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SCHOOL OF NATURAL SCIENCE

DEPARETEMENT OF STATSTICS

A REASERCH REPORT

ON

DETERMINANTS OF MALNUTRITION AMONG UNDER-FIVE CHILDREN: A CASE OF ARSI ZONE SELECTED WOREDAS IN OROMIA REGIONAL STATE, ETHIOPIA

BY

DESTA NEGUSSU (M.Sc)

AND

BIRHANU BETELA (M.Sc)

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DECLARATION

We, Desta NigussuTessema (M.Sc by Applied Statistics) and Birhanu Betela Warssamo (M.Sc by Mathematical and Statistical Modeling [MASTMO]) hereby declare that this research report is our original work. This research has been submitted to Office of Research and Technology Transfer School of Applied Natural Science. We declare that this report has not been submitted before in part, or in full, for any other research report or community services at this or any other university in the country.

Name of the Principal Researcher: DESTA NIGUSSU TESSEMA

Signature: ___________________

Date: ______________________

Name of the Co-Researcher: BERHANU BETELA WARSSAMO

Signature: ___________________

Date: ______________________

ACRONYMS

CDC	Children Disease Control for Prevention
CDH	Community Development Health
CTC	Community Therapeutic Care
EDHS	Ethiopian Demographics and Health Survey
ENA	Essential Nutrition Actions
FANTA	Food and Nutrition Technical Assistance
MLE	Maximum Likelihood Estimator
MOPED	Ministry of Public Education Development
NCHS	National Center for Health Statistics
NIC	National Information System
NICS	Nutritional Information Communication Strategy
UNICEF	United Nations International Children's Emergency Fund
UNS	United Nations
USAID	United State Agency for International Development
WHO	World Health Organization
UNS/SCN	United Nations Sub-Committee on Nutrition
WAZ	Weight- for-Age Z score
HAZ	Height-for-Age Z score
WHZ	Weight –for-Height Z score

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DEFINITION OF TERMS

Z-score: A Z-score (or standard deviation score) is defined as the deviation of the value of an individual child from the median value of the reference population, expressed in standard values.

Stunting: or low **height-for-age** Z scores (HAZ) is an indicator of a reduced linear growth rate and represents a chronic state of malnutrition as it takes longer for impaired skeletal growth to become apparent. Stunting is defined as HAZ < -2.

Underweight: or low **Weight-for-age** Z-scores (WAZ) represent a global measure of malnutrition; a condition that reflects a deficit in weight for age or low weight-for-height; a composite measure of stunting and wasting. Underweight is defined as WAZ < -2.

Wasting: as measured by low **weight for- height** Z scores (WHZ), represents lower than expected body mass (tissue or fat) and is a good indicator of existing nutritional deficits. Is condition that reflects a deficit in weight relative to height due to a loss of both tissue and fat mass, usually resulting from recent severe inadequate nutritional intake and episode of illness

Wasting is defined as WHZ < -2.

Malnutrition: Any disorder or condition resulting from excess or deficient nutrient intake. Malnutrition takes both forms: under nutrition (wasting, underweight, stunting or micronutrient deficiencies) and over-nutrition (overweight and obesity). This study was address for only **under nutrition.**

ABSTRACT

The study has been aimed to identify determinants associated with malnutrition of under-age five children with the use of cross-sectional data and probabilistic sampling method, anthropometric measurements of 997 sampled children under the age 6-59 months and information were taken from mothers/care givers of children on demographic, maternal factors, health seeking and nutritional factors. Multivariate logistic regression analyses were applied. The study revealed that The Prevalence of stunting, underweight and wasting was 43.4%, 27.1 % and 14.8%, respectively. On the levels of malnutrition by gender, the analyses indicate that stunting and underweight were higher among male than female children at 47.8%, 40.5%and 30.3%, 24.8% respectively. Whereas female children were slightly more wasting than their male counterparts. From the common forms of malnutrition such as stunting, wasting and underweight, stunting was the most common problem among under-five children in the woredas. Logistic regression analysis revealed that factors, such as age of a child, sex of a child, source of drinking water, type of toilet facility for household, mothers' education, mothers' occupation, mother's age at first birth, child birth order, preceding birth interval of child, mother's pre-natal and postnatal care visit, breast feeding duration of child, household size and child's birth weight had statistically significant effect on the nutritional status of children under age five in the woredas. The empirical results of the overall findings underlines that the key determinants of child nutrition status are complex and interrelated, requiring a multilayered and all rounded interventions for improving the severity and ultimately alleviating the problem. The prevalence of stunting is high for the child who never breast feed at all. A child who feed breast milk for 13-24 months was less likely to be stunted than the reference category (>24 months). A source of drinking water is also found to be significant determinant of the child nutrition status measured WAZ. Specifically, the estimation result shows that children from households, who use safe water source, are less likely to be underweight than those who do not use safe water sources for drinking purpose. Child birth weight was also one of the significantly associated factors with nutritional status measured WHZ of children. With a decrease of birth weight of children, increase risk of being under-nutrition. Zonal Health Department and Woreda Health Office should be strengthening the health extension program to improve and provide necessary education on nutritional program, environmental sanitation, hygienic practice, breast feeding duration, and weaning practices. And allow mothers to attain their highest level of education and therefore improve the socio-economic status of mothers by giving them a good opportunity to have a better occupation.

Key Words: *Nutritional Status, Multivariate Logistic Regression, Malnutrition*

1. INTRODUCTION

1.1 Background of the Study

The World Health Organization (2013) estimates that there are 178 million children that are malnourished across the globe, and at any given moment, 20 million are suffering from the most severe form of malnutrition. Malnutrition contributes to between 3.5 and 5 million annual deaths among under-five children. UNICEF estimates that there are nearly 195 million children suffering from malnutrition across the globe. In 1997, the World Health Organization had observed that 60% of the deaths occurring among all the under-five children in developing countries were attributed to malnutrition (Murray and Lopez., 1997). Most of the damage caused by malnutrition occurs in children before they reach their second birthday, in the time when the quality of a child's diet has a profound impact on his or her physical and mental development.

Child malnutrition is the most devastating problem currently facing the majority of the world's poor (WHO, 2008). It has been estimated by the global burden of disease study that under-five malnutrition alone has caused approximately half the under-five children deaths in developing countries, making it one of the most important problems in the developing world (Pelletier et al., 1994; Heinkens et al., 2008).

