, dataset source, and methodological review of the whole study. It lays out the basis for the thesis by providing clear guidelines of the research. In chapter four, a descriptive analysis is pursued in a bid to describe the main socioeconomic, demographic, economy characteristics, and malnourished and nourished child characteristics. An econometric estimation is also executed here, which basically investigates impact and relationship of households' various variables on the determinants of child malnutrition.Finally, chapter five brings the thesis in to culmination by concluding on the main findings of the study and pinpointing policy implications from the main findings, and bringing issues for further research.

CHAPTER TWO

2. REVIEW OF LITERATURE

An attempt is made in this chapter to discuss concepts used in the present study and to review the available literature on the subject of the study.

2.1 Empirical Studies and Definitions

2.1.1. Empirical Studies

Malnutrition remains one of the most common causes of morbidity and mortality among children under five children throughout the world (UNICEF, 2005) and specifically under nutrition is one of Africa's most fundamental challenges for improved human development (Kasirye2010).According to World Bank (2003), child malnutrition increases the risks of death and impairs cognitive development in children, affecting their future productivity and earing's.There is a general decline in levels of child malnutrition at world (de Onis et al., 2004; UNICEF, 2009). An analysis of global trends in the prevalence of child stunting and underweight, covering the period 1990-2000, showed a decline in stunting from 34% to 27%, and a decline in underweight from 27% to 22% (de Onis et al., 2004). According toUNICEF (2009), the proportion of stunting among children under age 5 in the developing world decreased from 40% to 29% between 1990 and 2008.

Prevalence of child stunting is remains high in sub-Saharan Africa. In Ethiopia, Madagascar, Niger, Malawi, Senegal, and Rwanda more than half of children under age 5 are stunted (Kothari and Noureddine, 2010). This persistent high level of stunting is an indication of the challenges of civil conflicts, commodity prices shocks, droughts and floods in these countries (Todd and Meera, 2006).

In Ethiopia the prevalence of child stunting has remained 44%, while underweight is at 26% (EDHS, 2011) coupled with high rates of child mortality, these problems continue to undermine the government's efforts to provide quality healthcare and to reduce levels of

mortality and malnutrition. To realize this objective, the government of Ethiopia has formulated a number of strategies that provide a framework for improving child health. One of the priorities in the Health Sector Development Plan (HSDP) IV is improving child health, with a goal to reduce the under-five mortality rate to 68 per 1,000 live births and the infant mortality rate to 31 per 1,000 live births by 2015 (MOH, 2010 cited in EDHS,2011).Despite these efforts, lack of progress in addressing the key determinants of childhoodmalnutrition, morbidity, and mortality continues to slow the achievement of these objectives. Under-five mortality remains high, at 88 deaths per 1,000 live births in 2011.

2.2 Measurement of Children Nutritional Status

According to EDHS (2011), Child malnutrition is usually analyzed using different dimensions. Due to absence of data related to consumption of calories and micronutrients by children, empirical studies use the standard anthropometric measurements of the child's height, weight and age as indicators of malnutrition. Three commonly used measures are height-for-age, weight-for-height and height-for-weight.

2.2.1Height-for-age

The indicator indicates the prevalence of stunting which can arise as a result of past growth. It gives information on the nutritional situation in the past and indicates whether a child suffers from chronic malnutrition (is "stunted") or not. Failure that is children may have stilted growth due to long-term inadequate care. Moreover, the height-for-age index provides an indicator of linear growth retardation and cumulative growth deficits in children. Children whose height-for-age Z-score is below minus two standard deviations (−2 SD) from the median of the WHO reference population are considered short for their age (stunted), or chronically malnourished. Children who are below minus three standard deviations (−3 SD) are considered severely stunted. Stunting reflects failure to receive adequate nutrition over a long period of time and is affected by recurrent and chronic illness. Height-for-age, therefore, represents the long-term effects of malnutrition in a population and is not sensitive to recent, short term changes in dietary intake.

2.2.2Weight-for-height

This is used to indicate the problem of muscle wasting may have risen from recent and acute constraints whether a child from acute malnutrition (is "wasted") or not. The weight-for-height index measures body mass in relation to body height or length; it describes current nutritional status. Children with Z-scores below minus two standard deviations nutrition of (−2 SD) are considered thin (wasted) or acutely malnourished. Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. Children with a weight-for-height index below minus three standard deviations (−3 SD) are considered severely wasted. The weight-for-height index also provides data on overweight and obesity. Children more than two standard deviations (+2 SD) above the median weight-for-height are considered overweight, or obese.

2.2.3 Weight-for-Age

This indicator is used to detect malnutrition that could occur due to both the current and past constraints of life, it is mainly used to monitor the growth of children. If a child is "underweight" the causes can be "chronic" or "acute" malnutrition. Rapidly changing WFA can be assumed to be the result of changing WFH, while low WFA among older children is more likely to be the result of low HFA. Weight-for-age is a composite index of height-for-age and weight-for-height. It takes into account both chronic and acute malnutrition. A child can be underweight for his/her age because he or she is stunted, wasted, or both. Weight-for-age is an overall indicator of a population's nutritional health. Children with weight-for-age below minus two standard deviations (−2 SD) are classified as underweight. Children with weight-for-age below minus three standard deviations (−3 SD) are considered severely underweight

In general, underweight or wasting may be driven by short-term factors like illnesses or food intake fluctuations throughout the year, stunting is considered a more precise indicator of long-term malnutrition. For this reason, stunting is also indicated by the

WHO as a reliable measure of deprivation (WHO,1986) and most of the relevant literature on child malnutrition focused on stunting more than on wasting or underweight.

2.3 Determinants of Child Malnutrition

The causes of malnutrition are numerousand multifaceted. These causes are intertwine with each other and arehierarchically related. The most immediate determinants are poor dietand disease which are themselves caused by a set of underlying factors;household food security, maternal/ child caring practices and access to health services and healthy environment. These underlying factorsthemselves are influenced by the basic socio-economic and politicalconditions (Müller O, and Krawinkel M, 2005).The main important associated factors of under nutrition include the education, income, and nutritional situation of the parents, access to clean water and sanitation, access to primary health care, sex and age of child.

Factors that are contributing to malnutrition may differ among regions, communities and over time. Identifying the underlying causes of malnutrition in a particular locality is important to solve the nutritional problems. Various studies have been made and conclusions were reached by different scholars in the past regarding predictors of health and nutritional status. Survey of available literature indicated that factors like knowledge of health practices and caring level, educational level of parents, access to or interactions of age of the child have strong effect on household and community variables in which the child grows up Merrill W (1984).Different studies in Africa suggest that malnutrition among boys is consistently higher than malnutrition among girls (Christiaensen and Alderman, 2004; MoFED, 2002a)

Study conducted on malnutrition among under five childrenin Bangladesh revealed that household economic status, mother'seducation, father's education, mother's antenatal visit,mother's ageat birth and mother's BMI are the most significant factor/determinants of child's malnutrition Siddiqi NA, Haque N, Goni MA (2011).Low maternal income and overcrowding were associated with higher prevalence ofwasting. However, no

association was found between the source ofdrinking water or social class and malnutritionSapkota VP, Gurung CK (2009).

Study conductedon prevalence and determinants of malnutrition among Under-fivechildren of Farming Households in Kwara State, Nigeria, malnutritionwere significant associated gender and age of child, education and bodymass index of mother, calorie intake of the households, access to cleanwater and presence of toilet in the households USAID (2007).

In kenyatrends of undernutrition and overnutrition studies conducted among children age 0 to 59 months reported that the effect of wealth index, maternal education, and maternal BMI on child undernutrition changed over time, with wealth and maternal education having a reduced effect. The results suggest an emerging trend of a double burden of malnutrition, with stunted children whose mothers are overweight (Peninah K. Masibo,2013).

Studies showed that household income growth an important determinant of weight for age for children under age five in Tanzania (Alderman et al., 2006). Studies conducted by Saaka and Osman, 2013 reveled that households with high socio-economic status are positively associated with improved dietary diversity and food access, which is extremely important to improve the nutritional status of children.

According to studies conduct by Fentaw*et al*.,2013 children living in households headed by women are more likely to be undernourished because such households have limited access to resources and health services (Louat*et al*., 1993). Female headed households often face financial and time constraints as a result of absence of a partner either due to death or divorce (Schiller, 1996).Access to health services impacts nutritional status as children without access to such services are more likely to be malnourished or exhibit weight loss due to untreated diarrhea and other infectious diseases. In Ethiopia it is estimated that only 38–47% of the total population has access to health services (Degefe and Nega, 2000)

According to the Ethiopian Economic Association determinant of nutritional status of children indicated by wasting and stunting in Ethiopia were found to be child characteristics, maternal education, and economic status of the household, access to the media, child caretakers, education levels of parents and future parents and quality of health facilities contribute positively to nutritional outcome (Ethiopian economic Association)

Study conducted by Bayesian Approach to identify predictors of nutritional status in Ethiopia, the main predictors of children nutritional status were place of residence, maternal education, occupation of mother, Preceding birth interval, source of water drinking, age of child, sex of child, Mother's BMI and age of mothers Tesfaye M (2009).

Study conducted in rural Tigray region revealed that, a very high proportion of the mothers (80%) initiated feeding of newborns with pre-lacteal feeds primarily butter or water. Child age, maternal anthropometric characteristics, inadequate complementary foods,and area of residence were the main contributing factors to child malnutritionMulugeta A, Hagos F, Kruseman G, Linderhof V, Stoecker B, et al(2005). The prevalence of stunting and underweight were significantly associated with the age group of children in Aynalem village in Tigray region. Both highest prevalence of stunting and underweight were observed among the age group of 12-24 months whereas the lowest prevalence of stunting, wasting, and underweight were observed among the age 0-6 months age group Taffesse S, Goitom L (1997).

Variables such as sex and age composition within the household, parental education levels, social capital, marital status, community characteristics, economic shocks and levels of food aid are also presented in the literature as determinants of children's nutritional status (MEKONNEN A., JONES N., TEFERA B, et al.,2005).Lack of knowledge of the magnitude and direction of the impact of most of these variables in Ethiopia affects development of effective policies and deployment of resources. It is important to improve the understanding of the socio-economic determinants of malnutrition in order to develop a more comprehensive policy approach.

Study conducted at Oromia region the main associated factors of stunting were found to be child age, family monthly income, and children were received butter as pre-lacteal

feeding and family planning. Underweight was associated with number of children HHs and children were received butter as per-lacteal feeding. Treatment of water in HHs the only variable associated with wasting (KebedeMengistu, KassahunAlemu and Bikes Destaw 2013).

2.4Child malnutrition Trend in Ethiopia (2000-2011)

Notwithstanding the efforts made to monitor and reduce child malnutrition particularly chronic malnutrition (stunting) in Ethiopia is still suffered by 44% of under-five children (EDHS,2011),one of the highest percentages in the Sub-Saharan countries (FAO,2009).The poverty line decline from year to year while the child malnutrition dose not decline parallel with the decline level of the poverty.

As in the Ethiopian and demographic survey indicated stunting prevalence decreased by 12percent (from 58 percent to 51 percent) between 2000 and 2005(by taking 2000 as base year) and by an additional 14 percent to 44 percent between 2005 and 2011(by taking 2005 2000 as base year). The decline in the proportion of stunted Ethiopian children shows improvement in chronic malnutrition over the past eleven years (EDHS, 2011).A similar pattern is also observed for the proportion of children underweight which dropped by 20 percent from 2000 to 2005(2000 as base year) and 12 percent from 2005 to 2011(2000 as base year).

2.5 Operational Definition of Terms

Malnourished: A child was labeled as malnourished if any of the nutritional assessment indices weight for height, weight for age, or height for age is abnormal.

Stunting: A child was defined as stunted if the height for age index was found to be below -2 SD of the median of the Standard.

Underweight: Refers to a deficit and is defined as underweight below the -2 SD from the NCHS/WHO reference of the median of the standard curve. A severely underweight was diagnosed if it was below -3 SD.

Wasting: Nutritional deficient state of recent onset related to sudden food deprivation or mal-absorption utilization of nutrientswhich results weight loss, weight-for-height below-2SD from the NCHS/WHO median value. Severe wastage was diagnosed if it was below -3 SD.

Anthropometry: Measurement of the variation of physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition by weight-for-age, height-for-age and weight-for-height (WHO, 2000).

The immediate: causes of malnutrition such as inadequate dietary intake and infectious disease, measles.

The underlying: causes such as household food insecurity, Inadequate care of sharing the food within family members, inadequate maternal and child care, inadequate health services and health environment, Unhygienic living conditions and inadequate health services and health environment.

The basic causes: related with political, economic insecurity, and lack of resource. The basic causes at societal level lead to the underlying causes at the house hold level and this leads to immediate causes which finally lead to malnutrition. Sustained healthy and active life is only possible when these underlying determinants food, health, and care are each maximized.

CHAPTER THREE

3. DATA AND METHODOLOGY

3.1 Overview of the Study Area

3.1.1 Setting and demographics

Tigray is located in the North most part of the Country. It stretches along $12^0 15'$-$14^0 57'$ North to $36^0 27'$-$39^0 59'$ East. The total landmass of the region is 54,572.6 Sq.km (BoFED), The central zone of Tigray is bounded to the North with Eritrea, to the West with the North Western zone, to the East with the Eastern zone and to South with South Eastern zone of the region and Amhara region. With total area of 9,358.36 Sq.km., Central zone is located in between the geographical coordinates of $38^0$25' to $39^0$20' East and $13^0$10' to $14^0$38' North. This zone is one of the densely populated (127 people per km^2) areas of the country with huge potential work force which comprises of well-known historical mountains like Soloda of Adwa, Work-Amba of Temben, Mountain-chains of Ahsa'a and the miraculous monuments of Axum. Rivers like Tekeze and Mereb with 608 and 440 kilometers in total length respectively (CSA, Statistical Abstract, 2006) and having huge annual water runoff including their tributaries are also found in this zone.

According to the CSA projection for July 2008, the total population of the region is 4 million, of which about 51% are female. While for the central Zone has a total population of 1, 245, 824, of whom 49% are men and 51% women.

3.1.2 Socio-economic conditions

The traditional production system of low-input mixed farming, described as a drought spatial adaptive mechanism, is common in all districts. Most households use traditional production techniques. Traditional techniques of farm production include wooden plows, ox-plowing, and hand sickles.The primary objective of households is to satisfy subsistence food requirements. The cropping system is mainly based on cereals: teff, wheat, and barley producing the staple diet. Livestock is an indispensable component in the subsistence economy in the study areas.

The study areas are predominantly sedentary agriculturalists and subsist mainly on the plough cultivation of cereal crops, and animal husbandry also plays a secondary role. The ecological setting of farm is dry with little surface water and subject to irregular rainfall. The study areas subsist mainly on the plough cultivation of cereal crops. The chief subsistence crop in the areas is barley. Apart from this, maize, *teff*, red sorghum, lentils, and linseed are also grown in the areas and total annual harvest production of the zone is 11.9 million quintal on average and have total 195, 299 hectare of land is available which is for harvesting (Annual Report Central Zone Administrative 2005).

The rural economy of Tigray in general and central zone in particular is mainly one of subsistence in which the produce is largely consumed by the household. This does not mean that all that is produced is necessarily consumed by the household. It only means that the primary aim of production is consumption, not sale.