Childhood undernutrition in the form of chronic and acute malnutrition coexists in many populations in developing countries. Unlike acute malnutrition which is associated with immediate crisis such as periodic food shortages, chronic malnutrition is due to inadequate nutrition over a prolonged period resulting from latent poverty, chronic food insecurity, poor feeding practices and repeated episodes of health problems (such as infections) or poor health services in an unhealthy environment (Khan Y, Bhutta ZA, Muller O, Krawinkel M]. Recent estimates indicate that, 165 million of all children under 5 years worldwide are stunted and a further 52 million are wasted; Africa and Asia have the highest burden (Black RE, Walker SP, Christian P, de Onis M, et al). Underweight, wasting and stunting respectively contribute to 19.0, 14.6 and 14.5 % of global deaths (Black RE, Allen LH, Bhutta ZA, and Caulfield LE et al). Vitamin A and zinc deficiencies contribute substantially to micronutrient deficiency related-deaths whilst iodine and iron deficiencies coupled with stunting alone, contribute to children not reaching their full developmental potential (Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al). Also children who survive malnourished childhood are less productive physically and intellectually, and are more prone to chronic illness and disability in adult life (Pelletier DL, Millward DJ, Jackson AA).

Malnourished children have lowly resistance to infection; therefore, they are more likely to die from common childhood ailments such as diarrheal diseases and respiratory infections (Aschalew, G. 2000). In addition, malnourished children that survive are likely to suffer from frequent illness, which adversely affects their nutritional status and locks them into a vicious cycle of recurring sickness, faltering growth and diminished learning ability (Nguyen and Sin, 2008).

The effects of malnutrition on human performance, health and survival have been the subject of extensive research for several decades and studies shown that malnutrition affects physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity and contributes greatly to the disability-adjusted life years worldwide (Cathrine, 2005; Ngoc and Sin, 2008).

The most sever adult and child malnutrition is found in sub-Saharan Africa and Southeast Asia (Caulfield et al., 2004). Consequently, it is estimated that globally among the under 5 children

226 million were stunted, 67 million were wasted and 183 million weigh less than they should for their age**.** Despite the continued progress in all the developing countries, it is still predicted that there were be 128-155 million underweight children by the year 2020 with 35% of these children to be from sub-Saharan Africa (Smith et al., 2003).

In Ethiopia child malnutrition is enormous challenge (MOFED, 2002, 2006). It constitutes a particularly daunting challenge as the country had a 10.4 % under-five mortality rate in 2009, of which the majority was linked to severe and mild to moderate malnutrition (UNICEF, 2010). National data, according to the 2005 Demographic and Health Survey, show that stunting (chronic malnutrition) and underweight (chronic and acute malnutrition) in children less than five years of age were 47% and 38%, respectively (CSA, 2006).

These figures are among the highest in the world and are severe even by sub-Saharan African standards (UNICEF, 2010). There is a growing consensus that poor nutritional status during childhood can have long-lasting scarring consequences into adulthood, both in terms of health and mortality, and in terms of other measures of human capital such as schooling and productivity, which in turn may diminish their working capacity during adulthood and have negative effects on national economic growth (GLEWWE and MIGUEL, 2007).

Child malnutrition may also lead to higher levels of chronic illness and disability in adult life which may have intergenerational effects as malnourished females are more likely to give birth to low-weight babies (SILVA, 2005). Inability to reduce the prevalence of malnutrition in under-five children will lead to non-achievement of one of the key targets of the first Millennium Development Goal, eradication of extreme poverty and hunger.

According to the Solomon et al., (2008) there has been improvement in the nutritional status of children in Ethiopian for past five years based on data taken from EDHS (2005). Even though, the malnutrition is remained the most series problem yet as different literatures stated (Woldemariam and Timotiwos, 2002; FANTA, 2008; Girmay et al., 2010) and according to the survey result carried out in different regions in Ethiopia, acute malnutrition ranges from 6.9% to 23.4 % .

Under nutrition is a deficiency of kilocalories and/ or nutrients and often presents as slow growth and development (WHO, 2003). Under nutrition remains a major cause of disability and mortality, ranked as the top cause of global burden of disease (WHO, 2003). The term malnutrition was used to signify under nutrition for the remainder of this study.

Thus, there is need to address the immediate causes of malnutrition and also their underlying basic factors if developing nations are to achieve nutritional well-being and reach functional and productive capacity in the population (Mariana et al., 2006). There are a wide range of factors that determine the nutritional status of children. These can broadly be classified into child characteristics including age and gender of the child, household characteristics, particularly parental characteristics, and community variables (Mariana et al., 2006).

The main statistical method used in this study was Binary Logistic Regression Models to estimate various possible factors associated with the nutritional status of children under-five years of age.

1.2 Statement of the Problem

Effective nutrition is one of the most important health determinants among citizens of any developing country including Ethiopia. However, malnutrition remains a big threat to almost all regions in Ethiopia particularly in the rural area of the country (EDHS, 2016).

Nutritional status during childhood has consequences until adulthood. Deficiencies in nutrients or imbalances between them can have dire long-term effects for the individual (Kibel et al., 2007). As different literatures illustrated, malnutrition is one of the major problem in Ethiopian and there are various factors contributing to malnutrition among children under-five years of age (UNICEF, 2006; Yewelsew et al., 2008).

Thus, measuring the child's nutritional status is important because of both the long-term and short-term effects on the health, educational, the cognitive abilities of the child, and also severe consequences effects to the child's ability to function as a healthy, productive and self-supporting community member in the long-term.

Given the fact that a lot of studies on the determinants of malnutrition among under-five children have been conducted in different regions of a country, there is need to examine if the same factors are responsible for malnutrition among children under-five years in the districts of Merti and Chole woreda of Arsi Zone hence forming the research gap.

1.3 Objective of the Study

1.3.1 General Objective of the Study

- The general objective of this study is to identify the determinants of nutritional status of children under-five in the selected woredas.

1.3.2 Specific Objective of the Study

The study addresses the following specific objectives;

- To ascertain the relationship between the assumed factors and malnutrition measures of children under-five years of age.
- To differentiate groups under higher risk and to estimates the prevalence of malnutrition.
- To identify which type of malnutrition is highly observed in the selected Woredas. Age and sex related malnutrition measures.
- To provide scientific information about nutritional status of children under age five to the concerned body.

1.4 Scope of the study

The study considered children below five years living in the selected woreda's in Arsi Zone. This is because children under age five are normally the most at risk of malnutrition within households and communities in Ethiopia.

1.5 Significance of the Study

One of the core points of the country's policies is bringing sustainable growth and development for under-five children and to reduce risk factors associated with nutritional status. Without identifying factors associated with nutritional status among children, it is difficult to overcome problems related with malnutrition. However, resource allocation for reduction of malnutrition alone can't bring the sustainable child growth and development.

Since children are economic assets to the world and their future development outcome can be influenced by their nutritional status, the mechanism and consequences of malnutrition need to be understood better. Therefore, this study were tries to identify factors affecting nutritional status of children under the age 6-59 months old by taking the Anthropometric measurement on

(6-59 months) old children and conducting administered questionnaires to father, mothers/ care givers of children on demographic, socio-economic, environmental, nutritional, and health seeking factors in selected woreda's.

Hence, the study provides information that could be used for nutritional surveillance and targeting programs that would focus more on populations at risk particularly the under-five children. The study also makes important contribution to future research by contributing to the existing literature particularly on nutrition among under-five children. The finding further avails information that could be used in policy planning and implementation particularly in vulnerable groups.

2. REVIEW OF RELATED LITERATURE

2.1 Introduction

This section presents a synthesis of some reviewed literature on the determinants of malnutrition among under-five children in different settings particularly in developing countries.

2.2 Global Level of Malnutrition

Malnutrition, through its synergistic relationship with infections and disease, has a powerful impact on child mortality (Smith and Haddad, 2000). Malnourished children have lowered resistance to infection; they are more likely to die from common childhood ailments like diarrheal diseases and respiratory infections; and for those who survive, frequent illness saps their nutritional status, putting them into a vicious cycle of recurring sickness, faltering growth and diminished learning ability (Andrea et al., 2009).

However, perhaps most disconcerting are the long-term effects, in that malnutrition during childhood not only has consequences during childhood, but in adulthood as well (Smith et al., 2003). Malnourished children are also more prone to infections that are often fatal or mental and physical disabilities. Promotion of good nutrition is a key issue in the healthy development and long-term well-being of the child (Kibel et al., 2007). The problem is that there are separate and mutually re-enforcing determinants of nutritional status and infection malnutrition and infectious diseases have been postulated to be "synergistic" (Chen and D"Souza, 1989). However, income and food availability are insufficient conditions, and though most previous studies of child malnutrition and its consequences have focused on economic factors, maternal education, and health service use and provisioning (Smith & Haddad, 2000).

In a study conducted by (Scanlan, 2004), it was estimated that 25% of child mortality in lesser-developed regions can be attributed to children's low nutritional status. Specifically and on a daily basis, many African children suffer morbidity and mortality consequences due to malnutrition (Bloss et al., 2004). Sub-Saharan Africa is the only region in the world where child malnutrition has been continuously increasing (Smith & Haddad, 2000). Worldwide, over 10 million children under the age of 5 years die every year from preventable and treatable illnesses despite effective health interventions. At least half of these deaths are caused by malnutrition (Sasha, 2009). It is now projected that little progress were be made in sub-Saharan Africa to ameliorate child malnutrition by 2020 if nothing is done quickly and drastically. Under the most pessimistic projections, the number of malnourished children (and therefore those at heightened risk of mortality) is expected to increase to 55 million by 2020, or 32.4% of all children in sub-Saharan Africa (Smith et al., 2003). Globally there were approximately 13 million children suffering from severe acute malnutrition (i.e. severe wasting and edematous malnutrition), and estimates are expected to this figure climb to approximately 20 million when the new WHO growth standards are applied (Save the Children, 2007).

2.3 Ethiopian Level of Malnutrition

In Ethiopia, almost half of all children under the age of five are stunted – that is, they are too short for their age, with one fourth of children being severely stunted. Stunting reflects a failure to receive adequate food intake over a long period of time, and is, therefore, a measure of chronic malnutrition. One in ten children under five years is wasted – that is, they are too thin for their height. Wasting reflects the failure to receive adequate nutrition in the period immediately preceding the survey. It is considered a measure of acute malnutrition. Two-fifths of children age five and under are underweight – that is; they are too thin for their age. Underweight is a composite indicator combining both chronic and acute malnutrition. Half of all Ethiopian children are chronically malnourished. Chronic malnutrition affects children across the country. The highest rates of stunting are found in Amhara and SNNP. Children living in rural areas are more likely to be stunted than children living in urban areas (48 percent vs. 30percent). In addition, children of mothers with no education are twice as likely to be stunted as children of mothers with a secondary education or higher (49 percent vs. 24 percent) (EDHS 2005).

Stunting has decreased only slightly since 2000 (from 52 percent to 47percent). There was no change in the percentage of children wasted during the same period. The percentage of children underweight has decreased more dramatically, from 47 percent to 38 percent in the past five years. Rates of stunting – or chronic malnutrition – are higher in Ethiopia than in other countries in the region. Almost half of children in Ethiopia are too short for their age, compared with one-third of children in Kenya. Although the rate of stunting in Ethiopia has decreased over the past five years, it remains one of the highest levels of chronic malnutrition in the world. Although rates of wasting – or acute malnutrition – are lowering in Ethiopia than they are in Eritrea, they are significantly higher than in other countries in the region for which data are available. Wasting rates in Ethiopia are twice that of Kenya and almost three times that of Uganda, Rwanda, and Tanzania. Overall, these data show that, in spite of improvements in the past five years, the nutritional status of the children of Ethiopia lags behind the other countries in the region **(**EDHS 2005).

Ethiopia is among the nations with the highest under-five mortality rates in the world and at least 53% of mortality can be attributed directly or indirectly to malnutrition (Woldemariam and Timotiwos, 2002). Malnutrition is one of the most important public health problems in the country which accounts more than 40% prevalence of Stunting (Yimer, 2000). The level of stunting, underweight, and wasting are also higher for rural children than urban children. This shows that Ethiopia has a very high prevalence of stunting, underweight and wasting according to the classification established by the World Health Organization to indicate levels of child malnutrition (Lindsay and Gillespie, 2001).

National governments and donors emphasize the progressive realization of access to food and good nutrition as a human right. For this reason, reducing food insecurity and improving nutrition have acquired increased importance within the context of poverty reduction strategies (Mesfin, 2008). There is need to address the immediate causes of malnutrition and also their underlying basic factors if developing nations are to achieve nutritional well-being and reach functional and productive capacity in the population (Jane et al., 2006). Furthermore, Planners in government agencies and the donor community have tended to address malnutrition primarily as a food supply issue. Yet various studies have shown that it is a more complex phenomenon that stems from various underlying determinants, including a lack of optimal feeding practices for infants and young children (Jane et al., 2006).

2.4 Malnutrition Among Under-Five Children

Research findings indicate that poor nutrition during childhood is one of the most important conditions that impede the physical and the mental development of children which ultimately propagates the vicious cycle of intergenerational malnutrition. Consequently, the effects of under-five malnutrition are permanent and cross into the adulthood stage of the child (Jesmin*et al.,* 2011).