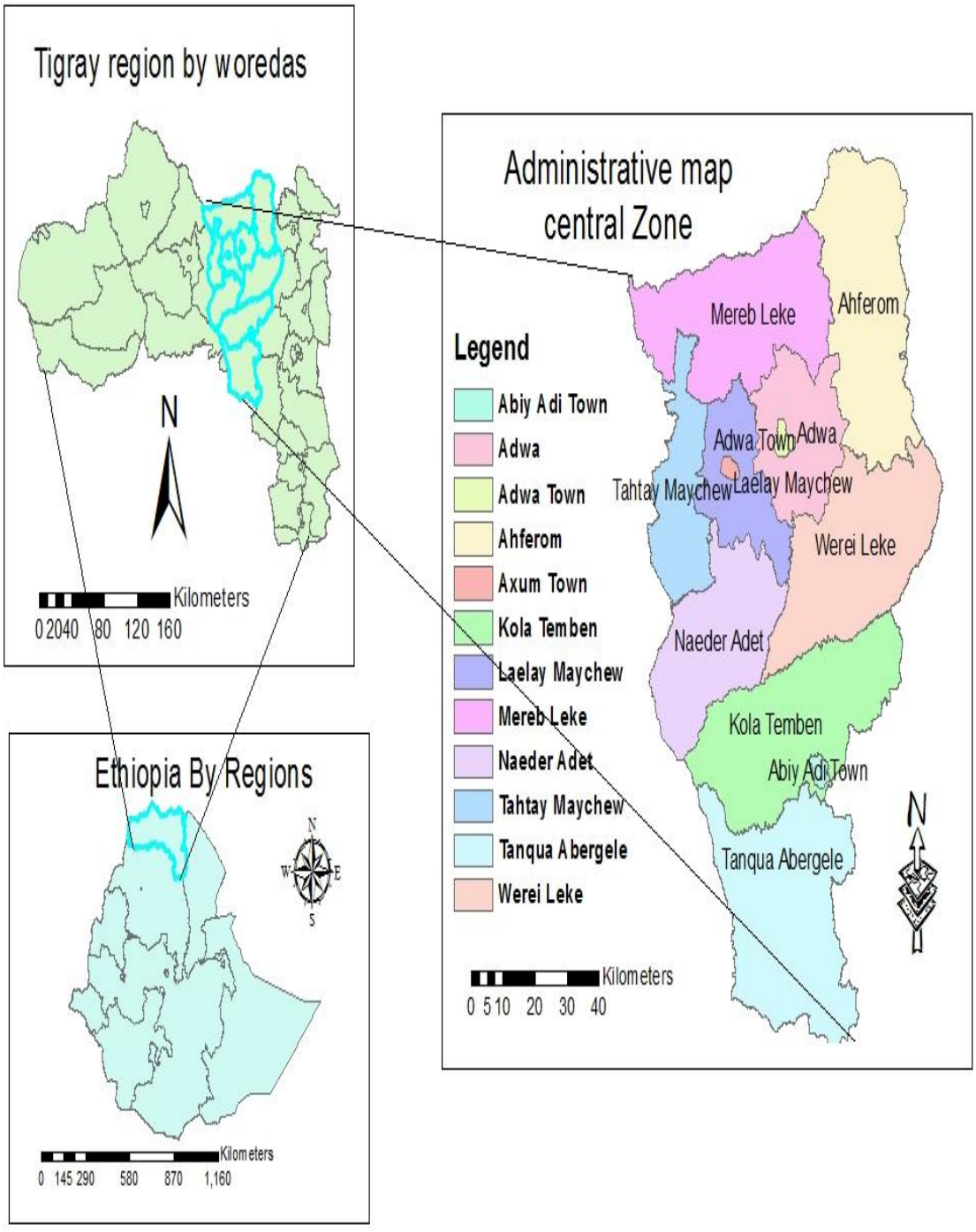

Figure 3.1: Map of Tigray

3.1.3 Infrastructure

Central zone has improved its infrastructure facilities especially in the last ten years since 2004. Services like road condition, telephone, and electricity and health facilities. The zone has 523 primary, 38 secondary and preparatory,5 TVET, 2 collage and 1 university which is Axum university. Moreover, there is 3 hospitals, 2primaryhospital, 57 health facilities and 170 health posts are available in this zone. Clean water coverage for the rural area is 80%(AnnualReportCentral ZoneAdministration, 2013/14BY).

3.2 Data Source

The study analyses the determinants of child malnutrition. The data for this paper was drawn from a cross sectional dataseta total sample of 600 rural household surveys conducted by REST (2013) obtained from the study areas. Over 254 children under five years with complete and plausible anthropometric data were used. The original dataset for the child had a sample size of 362 children with anthropometric data. When height-for-age values less than -6 and greater than +6 standard deviations were excluded from analysis as recommended by CDC/WHO to eliminate all possible outliers and by removing under and older children 6-59 months the sample size was reduced to 254. Hence,the studyfocusedon 6-59 months age.

In 2013, REST conducted a survey in 12 Woreda form all zone ofTigrayregions to assess the impact of safety net program in the rural areas of these woerda.The major data input for the study is cross sectional which is important to analyze the most economic variables of the study and then necessary data manipulation and analyzes has been made using descriptive statistics analysis and econometrics analysis mainly logistic regression model.

3.3 Method of Data Analysis

3.3.1 Descriptive Statistics

Descriptive statistics gives a clear picture of the characteristics of children under five years which problem of malnourished and not. By applying descriptive statistics, one can describe, compare, and contrast different categories of sample unit (child stunted/ malnourished and not) with respect to the desired characteristics. In this study, descriptive statistics, such as mean, standard deviation, percentages, frequency of occurrence, t-test and chi square, has been used, along with econometric models, to analyze the collected data.The models with indices are compared to a preexisting model in order to identify immediate and underlying determinants of height-for-age (HAZ) Z-scores (an indicator of long-term health and nutritional status) in Central zone of rural Tigray and examine the relative impact that changes in these factors.

3.3.2Anthropometric

The analysis was conducted by Anthropometric indices data (to convert nutritional data into Z-scores of the indices: Height-for-age, weight-for-age and weight-for-height Z-scores) computed using **SMART Nutrition Survey Software** developed by Dr. Juergen and Prof. Micheal (WHO, 2006[2]).Moreover anthropometric data used as indicators of malnutrition height-for-age, weight-for-height and weight-for-age Z-scores, with the 2006 WHO growth scale as a reference. This way of measuring malnutrition has the advantage that it only needs information on age, height and weight of children. Other methods like using clinical signs or biochemical indicators need more and deeper information, rarely available from non-specific household surveys.In particular, I preferred to focus on height-for-age, weight-for-age and weight-for-height 3 indicators in

[2] The new standards are based on children from Brazil, Ghana, India, Norway, Oman and the United States of America. They are designed to describe how all children should grow, and not how they actually grew in a single reference population at a specified time (Van de Poel et al.,2008).

the form of Z-scores, which compare children's values with a well-nourished reference population (WHO, 2006).

To assess the chronic nutritional status of children,I used height-for-age z-scores following the Child Growth Standards of the World Health Organization. The height-for-age z-score, as defined by WHO, expresses a child's height in terms of the number of standard deviations above or below the median height of healthy children in the same age group or in a reference group.I classified children as being stunted if they had a height-for-age z-score of less than−2(WHO, 2006).

3.3.3 Logistic regression model

In order to further analyze the determinants the most commonly used qualitative response logistic regression model Ferder et al(1985) was employed. To define child malnutrition, I followed the national report of Ethiopia EDHS, 2011 and the guidelines of the World Health Organization (WHO, 2006).According to these reports; a child is malnourished if the Z-score is below -2 standard deviation (SD) from the median of the reference population. The dependent variable in this study was expressed as the number of under-five malnourished children in the study area.The dependent variable pi, which is binary variable with value 1if malnourished, in respect to child stunting (z-score less than 2) otherwise 0.

These models specify a functional relation between the probability being malnourished child and various explanatory variables. Hence, factors (independent variables) that affect child malnutrition can be expressed both quantitatively and qualitatively.

The study attempts to develop logistic regression model to identify the determinants of child malnutrition using the cross sectional data REST project area Survey (Central Zone of Tigray).

$$\mathrm{P}_i = \frac{1}{1+e^{-Z_i}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where P_i is the probability of malnourished (Specifically undernourished)?

– Z_i is a function of n-explanatory variables(x) expressed as:

$$Z_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{in} X_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

β_0 is the intercept

β_0 , $\beta_2 \ldots \beta_n$ are coefficients of the equation in the model

$$P_i = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{in} X_n)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Therefore, taking the ratio of the probability of Malnourished to well nourish can be written as:

$$\mathbf{1 - P_i = \frac{1}{1 + e^{Z_i}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)}$$

- Therefore, taking the ratio of the probability of Malnourished to well nourish can be written as:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Now $\frac{P_i}{1 - P_i}$ is simply the odds ratio in favor of Malnourished in well nourished.

It is the ratio of the probability that the child will malnourished to the probability that the child will nourished/normal. Finally taking natural log of equation 5 we get:

$$L_i = \ln \frac{P_i}{1 - P_i} = Z_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_n X_{in} \text{ --(6)}$$

Where, Li is log of the odds ratio, which is linear not only in X, but also in the parameters. Thus, if the stochastic disturbance term (Ui) is introduced, the logit model becomes:

$$Z_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{in} X_n + U_i \text{ ---------(7)}$$

In this study, the above econometric model was used to analyze the data. The model was estimated using the iterative maximum likelihood estimation procedure.

3.3.3 Parameter estimation

Estimation of the values of the unknown parameters Bo and Bi's is required in order to fit the logistic regression model. Unlike the linear regression which uses the least square estimation (OLS) method, this model estimates the parameters using the Maximum Likelihood (ML) method (Maddala, 1992, Gujarati, 1988). Due to the non-linearity of the logistic regression model, an iterative algorithm is necessary for parameter estimation. Maddala (1992) pointed out that of ML is a very general method of estimation that is applicable to a large variety of problems. In many cases, it is convenient to maximize the logarithm of the likelihood function rather than the likelihood function itself and the same results are obtained.

It is necessary to check for the existence of higher multi-collinerarity among the continuous variables and verify the degree of association among discrete variables before taking the selected variables into the logit model. The reason for this is that the existence of higher multi-colliniarity results in substantially higher standard error (or low t-static) and non-significant coefficient. Using collin the Variance Inflation Factor (VIF) was used to test for the existence of multi-collinearity between continuous explanatory variables. As a rule of Thumb, Values of VIF greater than 10 is often taken as a signal for the existence of multi-collinearity problem in the model (Gujarati, 1995). Moreover, condition index is computed and if the value is greater than or equal to 20, it is possible to expect that there could be a potential problem. However, our results show very low level of value indicating that there is no serious multi-collinearity problem in our parameter estimation.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Descriptive Statistical Analysis

Discussions in the last two chapters have laid the theoretical and methodological foundations for the subsequent descriptive and empirical analysis to be made in the coming two sub sections. As such trying to give answers to the central research questions, this section has been primarily focused on the first objective so as to reach some conclusions. The main theme of this section is, therefore, to analyze demographic characteristics, farm economy characteristics, child characteristics of the study area in a descriptive sense. As a preliminary discussion, this section provides analysis of household's various socioeconomic attributes that have influence on the nutritional status of children.

4.1.1 Socioeconomic and demographic background

Of the 254 sample respondents, 82 percent reported that they were participating in agricultural cultivation activities, while the remaining 18 percent of the respondents reported that they were not engaged in any farm activities. From the total sample household 254majority of the households (70%) are male-headed households and the remaining 30% female headed household. The table below signifies that the sampled household's head comprises various age groups ranging from 21 to a maximum of 80 years and the mean age of household head in the sample was 39.8 years, indicating that household heads in the area were relatively young.