It is important to note that child malnutrition is associated with inappropriate feeding practices that occur mostly in the first two years of life. There is a global and national understanding on the association between child malnutrition and inappropriate feeding practises as observed in the nutrition policies of Ethiopia (MoH 2005). Similarly, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) developed a global strategy for infant and child feeding that was adopted by the 55th World Health Assembly in 2001(Arun and Jon., 2004).

A well-nourished child is one whose weight and height measurements compare very well with the standard normal distribution of heights and weights of healthy children with same age and sex categories. Nutritional status is primarily measured by a child's growth in height and weight and is directly influenced by food intake and the occurrence of infections. Chronic malnutrition in form of stunting, wasting and underweight are assessed at the population level.

2.5 Child related factors of under-five malnutrition

There are a number of demographic and environmental variables that researchers have found significant in influencing under-five malnutrition however the study focused on few of them that included sex of child, age of child, birth order, birth interval, breast feeding duration of child, child birth weight and morbidity status of child.

2.5.1 Sex of child

From the reviewed literature, there seems to be a consensus that malnutrition among under-five children is greater among boys than girls. The cause of this discrepancy is not well established in the literature but it is believed that boys are more influenced by environmental stress than the girls (Henry et al., 2007; Nguyen and Kam., 2008; Sarmistha, 1999).

According to a study done in Kwara state Nigeria, Babatunde (2011) reported that there was a significant relationship between sex of a child and malnutrition, Male children were more likely to be malnourished than their female counterparts. This is probably due to increased attention paid to female children unlike the male children. Another study done in Botswana revealed that stunting, wasting and underweight were also significantly more prevalent among boys than girls (Salah and Nnyepi., 2006).

A study by Olwedo*et al.,(*2008) on the factors associated with malnutrition in internally displaced persons' camps of Northern Uganda indicated that a male child was nearly two times more likely to suffer from acute malnutrition compared to a female child (Adjusted odds Ratio of 1.56 at 95% C.I 1.15-2.13 with p-value=0.004**). This situation could be due to the fact that boys are rare at home given the fact that they tend to be active running around in the neighborhood as compared to female children who in most cases eat whatever small feeds that their mothers got since they are always with them at home. The above findings are approving with the findings in Kombolcha district of Eastern Hararghe Zone which found out that there was significant relationship between gender and under-five malnutrition.

2.5.2 Age of child

Recent studies have found out that younger children are less likely to be malnourished than the older children. In the growth life cycle of children, weaning and less breast milk make them more vulnerable to under-five malnutrition. However, after weaning, the children begin to get adequate nutrition when they get used to complementary feeding (Shrimpton *et al.,* 2001).

It is important to note that specific ages, children's nutritional status is sensitive to feeding, weaning practices, care, and exposure to infection. A cumulative indicator of growth retardation (height-for-age) in children is positively associated with age. A study done in our country (Ethiopia) has also shown an increase in malnutrition with increase in age of the child (Yimer, 2000). The findings are similar in Kombolcha district of Eastern Hararghe Zone where the probability of child malnutrition is significantly higher among children who are relatively aged. In particular, as child age increases by one month, the probability of being normal in nutrition status decreases by 1.2% in HAZ, 1.7% in WAZ and 1.1% in WHZ**.**

2.5.3 Birth Order

Research findings indicate that malnutrition is rare among under-five children of birth order 2-3 and that higher birth order (5+) is positively associated with child malnutrition (Sommerfelt*et al.*, 1994; Jeyaseelan, 1997). In a study carried out among 6939 children underfive years in Bangladesh, the prevalence of stunting increased with birth order hence most of the children who were of birth order more than two had greater chances of stunting and wasting (Rayhan and Hayat., 2006).

Worthy to note is that few studies according to the literature search have been conducted on the subject of child birth order and malnutrition among under-five children. During the study in Merti and Chole districts, it was found quite easy to get actual information concerning birth order because the respondents found it easy to recall after all, they could easily tell by looking at their children.

2.5.4 Birth Interval

In another study conducted in Bangladesh, children within the first birth interval were 1.66 times more likely to be stunted and children whose preceding birth interval was less than two years were 1.32 times significantly more likely to be stunted as compared to children of a preceding birth interval 24 months or above. Similar results were observed for underweight children (Nure.,Nuruzzaman and Goni, 2011). The study indicated that preceding birth intervals and child stunting were statistically significant ($p<0.05$). Preceding birth intervals of 18-35 months had a marginally positive significance on stunting whereas the interval of more than 48 months shows a negative relationship on stunting.

According to UBOS and Macro International Inc (2007), malnutrition is highest if the birth interval is less than 24 months (41 percent) since it is an important indicator of the nutritional status of children. Child birth intervals were statistically significant in this study.

2.6 Maternal factors of malnutrition among under-five children

A lot has been written about the socio-economic determinants of malnutrition among children under-five by several researchers in both developed and developing countries. This study focused on mother's age at birth, maternal education, marital status and maternal occupation. Some other variables like place of residence and region were not applicable since the study was conducted in rural areas of Oromiya regional state.

2.6.1 Mother's age at birth

Mothers age at birth has been associated with malnutrition among under-five year old children for example it was found out in Bangladesh that children whose mothers were less than 20 years at the time of birth were 1.22 times more likely to be stunted, wasted and underweight compared to children whose mothers were 20 years and above at birth (Nure., Nuruzzaman and Goni, 2011).

A number of studies have reported that mother's age at birth is one of the most important determinants of malnutrition among under-five children. It has been suggested that the risk is greater in younger mothers particularly those below 24 years because they are not ready to take care of the child including providing all the necessary attention required for the baby. Similarly, under-five malnutrition is higher also among children whose mothers give birth when they are older especially after 35 years. This is attributed to the fact that giving birth at an older age is associated with a higher likelihood of giving birth to babies with a low birth weight (Shrimpton etal., 2001; Jeyaseelan, 1997). However, it is important to note that children of the younger mothers are traditionally cared for by their grandmothers in Turkey and this was associated with low levels of malnutrition among children of younger mothers less than 24 years (Ergin*et al*., 2007).

2.6.2 Maternal Education

Mother's education level affects child's nutrition through her choices and health seeking skills related to nutrition, hygiene, preventive care and disease treatment. Mother's responsibility to care for herself during pregnancy and her child through the most vulnerable stages of its life significantly affects under-five child malnutrition. Several studies reveal that mother's education is associated with good nutrition practices and particularly under-five child nutrition

(BabatundeandQaim, 2010; Olwedo*et al.,* 2008; Webb and Block., 2004; Shrimpton *etal.,*2001). These studies have pointed out the fact most women with low education spend more time in gardens and feed their children on less nutritious foods. Women who spend more time in gardening get limited time to attend to their children and prepare for them nutritious meals unlike their educated counterparts who normally focus on good child nutrition practices even when they are absent from home most of the time. Education helps mothers gain additional knowledge about the adequate intake of food for their children in terms of correct quantity, quality and frequency. It also determines her income and this helps her access proper nutrition for the child as well as health services.

According to Sommerfelt et *al.,* (1994), there is a negative association between the mother's education and under-five child malnutrition. The higher the level of mothers' education, the lower the percentage of under-five children classified as undernourished. According to the study, malnutrition was most prevalent among children whose mothers attended primary school. It is however important to note that the decline in the levels of malnutrition with increasing maternal education is not always gradual. In some countries, malnutrition levels are fairly similar among children whose mothers attended primary or secondary school while elsewhere there is a greater similarity with children whose mothers attended primary school or had no formal schooling. Median levels of malnutrition across all countries range from 36 percent for children whose mothers had some primary education to 16 percent for children of mothers with secondary or higher education.

Based on the study conducted at Sidama Zone by Derege D (2011),educational level of mother had significant association with nutritional status of children under age five. From this category, children who were born from mothers who had no education, had primary level of education, had secondary school educational level and had above secondary school education level, 219 (51.2%), 155 (36.2%) and 109 (25.5%) were stunted, underweight and wasted, respectively. And also, 78 (34.8%), 50 (22.3%) and 43 (19.2%) of children were stunted, underweight and wasted, respectively were whose mothers had primary level of education.

In addition, 14 (38.9%), 14 (38.9%) and 11 (30.6%) of children were stunted, underweight and wasted, respectively were from mothers had secondary level of education and 15 (45.5%), 17 (51.5%) and 8 (24.2%) were stunted, underweight and wasted, respectively were children whose mothers had above secondary school educational level.

In a similar study in Bangladesh, children of mothers with no education and primary education were 28% and 33% respectively more stunted than children of mothers with secondary or higher education. Wasted and underweight children also showed similar results. Children whose mother had no education or had primary education were more times significantly stunted and underweight than children whose mothers had secondary or higher level. However for wasting, children whose mothers had primary or secondary education had 0.87 times lower odds of wasting than those of mothers with higher education (Nure, Nuruzzaman and Goni, 2011).

According to Lisa (2000), education of a mother has several potentially positive effects on the quality of care of children and consequently malnutrition. More educated women are better able to process information, acquire skills and model positive caring behaviors. More educated women tend to be better able to use healthcare facilities to interact effectively with health care providers, to comply with treatment recommendations and to keep their living environment clean. Education also increases women’s ability to earn income but this increase the opportunity cost of their time which may mitigate against some important care giving behaviors for example breastfeeding.

2.6.3 Marital Status

On the study about mothers' marital status and under-five child nutrition, some findings in in our country (Ethiopia) reveal that child's malnutrition is significantly associated with marital status. It was found out that under-five child malnutrition is higher among unmarried rural and divorced/separated women compared to married ones (Teller, 2000). Similarly, being a married mother was positively associated with good nutritional status among children under-five years in the Volta region of Ghana (Appoh and Krekling., 2005). Contrary to the above, a study in Tanzania revealed that mothers who are married were more likely to have undernourished children unlike those that were unmarried perhaps because of the co;st of maintaining families hence sometimes these families fail to produce nutritious supplements to the under-five children (Nyaruhucha*et al.*, 2006).It is however important to note that there is scanty literature linking mothers marital status and malnutrition among under-five children in developing countries.

2.6.4 Maternal Occupation

Previous studies have found out that mother's occupation is one of the determinants of under-five malnutrition in most developing countries. A study in Vietnam revealed that children from mothers who were laborers or farmers and housewives had a greater prevalence of stunting, underweight and wasting than those from mothers who worked in office or were housewives (Nguyen and Kam, 2008). This is because working mothers rarely get time to take care of their children. They also leave their children at home with other siblings who may neglect feeding them following the right frequency and this sometimes worsens the problem of malnutrition. It is also common for mothers to fail to provide complementary feeds including protein foods since most of them cannot afford them (Olwedo*etal.*, 2008; Rukundo 1988).

Mother's occupation is one of the indicators for access to adequate food supplies, use of health services, availability of improved water sources, and sanitation facilities which are prime determinants of child nutritional status (UNICEF, 1990). A study done on most of the DHS surveys conducted in developing countries (Loaiza, 1997) especially in the Southern Nations, Nationalities and Peoples Region (SNNPR) of Ethiopia showed that under-five children from low economic status households were the most affected by malnutrition. A study conducted by Derege D in Sidama Zone (2011) also showed that from a few predictors, mother's occupation was selected by the final model using (multivariate logistic regressions by the Forward Stepwise (Likelihood Ratio)) method.

According to a review of Demographic and Health Surveys in selected African countries, malnutrition is more prevalent among children whose mothers did not work for instance according to DHS 1986-89, Burundi had 48% of stunted growth among children from non-working mothers while Zimbabwe had 31.0% of her children stunted among non-working mothers while 27.5% were among working mothers. Wasting and underweight were also more common among the children of non-working mothers (Sommerfelt et *al.,* 1994). The above findings contradict study results were working mothers particularly crop cultivators had more chances of having malnourished children than their counterparts particularly pastoralists because they spent the bigger part of the day at home which helped them feed their children.

3. METHODOLOGY

3.1 Description of Study Area and Population

3.1.1 Description of Study Area

Arsi is one of the zones of the Oromia Region in Ethiopia. It is also the name of a former province. Both the Zone and the former province are named after a subgroup of the Oromo, who inhabit both. Arsi is bordered on the south by Bale, on the southwest by the West Arsi Zone, on the northwest by East Shewa, on the north by the Afar Region and on the east by West Hararghe. The administrative center of this zone is in Asella; Asella was the capital of ArsiProvince until that province was demoted to a Zone of Oromia with the adoption of the 1995 Constitution. Asella retains some administrative functions as the seat of the present Arsi zone, located in the Arsi zone of the oromia region about 175 kilometers from Addis Ababa. This city has a latitude and longitude of 7°57′N 39°7′E, with an elevation of 2,430 meters.

Merti is one of the woredas in the Oromia Region of Ethiopia. Part of the Arsi Zone, Merti is bordered on the south by Sude, on the west by Jeju, on the northwest by the Misraq Shewa Zone, on the north by the Afar Region, on the east by Aseko, and on the southeast by Chole. The administrative center of this woreda is Abomssa.

Abomssa is a town in central Ethiopia; the name comes from the Oromo word for "friend, comrade". Located in the Arsi Zone of the Oromia Region, the town has a latitude and longitude of 8°35′N 39°51′E and an altitude of 1438 meters. It located about 199 kilometers from Addis Ababa.