Table 4.1: Descriptive Statistics of Household Characteristics for continuous Variable

SN	Variable	Stunted (Malnurished)		Not Stunted (Normal)		t-value	Total	
		Mean	StDev	Mean	StDev		Mean	StDev
1	Household head age	38.8	8.9	40.9	0.8	-1.68	39.8	0.6
2	Household family Size	5.7	1.7	5.7	1.7	-0.073	5.7	1.7
3	Oxen ownership	0.8	0.8	0.8	0.8	(0.287)	0.8	0.8
4	Radio Ownership	0.2	0.4	0.3	0.5	0.496	0.3	0.4
5	Child Birth Interval	21.8	10.2	36.1	14.2	9.3***	28.8	14.2
6	Child age	33.1	14.0	31.6	15.7	-0.81	32.4	14.8
7	Number of month's food availability Farm Resource and safety net program	10.0	2.3	10.0	2.1	(0.20)	10.0	2.2

Source: Own Computation
NB: ***, **,* significant at <1%,5% and 10% probability

The average family size of the sample households is found to be about 5.7 persons, which is above the regional average 4.3(CSA, 2008); the largest family size being 11 and the smallest is being 2 in the study areas. For the malnourished and nourished child households the average family size is 5.67and 5.66 respectively.Moreover,the average birth space of children in the survey area is 28 months and the minimum is 6 months age. Out of the 254 children in the sample households, 53% were male, while 47% were female. The mean age of children was approximately 33 months and the minimum and maximum age of the sample children is 6 and 59 months.

The t-test shows significant difference between the stunted and not stunted households with respect child birth interval.However, there is no significant difference between the two household groups in terms of household family size, age of household, oxen ownership, radio ownership, number of month's food availability farm resource and safety net program.

Table4.2: Descriptive Statistics of Household Characteristics for Contingency Variable

SN	Variable	Stunted (Malnurished)	Not Stunted (Normal)	P-value
	Household Head Sex_Male	75	65	
1	Household Head Sex_Female	25	35	0.080*
2	Household Head education	34	87	0.000***
3	Availability of latrine	68	81	0.019**
4	watersource	83	93	0.02**
5	Use of Treated Water	82	92	0.023**
	Child Sex_Male	65	41	
6	Child Sex_Female	35	59	0.000***

Source: Own Computation
NB: ***,**,* significant at <1%,5% and 10% probability

Clean water and toilet facilities are indicators of healthy environment which can improve child health and nutrition. The result show that about 72% of the households have access to clean water/protected water, while 74% have sanitary toilet in their house.The t-test shows significant difference between the stunted/malnourished and not stunted/normal of children with respect to household sex, household education, and availability of latrine, water source, use of treated water and sex of child.

Table4.3: Marital Status by Household Groups

		Stunted		Not Stunted /Normal		Total Sample	
SN	Marital Status	N	Share_%	N	Share_%	N	Share_%
1	Married	99	76.2	95	76.6	194	76.4
2	Divorced/Separeted	25	19.2	20	16.1	45	17.7
3	Widowed	4	3.1	8	6.5	12	4.7
4	Single	2	1.5		-	2	0.8
5	Married more than one		-	1	0.8	1	0.4
	Total Observation	**130**	**100.0**	**124**	**100.0**	**254**	**100.0**

Source: Own Computation

As can be noticed in table above, the marital status of the households indicates that about 76% are married with single spouse, and others like divorced/separated, widowed, married more than one and single with 17.8%, 4.8%, 1.1% and 0.7% respectively. Overall, it can be concluded from this data that separation (24%) is pervasive among the sample households.

4.1.2 Farm economy characteristics

Land

Land owner ship is one of the major determinants of the socio economic livelihood of the rural population. The average size of the land holding owned by a household is about 2.6 tsimad, the maximum and the minimum being 13tsimad and 0tsimad, respectively.

Table4.4: Land Use of Households in Hectare

Variable	Obs	Mean	Std. Dev.	Min	Max
totaplotsize	254.00	2.56	2.41	-	13.00

Source: Own Computation

Table 4.5: Land Size of Households by their Nutritional Status

SN	Land Size Class Interval	Stunted		Not Stunted /Normal		Total Sample	
		N	Share_%	N	Share_%	N	Share_%
1	0	30	23.1	23	18.5	53	20.9
2	<=1	20	15.4	16	12.9	36	14.2
3	1-2	33	25.4	39	31.5	72	28.3
4	3-4	10	7.7	13	10.5	23	9.1
5	4-5	20	15.4	17	13.7	37	14.6
6	**X>5**	**17**	**13.1**	**16**	**12.9**	**33**	**13.0**
	Total Observation	**130**		**124**		**254**	

Source: Own Computation

In the study area the case of land holding is characterized by the smaller plots of land.This could be due to the reason that the lands of households have been divided and being given to the adult sons and daughters. Asindicated in the table above 20.9% of the households do not own any plot of land. In addition, about14.2% possess less than 1Tsimad of land, 24.2% of household owns less than 2 Tsimadwhere one hectare equals to 4 Tsimad.There is also about27.6%farming households who own land size of more thanone hectare.

4.1.3 Livestock Production

In the study area livestock are used for different purposes. Cattle are used especially for milk and meat, source of income and as drought power. Equines are used for transportation; sheep and goat are also source of income. The households also obtain income from the sale of animal products such as eggs, honey, cheese, butter, milk, skin and hides. In the study areas, the average total livestock unit (TLU) of the malnourished child households was 2.47, while 2.35 for the nourished child household as indicated in the table below.

The average number of assets owned per household is found to be 0.74, 1.1,1.6 and 2.5 for, oxen, sheep & goat and chicken, respectively. This implies that large numbers of households do not own two oxen minimum number required to till their land.

Table 4.6: Livestock Ownership of households by their Nutritional Status

SN	Livestock Type	Stunted		Not Stunted /Normal	
		Mean	StDev	Mean	StDev
1	TotalLivestok birr	11,466	11,651	11,466	12,408
2	Livestok no	5.47	5.73	5.14	5.42
3	Tropical Live stock Unit(TLU)	2.46	2.16	2.35	2.1
4	TotalLivestok NO				
	Oxen	0.77	0.78	0.74	0.81
	Clves	0.35	0.51	0.37	0.53
	Bull	0.18	0.44	0.13	0.42
	Heifers	0.16	0.39	0.18	0.41
	Local Cows	0.53	0.67	0.54	0.76
	Improved cows	0.03	0.20	0.04	0.20
	Sheep	1.05	2.36	1.25	2.65
	Goats	1.75	3.45	1.37	3.04
	Donkey	0.57	0.72	0.52	0.63
	Horses	0.06	0.74	-	-
	Mules	-	-	-	-
5	Bee Number	0.12	0.44	0.09	0.44
6	Chicken Number	2.45	3.16	2.86	3.89

Source: Own Computation

Table4.7: Number of Oxen Owned by Individual Household

SN	Oxen owned Class Interval	Stunted		Not Stunted /Normal		Total Sample		Cumla%
		N	Share_%	N	Share_%	N	Share_%	
1	0	58	44.6	56	45.2	114	44.9	44.9
2	1-2	71	54.6	67	54.0	138	54.3	99.21
3	3-4	1	0.8	1	0.8	2	0.8	100.00
	Total Observation	**130**	**100.0**	**124**	**100.0**	**254**	**100.0**	

Source: Own Computation

In the study areas, land preparation is carried out mainly using oxen. The land is ploughed 2 to 3 times before planting especially for field crops. Like in most parts of Ethiopia, draught animals in the region are used as sources of ploughed for farming. A significant number of farmers have no or only one ox for the purpose of farming. According to the study, about 44.9% of the households did not possess any oxen; while those who owned only 1-2 oxen formed 54.3% in the samples implying 81.4% of the respondents had two or no oxen. In the study areas, households possessing a maximum three up to five oxen consists 0.8% of the total sample households.

4.1.4 Sufficiency of Own Crop Production and PSNP Source

The findings on the table below presents on how long household's current year own crop production and PSNPsource lasts in feeding the households.Out of the total households in the study area, 47 percent reported to have enough own production and PSNP source that lasts for above 11 months in feeding the households. About 26 percent of the households reported that their crop production and PSNP could take them at least 10 months while 28 percent of the households believe that from both source lasts 2-8months, 97 percent have indicated that their production could take those five to twelve months. On the other hand, only 3 percent of the households reported that their current year production and PSNP source sufficient for up to four months. From this it is observed that about 47% of the total household their food is secured throughout the year while more than half of the survey household could not able to cover the whole year from both source.

Table4.8TheNumber of Months that OneYear's Production and PSNP SourceSubsists

SN	Class interval (Months)	Stunted		Not Stunted /Normal			
		N	Share_%	N	Share_%	N	Share(%)
1	2-4	3	2	1	1	4	2
2	5-6	5	4	9	7	14	6
3	7-8	28	22	24	19	52	20
4	9-10	32	25	33	27	65	26
5	11-12	61	47	56	45	117	46
6	X>13	1	1	1	1	2	1
	Total No of observation	**130**	**100**	**124**	**100**	**254**	**100**

Source: Own Computation

4.1.5 Age and Sex Composition of Children

Total 254sample children were drawn from the central zone for further anthropometric analysis. Among these children 53% are male and the remaining 47% are female children. The proportion indicates that there was more male representation in terms of gender. The mean age was 32.4 months. The mean height and weight of the children in the central was 84.6cm and 11.6kg respectively.