Based on figures published by the Central Statistical Agency in 2005, this woreda has an estimated total population of 135,023, of whom 67,257 are men and 67,766 are women; 26,053 or 19.30% of its population are urban dwellers, which is greater than the Zone average of 12.3%. With an estimated area of 1,282.19 square kilometers, Merti woreda has an estimated population density of 105.3 people per square kilometer, which is less than the Zone average of 132.2

Chole is one of the woredas in Arsi zone Oromia Region of Ethiopia. Part of the Arsi Zone, Chole is bordered on the south by Amigna, on the southwest by Sude, on the northwest by Merti, on the north by Aseko, and on the east by Gololcha. . Chole town is located in about 180 kilometers from Addis Ababa via Welenchite.

Based on figures published by the Central Statistical Agency in 2005, this woreda has an estimated total population of 111,831, of whom 56,029 are men and 55,802 are women; 7,557 or 6.76% of its population are urban dwellers, which is less than the Zone average of 12.3%. With an estimated area of 765.94 square kilometres, hole has an estimated population density of 146 people per square kilometre, which is greater than the Zone average of 132.2.

3.1.2 Study Population and Study Subjects

The target populations of the study were children under-age five (6-59 months) in the selected woredas.

- Household head, mothers or child care givers were target respondents.
- Children from 6-59 months old were use as study subjects.

3.2. Data Source and Study Design

The research instruments that were employee under this study were a primary data. The designs used in this study were cross-sectional quantitative and qualitative study. Data were gathered using a combination of a structured questionnaire and the collection of anthropometric measurements, such as height, weight and age of children under-five.

Information on the anthropometric measurements was collected by enumerators (by the help of health extension workers those who are employed each selected wereda and those who well trained on how to record the anthropometric measurements).

The Epi-Info version 3.4.3 and the 1978 NCHS/CD/WHO child growth chart reference score system were used to calculate height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) scores. Children with HAZ, WAZ and WHZ below -2 were characterized as stunted, underweight and wasted, respectively. And accuracy of all anthropometric measurements was upheld according to the international reference standard. There were no inconsistencies in data or anthropometric measures that could affect the results.

The other data related to covariate variables were collect by train data collectors using standard, structured and pre-tested questionnaires which were originally prepare in English and then translated into Amharic and Oromic. In order to minimize the errors in data collection perform by the enumerator, training were provide for five days to ensure that the enumerator understood the questionnaire. The questionnaires were design to have both qualitative and quantitative data.

3.3. Inclusion and Exclusion Criteria

- The study includes all healthy children aged 6-59 months old in the sampled household during the study period.
- When there is more than one child under-five in the selected household, we take the one who is older/ oldest.
- Children under five years of age and seriously ill or hospitalized for sickness during data collection were not selected for the analysis.

3.4. Sampling Design and Sampling Procedure

3.4.1. Sampling Design

The target population for this study were children under age five (6-59 months) and residing in the selected kebele's. In this study, a probabilistic sampling (stratified random sampling) technique was adopted as an appropriate sampling method for selecting a representative sample of the child in the selected kebele's. The stratification in the study were depends on the number of administrative ekeble's of the selected Woredas. Also we used systematic sampling technique to select the sample elements in each respective district (Kebele).

3.4.2. Sample Size Determination

In conducting researches that require taking a sample, we always have the stage of deciding the sample size. Determining the sample size for a study is a crucial component of study design. The goal is to include sufficient numbers of subjects so that statistically significant results can be detected. The decision is important because selecting too small sample size results in lack of precision to provide reliable answers to the questions that are under investigation while selecting too large sample size results in the wastage of time and resources for minimal gain. In order to have an optimum sample size, there are a number of issues/points one has to take into account. Some of the issues are: objective of the research, design of the research, cost constraint, plan for statistical analysis, and degree of precision required for generalization, degree of confidence with which to conclude etc. Based on the above information, there are several formulas developed for sample size calculation that conform to different research situations. As mentioned in sampling design, sampling technique used in this study were stratified random sampling techniques. Accordingly, the sample size determination formula adopted for this study was (Cochran, 1977):

$$n = \frac{\sum_{i=1}^{k}\left[\frac{N_i^2 P_i(1-P_i)}{W_i}\right]}{\frac{N^2 d^2}{Z_{\alpha/2}^2} + \sum_{i=1}^{k} N_i P_i\,(1-P_i)}$$

Where P_i is the estimated sub population proportion for strata i, N_i is the size of stratum (i); W_i is the estimated proportion of N_i to the total population N. The maximum allowable difference between the maximum likelihood estimate and the unknown population parameter, denoted by d, desired to be 0.04,is the precision level usually set by the investigator. The specification of d must be small to have a good precision. Z is the upper $\alpha/2$ points of standard normal distribution with α = 0.05 level of significance, which means $Z_{\alpha/2}$= 1.96.

To estimate/determine the proportion of nutrition status of child, P, in this study, we use the previous sampling of similar population. A study, which is carried out by Tadiwos Z. and Deginet A.(2013),has shown that the population proportion of malnourished (p) was **0.28633**. It is decided to use **P = 0.29** in this study for sample size determination for each district ($P = p_1 = p_2 = p_3 = \ldots = p_{29}$).The final sampling units were selected by using systematic random sampling technique based on the proportional allocation using stratification as described below in Table 1. The zone has 26Woreda's and using SRS we select the two woredas (Merti and Chole) from the selected woredas, Merti woreda has **23** districts and Chole wereda has **20** districts. A randomly selected 29 districts, 16 from Merti and 13 from Cholewere considered to be strata for this study.

The size of the sample in each stratum was determined in proportion to the size of the population of each stratum, termed proportional allocation described in Table3.1 below.

Table 3.1: *proportional allocations of sample size for each stratum*

No	**MertiDistrict**	**Population Size (Ni)**	**Sample Size (n_i)**	**No**	**CholeDistrict**	**Population Size (Ni)**	**Sample Size (n_i)**
1	Kebiro Oromo	361	22	1	YaeGugu	458	44
2	GateraKobire	385	23	2	Koro Gugu	371	33
3	GadoArba	580	38	3	Weregu	469	41
4	Hela Gadula	481	30	4	AshuteKofechisa	272	25
5	ShemoGado	292	17	5	Manga Werke	453	43
6	DembekaEftu	330	21	6	NiboLafto	531	47
7	Homba	463	28	7	MoyeGado	498	46
8	Ashe	534	32	8	Shabo Shule	285	27

9	AbasaGorba	367	21	9	Gado Sika	357	30
10	Wetero Dino	478	30	10	Manga Legebuna	464	40
11	Hela Tiya	452	27	11	JersaKechema	559	52
12	DembekaGerjele	545	33	12	ManjaAdere	446	42
13	Angada	286	16	13	GenboDuwa	257	22
14	Abomssa 01	827	54		**Total Populations**	**N**	**13,340**
15	Abomssa 02	1001	60		**Total Sample Size**	n	976
16	Golegota	538	32	With 5% No- Responses Rate (**n = 1,025)**			

Stratification was employed due to administrative convenience and a gain in precision in the estimates of the characteristics of the whole population over the simple random sampling technique. Hence, the sample size with N (N= 13,340) together with above specifications and 10% no- responses rate will give **n = 1,025.**

3.5. Variables Used in the Study

- **Dependent Variable (Y)**
  - The dependent variable used in this study was nutritional status of children under the age five of selected woredas which has determining standards: The National Center for Health Statistics (NCHS) and the WHO standards were used to determine the nutritional status of children. To accomplish this, the standard deviation of Z-scores of weight for age (WAZ), height for age (HAZ) and weight for height (WHZ) were taken in the study.

- **Child malnutrition**

The measure of child malnutrition in this study is a dummy variable with a value of 1 if the child malnutrition index is present and a value of 0 if otherwise as presented below.

- ✓ Is the child stunted? 0=No, 1=Yes
- ✓ Is the child wasted? 0=No, 1=Yes
- ✓ Is the child under weight? 0=No, 1=Yes

❖ **Anthropometric Measurements:**

These variables were considered as the dependent variables during statistical analysis.

Table 3.2: ***Categories of Nutritional Status*.**

HAZ	WAZ	WHZ
-2 to 6 z-score **Normal**	-2 to 5 z-score **Normal**	-2 to 5 z-score **Normal**
< -2 **Stunted**	< -2 **Underweight**	< -2 **Wasted**

Table 3.3: ***Categories of Nutritional Status and Levels of Malnutrition.***

Height-for-Age (HAZ-)	Weight-for-Age (WAZ)	Weight-for-Height (WHZ)
-2 to 6 **Normal**	-2 to 5 **Normal**	-2 to 5 **Normal**
-3 to -2.01 **Mild/Moderately Stunted**	-3 to -2.01 **Mild/Moderately Underweight**	-3 to -2.01 **Mild/Moderately wasted**
-6 to -3.01 **Severely stunted**	-6 to -3.01 **SeverelyUnderweight**	-5 to -3.01 **Severely wasted**

Source: *Addis continental institute of development, Addis Ababa, 2009 and WHO/NCHS child growth standard 2006.*

- **Independent Variables**

- Independent variables are variables that are expected to affect nutritional status of children under-five in the selected Woredas.

Table 3.4: ***List of Independent Variables with their Code and Description.***

Explanatory Variable	Coded as	Scale of Measurement
Child Factors		
Sex of Child *(Category)*	0 = Female 1 = Male	Nominal
Age of the Child *(Full Months)*	0 = 37-59 1 = 13-36 2 = <=12	Scale
Birth Order *(Count)*	0 = 1- 2 1 = 3 - 4 2 = 5th and more	Scale
Preceding Birth Interval *(Years)*	0 = No preceding birth 1 = 5 and above 2 = 3-4 3 = <=2	Scale
Child Birth Weight	0 = >3500 1 = 3001-3500 2 = 2500-3000 3 = <2500	Scale
Number of Children b/n 6-59 Months in Household	0 = <=2 1 = 3 -5 2 = More than 5	Ordinal
Morbidity Status of Child *(Category)*	0 = If the child was not suffering from diseases in the last three months 1 = If the child was suffering from diseases in the last three months	Nominal
Breast feeding duration of child *(Count)*	0 = > 24 months 1 = <13-24 months 2 = 6-12 months 3 = <6 months 4 = Never breast feed	Ordinal
Food feeding frequency of child in a day *(Count)*	0 = 4and above 1 = 2-3 2 = Once	Ordinal
Maternal Factors		

Mothers' Age at Birth*(Count)*	0 = 40 and above 1 = 30-39 2 = 20-29 3 = <20	Scale
Marital Status of Mothers'*(Category*	0 = Married 1 = Divorced/ Separated 2 = Widowed 3 = Never Married	Nominal
Mothers' Educational Status*(Category)*	0 = Higher education 1 = Secondary school completed 2 = Primary level 3= No education	Ordinal
Mother's Occupation*(Category)*	0 = Housewife 1 = Civil servant 2 = Wage labor 3 = Other	Nominal
Mother had pre-natal care visit with pregnancy of child	0 = Yes 1 = No	Ordinal
Mother had post-natal care visit after given birth of child	0 = Yes 1 = No	Ordinal
Household Related Factors		
Household Size*(Count)*	0 = 2-3 1 = 4-6 2 = 7 and more	Scale
Source of food for household*(Kind)*	0 = Own production 1 = Purchase 2 = Food aid	Nominal
Source of drinking water for the household*(Kind)*	0 = Pipe 1 = Protected well 2 = Unprotected well 3 = Ground surface water	Ordinal
Kind of toilet facility*(Kind)*	0 = Traditional pit latrine 1 = No facility/bush/ field	Ordinal
Anthropometric measurements		
Height of child *(Measure)*	Cm	Scale
Weight of child*(Measure)*	Kg	Scale
MUAC measurement	Cm	Scale

- **Anthropometric Analysis**

Anthropometry is a technique that uses human body measurements to draw conclusion about the nutritional status of individuals and population. This technique was used to assess the malnutrition status of under-five children (Gibson, 2005). Child variables that included age, sex, height and weight were entered in Epi Info3.4.3 software-nutrition module to generate measurement indices of height-for-age, weight-for-age and weight-for-height. The indices generated were compared with standard reference values for WHO Child Growth Standards and CDC 2000 to obtain the *Z*-scores. This was done automatically by Epi Info 3.4.3 computing software. For this study, three indices of malnutrition that included stunting, underweight and wasting were determined among all the under-five sampled children. Stunting refers to a low height-for-age which is a measure of chronic or long-term malnutrition in children. It is a good indicator of cumulative growth retardation. Children whose height-for-age *Z*-score less than -2 standard deviations from the median of the reference population were classified as stunted. Underweight denotes a low weight-for-age and it is a measure of combination of chronic and acute malnutrition. Children having weight-for-age *Z*-score less than

-2 standard deviations from the median of the reference population were regarded as underweight. Wasting represents a low weight-for-height and it is a measure of acute malnutrition, an indicator of short-term fluctuation in nutritional status. Similarly, all the children under-five years whose weight for height Z-scores are less than -2 standard deviation were regarded as wasted.