Table4.9: Age and Sex Composition of Children

SN	Child age Class interval(Months)	Boys		Girls		Total Sample		Ratio
		N	Share (%)	N	Share (%)	N	Share (%)	Boys:Girls
1	6-17	26	19	18	15	44	17	1.44
2	18-29	41	31	37	31	78	31	1.11
3	30-41	26	19	22	18	48	19	1.18
4	42-53	34	25	31	26	65	26	1.10
5	54-59	7	5	12	10	19	7	0.58
	Total Observation	**134**	**100**	**120**	**100**	**254**	**100**	**1.12**
			53		47		100	

Source: Own Computation

4.1.6 Nutritional Status of Children

4.1.6.1 Prevalence of malnutrition

Using each of the three indicators (weight-for-height, height-for-age and weight-for-age), in addition to Z-scores, the data classified as the child is wasted, underweight or stunted.

The results shows that ,as expected, the mean value of the z-sores is negative for each of the three indicators as indicated in the table 4.10 below with mean height–for- age being the lowest of the three indicators(-1.82)followed by mean weight-for-age(-1.38)and the highest recorded was weight-for-height(-0.36).A cut–off value of -2 standard deviations was used to define stunting (low height-for - age) underweight (low weight-for –age) and wasting (low weight-for– height).The proportion of underweight is 19%,while those who are stunted and wasted are 51% and 5.19% of the sample population respectively. When comparing this data with the national data of DHES,2011 presented in table 2 annex the percentage of total sample, the children in the survey sample are less wasted (5.19% compared with 9.7) but more stunted (51% compared with 44). The data also illustrates that the children of the central zone are malnourished in all indicators but the highest is for T/abergele,K/temben and W/leke.

Table 4.10: Anthropometric Measures for all Sample Woreda

SN	Indicators	Obs	Mean	Std. Dev.	Min	Max	%
1	Weight -for-age (waz)	254	(1.38)	1.09	(4.63)	3.30	18.50
2	Height-for-age(haz)	254	(1.82)	1.47	(5.41)	2.70	51.18
3	Weight-for-height(whz)	254	(0.36)	1.16	(3.97)	3.41	5.91

Source: Own Computation

4.1.6.2Child Acute Malnutrition Level (Wasting_ Weight-for-height)

Child Acute Malnutrition (Wasting) by Study Area

According to the findings of the survey, the prevalence of wasting in the rural central zone is 5.9% (15 children out of 254) were found below -2 Z-score and the average level of wasting for the sample survey was about 0.94.Results of EDHS in 2011 indicated that the prevalence rate of wasting for Tigray was 10.3 percent. Prevalence of wasting by gender suggests a possibility of bias with boys suffering higher degree of acute malnutrition than girls. Prevalence of wasting for boys is higher by about 33 percent than girls and in all weredas female children are better–off than their male counterparts interims of nutrition. The results of the survey in relation to age of a child revealed that the prevalence of wasting consistently shows a decreasing trend as the age of child increases. The prevalence of wasting is lower for children of age three years and over and is highest for children aged 6 months to 17 months.

Table4.11: Acute malnutrition (Wasting) by Sex and Woreda

Description	Woreda Name					Total
	Mereblek	Ahferom	T/Abergel	Kola temb	W/leke	
Wasted						
Boys	1	1	4	3	1	10
Girls			2	2	1	5
Total	**1.0**	**1.0**	**6.0**	**5.0**	**2.0**	**15.0**
%	**0.4**	**0.4**	**2.4**	**2.0**	**0.8**	**5.9**
Normal						
Boys	14	25	31	35	19	124
Girls	15	14	32	37	17	115
Total	29	39	63	72	36	239
%	**11.4**	**15.4**	**24.8**	**28.3**	**14.2**	**94.1**
	30	40	69	77	38	254
Total Observation	**11.8**	**15.7**	**27.2**	**30.3**	**15.0**	**100.0**

Source: Own Computation

The table also signifies that wasting level for Merebleke and Ahferom is relatively lower than the prevalence of wasted for Tanqu-abergele, Kolla-Temben and W/leke. Therefore, the nutritional status of sample children is relatively better in Merebleke and Ahferom respectively.

4.1.6.3Chronic malnutrition (Stunting) Level

Stunting Levelby sex and age

According to the survey results, 51.18 percent of the total children aged 6 to 59 months in rural part of central zone suffer from chronic malnutrition. Reports on EDHS show that malnutrition in Tigray as of 2011was nearly 51 percent. Distribution of stunted children by gender suggests that at rural central zone level female children are more vulnerable to long-term malnutrition thanmale children. The prevalence at zone levelis 56 percent among boys and 47 percent among girls (see table 4.12) The prevalence of stunting by age and gender (see table 4.12) reveals that prevalence of stunting is highest for boys and girls at age group 18 to 29 while the lowest stunting for both sex was observed at age group 6 to 17 and 54-59 months for 6 to 17 which could likely be due to breastfeeding practices during infancy. Despite these variations across age groups, the prevalence of stunted 51 percent, and suggesting widespread malnutrition in all age group of the sampled children.

Table 4.12: Stunting Level by Sex and Age

		Stunted						Not Stunted /Normal					
	Age Class	Male		Female		Total		Male		Female		Total	
SN	Interval(M0nths)	N	%	N	%	N	%	N	%	N	%	N	%
1	6-17	11	15	6	11	17	13	10	17	17	27	27	22
2	18-29	23	31	21	38	44	34	21	35	13	20	34	27
3	30-41	17	23	9	16	26	20	11	18	11	17	22	18
4	42-53	19	26	15	27	34	26	13	22	18	28	31	25
5	54-59	4	5	5	9	9	7	5	8	5	8	10	8
	Total Observation	**74**	**100**	**56**	**100**	**130**	**100**	**60**	**100**	**64**	**100**	**124**	**100**

Source: Own Computation

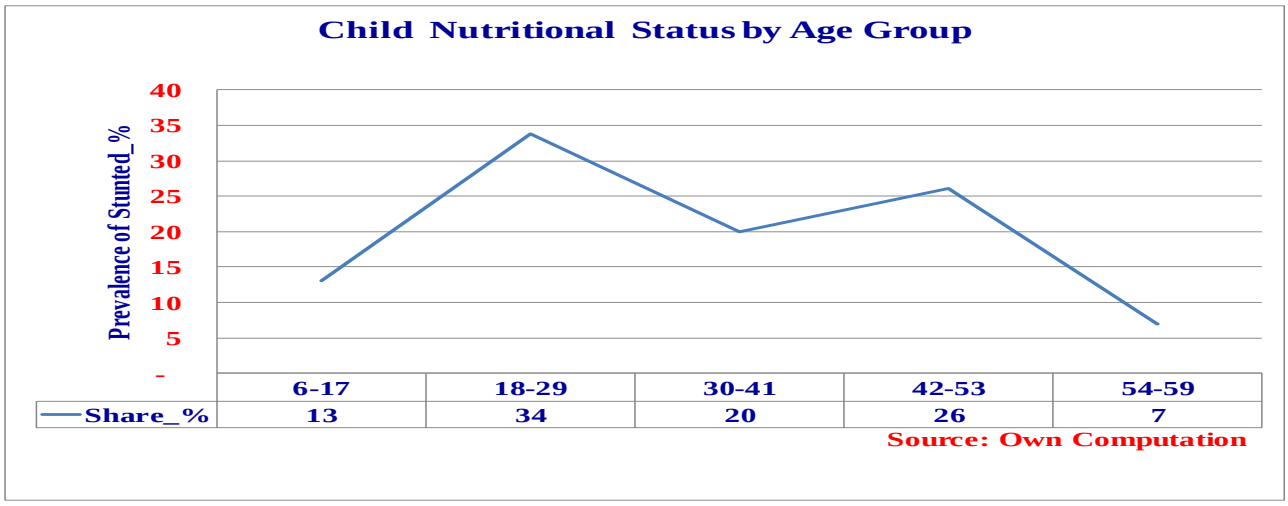

Figure4.1: Child Nutrition Status by Age Group

Chronic Malnutrition (Stunting)by Area

In relation to the aggregate level of stunting, the occurrence of stunting is relatively higher in k/temben and T/abergeleworedas compared to other woreds.This indicates that the chronic food insecurity is relatively lower in Mereblekewereda.

Table 4.13: heightage indicator by area

SN	Height-Age indicators	Merebleke		Ahferom		T/abergele		Kola Temben		W/Leke		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Prevalence of Stunted	12	40.00	23	56	34	49	39	51	22	58	130	51
	Not Stunted	18	60.00	17	41	35	50	38	49	16	42	124	49
	Total Observation	**30**	**100**	**41**	**100**	**70**	**100**	**77**	**100**	**38**	**100**	**254**	**100**

Source: Own Computation

4.1.6.4Child Prevalence of Underweight

Weight-for-age is a nutritional status indicator of malnutrition (either acute or chronicMalnutrition) based on the principle that a child has an expected weight for his/her age. Weight-for-age index measures the general nutritional status of children. It is a nutritional deficiency caused by recent and past malnutrition.The findings of the survey revealed a prevalence rate of 18.5 percent in rural central zone of Tigray and the average

of underweight is 0.81. About 35% children in Tigray were observed to be underweight in EDHS, 2011. The level of underweight and gender of a child shows gender bias. The prevalence of underweight is higher among boys (23 percent) than girls (14percent).Acute malnutrition is significantly higher in male children from T/abergelewereda than that of other weredas. The table also shows that in all weredas female children are better–off than their male counterparts' interims of nutrition.

Distribution of malnourished children by age describes in the table below exhibits that prevalence of underweight is lowest among younger children (6-17 months) and 18-23for boys and girls respectively. The proportion of low weight-for-age declines as the age of the child increases for boys.

Table4.14: Prevalence of Underweight by Sex and Age

		Underweight_Waz<-2						Normal_Waz>-2					
	Age Class	Male		Female		Total		Male		Female		Total	
SN	Interval(M0nths)	N	%	N	%	N	%	N	%	N	%	N	%
1	6-17	9	30	1	6	10	21	12	12	22	21	34	16
2	18-29	5	17	6	35	11	23	39	38	28	27	67	32
3	30-41	5	17	1	6	6	13	23	22	19	18	42	20
4	42-53	8	27	5	29	13	28	24	23	28	27	52	25
5	54-59	3	10	4	24	7	15	6	6	6	6	12	6
	Total Observation	**30**	**100**	**17**	**100**	**47**	**100**	**104**	**100**	**103**	**100**	**207**	**100**
							18.5						81.5

Source: Own Computation

4.1.7 Source of Drinking Water

As it is illustrated in table below about 80% of the sample households have the access to safe water (protected dug well, piped water and borehole water).Households that have reported protected well/spring as their source of drinking water constitute 5 percent. The survey also reveals that a very high proportion of households (49 percent) have reported to use borehole as source of drinking water and next to borehole many people (24%) have the access to pipe water as a source. About 20 percent are also found to have reported unprotected well spring, ponds, rivers and stream as their source of drinking water.In this regard 94% from Kolatemben, 100% Ahferom, 45% from T/abergele, 97% from Merebleke, and 74% fromW/leke getting water from protected water.

Table4.15:Main Household Water Sources

SN	Sources of Drinking Water	Merebleke		Ahferom		T/abergele		Kola Tembe		W/Leke		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Piped water	19	63	21	53	2	3	8	10	12	32	62	24
2	Bore hole	10	33	17	43	23	33	62	81	13	34	125	49
3	Protected Dug Well	-	-	2	5	1	1	2	3	3	8	8	3
4	Protected Spring	-	-	-	-	5	7	-	-	-	-	5	2
5	Unprotected Well	-	-	-	-	-	-	-	-	-	-	-	-
6	Unprotected Spring	-	-	-	-	26	38	4	5	-	-	30	12
7	Pond,River or Strem	1	3	-	-	12	17	1	1	10	26	24	9
	No of Observation	**30**	**100**	**40**	**100**	**69**	**100**	**77**	**100**	**38**	**100**	**254**	**100**

Source: Own Computation

The basic water storage material for 93%of the sample household is narrow neck/covered container, and90%of them don't apply any type of water treatment mechanisms to make the water safer to drink.Only10% householdsboil, addchlorine, strain through cloth or let the water stand and still.

4.1.8 Availability of Latrine facility

Availability of latrine facilities for households helps in lessening the spread of disease associated with poor sanitation. The data enables to assess the extent of availability of toilet facilities in the survey area. It can be observed from table below that the majority of the households (72percent) have the opportunity to use private pit latrine while, 28 percent of the households do not have latrine facilities. This indicatesthe level of awareness on sanitation has been improved at community level.

Table 4.16: Availability of Latrine by Woerda

SN	Wereda Name	No latrine		Own Latrine		Total	
		N	%	N	%	N	%
1	Merebleke	5	7	25	14	30	12
2	Ahferom	20	29	20	11	40	16
3	T/abergele	11	16	58	32	69	27
4	Kola Temben	23	33	54	29	77	30
5	W/Leke	11	16	27	15	38	15
	No of Observation	**70**	**100**	**184**	**100**	**254**	**100**
	Share(%)		**28**		**72**		**100**

Source: Own Computation

4.2 Econometrics Analysis

4.2.1 Introduction

In the previous section, it has been attempted to point out household socioeconomic and demographic background, economy characteristics, sanitation availability, child characteristics and malnutrition indicators in a descriptive sense. In doing so, the first research question has been dealt with. Some of the descriptive analyses in the previous section as well laid the ground for the forthcoming econometric analysis. This section will follow on the determinants of child malnutrition particularly stunted and its relationship with various socioeconomic, individual and child characteristics. In this regard logit model is used. Before applying the model, indices and variables' measurement specifications are developed and explained for socioeconomic and demographic variables, malnourished attributes, and nourished child characteristics. Then the model is estimated using the econometric software, STATA. By doing so, this section aims to give answers to the other research question and meet the objectives set in chapter one.

4.2.2 Specification and explanation of variables

The variables used in the analysis and their theoretical expectations about the sign and magnitude of these variables on the malnourished are specified and explained below. These variables were chosen based on the available literature. In order to make the estimation of the model more clear and make it easier for the reader to understand, the variables used are discussed below.

Dependent variable of the model: The dependent variable for logit analysis is dichotomous in nature. It is represented in the model by "1" for those who stunted/malnourished children and by "0" otherwise.

Independent variables: Based on literature review and past experience, the following factors are expected to influence the participation in the child malnutrition.

Age of Household Head

This is a continuous explanatory variable designating age of thehousehold head. It is hypothesized that older age of the household head is positively associated to the child malnutrition. This variable represents the number of years the household head has lived so far running from 17 to a maximum of 80 years;

Sex of Household Head

Sex refers to the sex of the household head and also provides indications of what resource is available for improved nutrition in the household. Very young, less educated and female-headed households are more likely to have malnourished children than others, For the purpose of this study, dummy specification is adopted coding male household heads as "1" and female household heads as "0".

Household familySize

Family Size: - It is hypothesized that family size is expected to have positive association with child malnourished, as family size increase child malnourished increase.Andit is a continuous variable.

Household HeadEducation:

Different studies recognize the important role that household/individual characteristics and parental levels of education play in shaping child nutritional outcomes.Moreover various studies also show that parental education especially that of mother has significant effect on child status this is a dummy variable classified as ability to read and write. Education is expected to have a negativeeffect onchild malnourishment. In this regard, literates are coded as "1" and illiterates as "0"; the educational status goes up until 8 years of formal education.

Oxen ownership: This is defined as the number of oxen a household possesses and it is a continuous variable. It is expected to have a negative relationship with the child malnourishment, because households who own more oxen able to plow their land effectively and this is expected to earn more income and able to secured their food.

Number of month's food availability Farm Resource and safety net program

Food security is expected to affect the general nutritional status of households.in this case the number of months covered food consumption which is sourced from the farm output and safety net program is expected to influence negatively the child malnutrition status. However, the distribution of food within the household could also be an important issue, particularly for children whose welfare depends on the decisions and actions of adult members of the household.It is a continuous variable.

Radio Ownership

Radio ownership is a continuous variable, was included in the analysis separately since, in addition to being indicator of wealth, it also indicates access to information that may influence childcare behavior. We see from the data that radio is owned by 27% of the households in the study area and expected negative effect on the child malnutrition.

Availability of latrine facility

Availability of toilet is related to sanitation of an environment and reduces the probability of infectious diseases and indirectly causes certain types of malnutrition and expected to have negative effect on the child malnutrition which is stunting.For the purpose of this study, dummy specification is adopted coding yes latrine availability in the household as "1" and No available of latrine "0".

Source of water

Unfavorable health environment caused by inadequate water and sanitation can increasethe probability of infectious diseases and indirectly cause certain types of malnutrition(UNICEF, 1990; Engle, 1992). A comparative study in some developing countries (Sommerfeltet al., 1994) and in Jimma, Ethiopia (Getaneh et al., 1998) showed that unprotected water sourceand non-availability of latrine were associated with low child stature. Moreover, households that use water from unsafe sources such as a river are more likely to have stunted children. A binary variable for the water source was constructed as protected (covered wells, both public and private) and unprotected water source (the river, irrigation, streams). For the purpose of this study, dummy specification is adopted coding use of protected water source as "1" and use un protected water source "0".

Use of Treated Water

Use of treated water is expected to have negative impact on child malnutrition because even if the water is obtained from an improved source, when the water needs to be fetched from a source that is not immediately accessible to the household, it may become contaminated during transport or storage (EDHS,2011).Hence, drinkingcontaminated water causes for different infectious diseases for children. For the purpose of this study, dummy specification is adopted coding use of treated wateras "1" and use of Treated Water"0".

Child sex

Different studies shows that malnutrition among boys is consistently higher than malnutrition girls (Chiristiaensen and alderman, 2004,Glewwe et al, 2002).hence it is expected positive relationship with malnutrition.For the purpose of this study, dummy specification is adopted coding male child sex as "1" and female child sex as "0".

Child Age

It is hypostasized that older children are more malnourished, and hence as age of children increase the probability of malnutrition increases. It is a continuous variable.

Child BirthInterval

Child birth interval have When pregnancies are closely spaced, it is often the case that the mother will have little time to regain lost fat and nutrient stores(MEKONNEN A., JONES N., TEFERA B. (2005), Child nutritional status is also expected to improve with higher birth spacing as the mother would get enough time for care and feeding. Studies showed that in most countries children born less than 24 months after the previous child was born (a short birth interval) have a higher level of stunting. It is a continuous variable.

4.2.3 Robustness check

As discussed earlier, the logit model was used to analyze the determinants of child malnutrition.The child either malnourished (Stunted) or Normal/nourished. Consequently, the variable to show malnourished was used as a binary dependent variable, taking a value "1" indicating the child is malnourished/stunted and "0" otherwise. Thirteen explanatory variables (seven continuous and sixdummy) were included in the model.

The problem of heteroscedasticity and multi-collinearity are very common in cross-section data. The data should be cleared before it is used for purpose of analysis. Moreover, using the box plot graph and histogram identifies the outliers and the most frequent observation is assigned for each site so that details do not get lost. The presence ofheteroscedasticity is detected by using the Brush Pagan test. This problem is addressed by calculating the robust standard error for the logit regression model.

Further, both the continuous and discrete explanatory variables were checked for the existence of multi-collinearity using Variance Inflation Factor (VIF) and contingency coefficients, respectively. The problem of multi-collinearity can be detected by looking at the correlation matrix between the variables. But when there are more than two variables in the estimation of a model, looking at the correlation matrix may not be a true indicator of the problem of multi-collinearity. Hence, Condition index is computed and if the value is greater than or equal to 20, it is possible to expect that there could be a potential problem.

As can be seen from the results presented in Annex table 2, there is no strong association among the variables. For this reason, all of the explanatory variables were included in the final analysis.Once the decision was made regarding the variables to be included in the model, the maximum likelihood method of estimation was used to elicit the parameter estimates of the binominal logistic regression model.

Pertaining to goodness-of-fit, the stata's output of logistic regression contains the log likelihood, chi-square and pseudo R-square for the model. These measures, together with others give a general gauge on how the model fits the data. The probability chi^2 shows significance of the result at less than 1% probability level indicating that the hypothesis that all the coefficients except the intercept are equal to zero is rejected. Besides, the commonly used test of model fit is the Hosmer and Lemeshow's goodness-of-fit test, which is "lfit". The result shows with a p-value of 0.93, we can say that Hosmer and Lemeshow's goodness-of-fit test indicates that our model fits the data well.

The sensitivity (correctly predicted malnourished/stunted) and the specificity (correctly predicted nourished/normal) of the logit model are 84.62% and 85.48%, respectively. Thus, the model predicts both groups accurately (Annex Table 1).

In this study, thirteen explanatory variables were assumed to influence childstatus(malnourished/stunted or not) in the study areas, and eightare found to be significant at less than or equal to ten percent probability level. Table 4.17 shows the

sign, magnitude and statistical significance of the estimated parameters and how much the observed values were correctly predicted by the logistic regression model.

Table 4.17: Parameter estimates of the logistic regression model

SN	Variables	Cofficents	Marginal Effect dx/dy
1	Familysize HH	0.0181(0.13)	0 .0041(0.13)
2	Sexof HH	1.077(-2.12)**	0.2464(2.25)**
3	Age of HH	-0.0412 (-1.78)*	-0.0103(-1.78)*
4	Education HH	-2.440(-5.8)***	-0.539(-7.56)***
5	Oxen Ownership HH	-0.1133(-0.41)	-0.0102(-0.41)
6	Own Pron &PSNP Consup coverage	-0.0409(-0.48)	-0.0102(-0.48)
7	Radio Ownership HH	-0.3939(-0.91)	-0.0985(-0.91)
8	Water Source HH	-0.6549(-1.01)	-0.2417(-1.06)
9	Use of treated water HHs	-1.019(-1.69)*	-0.2417(-1.88)*
10	Presenceof toilte HH	-0.8172(-1.93)**	-0.1998(-2.01)**
11	Child Sex	0.6989(1.81)*	0.1729(1.85)*
12	Child Birth Interval	-0.1284(-5.4)***	-0.0321(5.4)***
13	Child Age	0.0749(3.69)***	0.0187(3.69)***
	Constant	5.841(3.58)	
	Sensitivity=84.62%	**Number of obs = 254**	
	Specifity=85.48%	**LR chi2(13) = 165.47**	
	Log likelihood = -93.253775	**Prob > chi2 = 0.0000**	
		Pseudo R2 = 0.4701	
	***,**,* Level of Siginficance at 1%,5% and 10%		

Source: Own Computation

4.2.4 Results and discussion

The econometric software stata is used to estimate the parameter coefficients and predicted marginal values of variables. The direct interpretation of the coefficient estimates from the logit model is misleading. Therefore, the marginal effect is used to describe the impact of variables on child malnutrition/stunted.

Thirteen explanatory variables, seven measured as continuous variables and sixas dummy variables were identified to be major determinants of child malnutritionin this study. These include, family size, sex of household, age of household, education of household, radio ownership, oxen ownership, own crop and PSNP source, presence of latrine, water source,use of treated water, child sex, child birth interval and child age. Except for family size and sex of household (1=male), the remaining 11 factors were a priori expected impact on child malnutrition. Moreover, out of the thirteen proposed variables, eightof them were statistically significant in the model while the rest were not significant evenat 10% probability level.The significant variables are sex of household, age of household, education of household, presence of toilet, use of treated water, child sex, child birth interval and child age while the rest were insignificant variables. To get more insight in the determinants of child malnutrition, the interpretations of the variables are discussed below:

Sex of the household head

The variablewas found significant at 5% and positively associated with the stunted opposite to hypothesis, which implies stunted /child malnutrition increases as the house is headed by male than female counterpart. All other things being kept constant, the marginal effect tells child malnutrition increases by 0.246 as the household head is male, This suggests that children benefit more from resource allocation in female headed households than in male headed households. This signifies that female household heads allocating their time to improve the level of nutrition of their child for childcare. The result is consistent with other study results (Rogers LG,1999).However; Christiaensen, L., Alderman, H., 2004 noted that child nutrition status is not affected by the sex of the household head.

Age of household head

Opposite to expectation,this variable was found negatively associated with the malnutrition and significant at less than 10% with t = 1.78.Which implies child malnutrition decrease as age of household increases.All other things being kept constant,

the marginal effect tells child malnutrition decreases by 0.01as the age of the household head increased by one year.

Education of the household head

This variable is significant at less than 1% and associated negatively with stunted in the study areas.This indicates that households with relatively better educated face their child to less likely exposed to malnourished which is stunted than those headed by uneducated household heads.According to results reported in Table 4.17, an improvement in education level defined by the shift in educational level from illiterate (Xi=0) to literate (Xi=1) decreases the probability of child being stunted by 0.54. The possible explanation for this could be, as household head get educated they are more at ease to adapt and utilize new information available through health education, reading newspapers, watching television, listening to radio and other related awareness creating issues. Then this helps to improve nutritional status of their children. Various studies have concluded that parental education, especially that of mothers, is a key element in improving children's nutritional status Christiaensen and Alderman, 2004; Moen, 1993; Yimer, 2000;Geneboet *al*, 1999,Glewwe (1999).

Availability of latrine Facility of household

Having toilet in the household has a significant negative effect on the probability of stunting and This is not surprising as better sanitary conditions lower the risk of infectious diseases and malnutrition. The variable is significant at 5%.This shows that there is significant difference between households who have latrine and not. This could be justified by the reason that as household's use their surrounding for excretion than using of the toilet they can be exposed to sanitary disease diarrhea. Since children could not usetoilets by themselves and rather use any place around their fieldwhich this can exposed to sanitary problem and minimize their growth patterns, on the other hand availability of latrine results to have better sanitary environment that could have a positive effect on the nutritional outcome of children's. The result also consistent with different studies like research conducted by Armar-Klemesu et.al.,2000 and

Christiaensen, L., Alderman, H. et.al., 2004 also noted that possession of a tap and latrine both have a positive effect on child height for age.

Use of Treated Water

This explanatory variable is significant at 10% and negatively associated with child malnutrition. Present study showed that, children from family not treat their drinking water by boiling, straining through cloth and chlorine/wuha agar were more likely affected by malnourishment/stunted as compared to children were from family treat their drinking water.This finding similar to study conducted inOromiaregion byKebedeMengistu, KassahunAlemu and Bikes Destaw et.al.,2013.

Child Sex

The results show that sex of child is positively related to the probability of stunting, implying that other things being equal, male children are more likely to be stunted.This is probably due to increased attention being paid to female children.This finding is consistent with results of other studies on malnutrition in Ethiopia and other African countries.Male children are more likely to be stunted than female children (EDHS,2011). And this result also consistent with the research conducted by BekaTeshome, WambuiKogi-Makau, ZewdituGetahun, GirumTayeet.al.,2009 in West Gojam Zone,Christiaensen and Alderman,2004 sex-related differences in diet and child care require has been recommended.The energy requirement is different for boys and girls (WHO, 1985), especially as boys are often expected to help with more energy-consuming tasks while girls are frequently involved with chores within thehousehold.

Child birth interval

The result shows that child birth interval is negatively associatedwith the malnutrition at significant at 5%. As child birth interval increase by one month child malnutrition decreases by 0.0321.This shows that shorter birth intervals is positive relationship with the child stunted/malnutrition which means as having more children below five years of age would imply shorter birth intervals and more difficulty in caring for children, these

points towards the importance of birth spacing and family planning. The result is consistent with other studies; there is an inverse relationship between the length of the preceding birth interval and the proportion of children who are stunted. The longer the interval, the less likely the child could get stunted (EDHS,2011).

Child Age

Child age is as expected it is found that positively associated with the level of malnutrition and significant at1%.this result is consistent with different studies conducted.This result consistent with other studies conducted in Ethiopia and other developing countries, which showed the prevalence of stunting positively associated with child age Asres G, Eidelman AI (2011), Teshome B, Kogi- Makau W, Getahun Z, Taye G (2006), Mulugeta A, Hagos F, Kruseman G, Linderhof V, Stoecker B, et al. (2005). As result indicated on descriptive, the prevalence of child malnutrition increased with age. The national EDHS,2011 national also indicated that, the prevalence of stunting increases as the age of child increases consistent.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Even though poverty decrease from 2000-2011significantly, child malnutrition remains a major public health problem in Ethiopia and highest level among under five years children.

This paper examined the prevalence and determinants of malnutrition among under-five children of ruralhousehold'sin Central zone of Tigray. Descriptive statistics, Smart Nutritional Software and logitregression techniques were used to analyze anthropometrics data accessed from the Relief Society of Tigray collected in 2013.The analysis was based on binary malnutrition indices estimated using Logit regression.

Descriptive results indicate that, 51.18 %, 18.5% and 5.91% of the sample children were stunted, underweight and wasted respectively. The EDHS, 2011 reported similar scenario for the level of stunted at regional level but wasted and underweight result shows less than the EDHS,2011 reported(as 35.1% underweight and 10.3% wasting).

The logit analysis revealed that child's variables (child sex, age and child birth interval), parental variables (Sex of HH,Age of HH and education HH) and health variables (availability of latrine and use of treated water) were the significant determinants of child malnutrition.Household family size, ownership of oxen, ownership of radio, owns crop production and safety net program source and water source do not have any significant effects on malnutrition.

5.2 Recommendations for policy

Sticking to the findings of this study, Child stunted/malnutrition and education were found to be negatively and significantly associated, suggesting that literate household heads may realize on how to provide care (sanitary, nutrient food….) for their children. Thus, education could be an effective instrument in promoting child nutritional practices in a regional and local economy. Therefore, creating suitable ways to educate the household through adult literacy program, trainings through health extension workers are important;

Presence of latrine contributes to the child malnutrition is significant. Hence, necessary effort should be made to improve latrine availability and utilization in rural community of each household sustainably.

Age of the child has significant effect on the level of stunted/malnutrition and associated positively in the study area. Hence, age related diet and child care intervention will be important and this was also recommended by ZewdituGetahun, GirumTaye 2009 in West Gojam Zone.

Child birth interval is negatively associated with the stunting. Hence, these points towards the importance of birth spacing through use of different family planning ways.

Finally, a coordinated effort of all sectors will be vital to overcome the problem of stunted/malnutrition. Moreover, further research is required that tries to identify and analyze determinants of child malnutrition to tackle the child malnutrition in the study area and in the country in general.

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Annexes

Table1: parameter estimation

```
Logistic regression                               Number of obs   =        254
                                                  LR chi2(13)     =     165.47
                                                  Prob > chi2     =     0.0000
Log likelihood = -93.253775                       Pseudo R2       =     0.4701
```

malnothaz	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
familysize	.0180943	.1352666	0.13	0.894	-.2470234	.283212
sexofhh	1.017691	.480167	2.12	0.034	.0765813	1.958801
ageofhh	-.0412264	.0231845	-1.78	0.075	-.0866672	.0042144
education	-2.440411	.4208113	-5.80	0.000	-3.265186	-1.615636
radio	-.3938648	.4340351	-0.91	0.364	-1.244558	.4568283
oxen1	-.1132683	.2783878	-0.41	0.684	-.6588982	.4323617
owncroppsn~e	-.040915	.0854932	-0.48	0.632	-.2084786	.1266486
presenceof~e	-.8171667	.4231564	-1.93	0.053	-1.646538	.0122047
watersource	-.6549575	.64682	-1.01	0.311	-1.922701	.6127864
treatwater	-1.019026	.6045029	-1.69	0.092	-2.20383	.165778
child_sex	.6989465	.3859247	1.81	0.070	-.0574519	1.455345
childage	.0748632	.0202821	3.69	0.000	.035111	.1146153
childbirth~l	-.1284493	.0238002	-5.40	0.000	-.1750968	-.0818019
_cons	5.841018	1.631342	3.58	0.000	2.643647	9.038389

```
Marginal effects after logit
      y  = Pr(malnothaz) (predict)
         =  .49739732
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
family~e	.0045235	.03382	0.13	0.894	-.061755	.070802	5.66929
sexofhh*	.2464951	.10938	2.25	0.024	.032118	.460872	.69685
ageofhh	-.0103063	.0058	-1.78	0.075	-.021666	.001054	39.8071
educat~n*	-.5391678	.07134	-7.56	0.000	-.679001	-.399335	.598425
radio	-.0984635	.1085	-0.91	0.364	-.311128	.114201	.251969
oxen1	-.0283163	.0696	-0.41	0.684	-.164724	.108092	.740157
owncro~e	-.0102285	.02137	-0.48	0.632	-.052118	.031661	9.99606
presen~e*	-.1998362	.09918	-2.01	0.044	-.394219	-.005453	.740157
waters~e*	-.1600423	.15074	-1.06	0.288	-.455478	.135394	.88189
treatw~r*	-.2416791	.12874	-1.88	0.060	-.493998	.01064	.870079
child_~x*	.1729356	.09355	1.85	0.065	-.010425	.356296	.531496
childage	.0187153	.00507	3.69	0.000	.00878	.02865	32.4016
childb~l	-.0321115	.00594	-5.40	0.000	-.043762	-.020461	28.7874

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. lstat

Logistic model for malnothaz

                 True
Classified |      D          ~D  |      Total
-----------+--------------------+-----------
         + |    110          18  |        128
         - |     20         106  |        126
-----------+--------------------+-----------
     Total |    130         124  |        254

Classified + if predicted Pr(D) >= .5
True D defined as malnothaz != 0
--------------------------------------------------
Sensitivity                     Pr( +| D)   84.62%
Specificity                     Pr( -|~D)   85.48%
Positive predictive value       Pr( D| +)   85.94%
Negative predictive value       Pr(~D| -)   84.13%
--------------------------------------------------
False + rate for true ~D        Pr( +|~D)   14.52%
False - rate for true D         Pr( -| D)   15.38%
False + rate for classified +   Pr(~D| +)   14.06%
False - rate for classified -   Pr( D| -)   15.87%
--------------------------------------------------
Correctly classified                        85.04%
--------------------------------------------------
```

Table 2: Variance inflation factor (VIF) for continuous variables

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
  familysize |      1.26    0.791365
     ageofhh |      1.25    0.803177
    childage |      1.12    0.889481
       oxen1 |      1.12    0.894769
childbirth~l |      1.11    0.901893
owncroppsn~e |      1.08    0.928852
       radio |      1.02    0.982524
-------------+----------------------
    Mean VIF |      1.14
```

Table 3: Contingency coefficient for discrete variables

	sexofhh	educat~n	presen~e	waters~e	treatw~r	child_~x
sexofhh	1.0000					
education	0.0188	1.0000				
presenceof~e	0.0975	0.0640	1.0000			
watersource	-0.0821	0.1232	-0.1056	1.0000		
treatwater	-0.0001	0.0656	-0.0688	0.2940	1.0000	
child_sex	-0.0013	-0.2380	-0.0705	0.1209	-0.0108	1.0000

```
. lfit

Logistic model for malnothaz, goodness-of-fit test

      number of observations =       254
 number of covariate patterns =       254
           Pearson chi2(240) =       209.00
                 Prob > chi2 =         0.9265



. linktest

Iteration 0:   log likelihood = -175.98851
Iteration 1:   log likelihood = -105.37182
Iteration 2:   log likelihood =  -94.90815
Iteration 3:   log likelihood = -93.353777
Iteration 4:   log likelihood = -93.254257
Iteration 5:   log likelihood = -93.252396
Iteration 6:   log likelihood = -93.252396

Logistic regression                             Number of obs   =        254
                                                LR chi2(2)      =     165.47
                                                Prob > chi2     =     0.0000
Log likelihood = -93.252396                     Pseudo R2       =     0.4701

------------------------------------------------------------------------------
   malnothaz |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |   .9992247   .1214217     8.23   0.000     .7612426    1.237207
      _hatsq |   .0029658   .0563429     0.05   0.958    -.1074643    .1133959
       _cons |  -.0069109   .2263778    -0.03   0.976    -.4506031    .4367814
------------------------------------------------------------------------------

.
```

Table3: Trend of Child Malnutrition

Indicators	Year		
	2000	2005	2011
Stunting	57.8	51.5	44.4
Wasting	12	10	9.7
Underweight	42.1	34.9	28.7
Source:EDHS2011			