3.6. Statistical Methods

3.6.5 Statistical Analysis

Data were enter into a microcomputer and analyzed using Epi-Info version 3.4.3 and SPSS version 16.0. The Epi-Info version 3.4.3 software was used to analyze the anthropometric values. Weight, height, and age data were used to calculate the weight-for-age, height-for-age, and weight-for-height z-scores based on the National Center for Health Statistics 1978/WHO reference data. The SPSS software was used for statistical analysis of factors associated to nutritional status of children under the age five. Statistical significance were set at $p<0.05$.

The first part of the data analysis will be a univariate analysis of the characteristics of the study population according to the variables used in the study. The univariate analysis was present in the form of frequency tables, together with their relative frequencies. The second parts of the analysis of the data were a bivariate analysis in which the relationship between each dependent and independent variable, in turn, it were investigated and relationships were define using chi-square association table. The third section includes Binary Logistic Regressions for each nutritional status (stunted, wasted, and underweight).

3.6.6 Binary Logistic Regression Model

Logistic regression analysis extends the techniques of multiple regression analysis to research situations in which the outcome variable is categorical. Logistic regression allows one to predict a discrete outcome, such as group membership, from a set of predictor variables that may be continuous, discrete, dichotomous, or a mix of any of these (Gellman and Hill, 2007).

Generally, the dependent or response variable is dichotomous (Binary), such as malnourished or normal or success or failure etc, in such case logistic regression is applicable. The logistic regression is also preferred from multiple regression and discriminate analysis as it results in a biologically meaningful interpretation, it is mathematically flexible and it requires fewer assumptions (Hosmer and Lemeshow, 1989). Furthermore, Like any other model building technique, the goal of the logistic regression analysis is to find the best fitting and most parsimonious analysis, yet it is biologically reasonable model to describe the relationship between an outcome (response) and a set of independent (predictor or explanatory) variables (Hosmer, D.W.; Lemeshow, S., 1989). There are two main uses of logistic regression:

- ✓ To predict the group membership, since logistic regression calculates the probability of success over the probability of failure, the results of the analysis are in the form of an odds ratio.
- ✓ It provides knowledge of the relationships and strength among the variables.

3.6.6.1 Model Description

In setting up the logistic regression model, first it is important to establish the fundamental model for any multiple linear regression analysis. It is assumed that the outcome variable is a linear combination of a set of predictors. For outcome variable Y, and a set of n predictor variables, X_1, X_2,. . .X_n, we have the following (Agresti 2002):

$$\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon = \beta_0 + \sum_{j=1}^{n} \beta_j X_j + \varepsilon}$$

where β_0 is the expected value of Y when the X's are set to 0, β_j is the regression coefficients for each corresponding predictor variable X_j, and ε is the error of the prediction. Note that $Y\text{-}\varepsilon = Y'$ represents the expected value of Y i.e. E $(Y|X_1, X_2 \ldots X_n)$, is also known as the conditional mean (Sloan, 2001).

This multivariate model is useful when the response variable is continuous, but is not appropriate for dichotomous response variables, as is the case when Y child malnourished (1) or child is not (0) of nutritional status. As it is, the previous model would not produce values restricted to 1 or 0 as we desire. Many uninterruptable values between 0 and 1 and greater than 1 could be obtained. To prevent this from happening, we resort to the model of the logistic distribution (Sloan, 2001).

The logistic regression model indirectly models the response variable based on probabilities associated with the values of Y. Then we denote the event Y=1, when the subject has the characteristic of interest and Y=0, when the subject does not have that characteristic of interest. In logistic regression, a single outcome variable Y_i (i = 1 . . . n) follows a Bernoulli probability function that takes on the values:

$$Y_i = \begin{cases} 1 \; with \; probability \; \pi_i \\ 0 \; with \; probability \; 1 - \pi_i \end{cases} \qquad i = 1, 2, 3 \ldots n$$

Then π_i varies over the observations as an inverse logistic function of a vector X_i, which includes a constant and k explanatory variable then,

$$Y_i \sim \text{Bernoulli} (Y_i \mid \pi_i)$$

Where:

$$\pi_i = \frac{1}{1 + e^{-X_i \beta}}$$

The Bernoulli has probability function P (Yi | π_i) = Yi (1−π_i). The unknown parameter β = (β_0, β'_1), is a k × 1 vector, where β_0 is a scalar constant term and β'_1 is a vector with elements corresponding to the explanatory variables. The independent or predictor variables in logistic regression could be discrete, continuous or a mixture of both. And In logistic regression, the relationship between the predictor and response variable is not linear. Instead, the logistic regression function is used, which is the logit transformation of θ, and we assume that Y is dichotomous, taking on values of 1 on cases of interest (success) and 0 (failure). In theory of population proportion of cases for which Y_i=1 is defined as π_i= P (Y_i=1) and Y_i =0 is defined as 1- π_i =P (Y_i=0). Because of the reasons discussed above, the logistic regression model is used in order to address the issues under objectives of this study.

The logistic model is defined as follows. Let Y_{nx1} be a dichotomous outcome random variable with categories 1 child being malnourished and 0 for not. Let $X_{n \times (k+1)}$ denotes the collection of k predicator/explanatory Variables of Y, where:

$$X = \begin{bmatrix} 1 & x_{11}x_{12}\cdots & x_{1k} \\ \vdots & \ddots & \vdots \\ 1 & x_{n1}x_{n2}\cdots & x_{nk} \end{bmatrix}$$

Where X is regression matrix without the loading column of 1's termed as predictor data matrix. Then, the conditional probability that a child is malnourished given that the X set of predictor variables is denoted by P $(Yi = 1|X) = \pi_i$. The expression π_i in logistic regression model can be expressed in the form of:

π_i = P $(Yi=1|X_1, \ldots X_k)$ = the probability of i^{th} child being under nutrition/malnourished for X predictors variables. And

1- π_i= P $(Y_i = 0|X_1, \ldots, X_k)$ = the probability of i^{th} child being not under nutrition/malnourished for X predictors variables.

Yi = the observed nutritional status of child i in the selected Woreda's.

However, the relationship between the predictor and response variables is not a linear function in logistic regression; instead, the logarithmic transformation of equation yields the linear relationship between the predictor and response variables. So an alternative form of the logistic regression equation is the logit transformation of π_i which is given as follows:

In Equation (1) we use the model for the natural logarithm of the odds (log odds) to favor Y=1.

$$\pi_i = P(Y_i = 1|X_1 \ldots X_k) = \frac{e^{(\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+\cdots\beta_k X_{ik})}}{1+e^{(\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+\cdots\beta_k X_{ik})}} = \frac{e^{X\beta}}{1+e^{X\beta}} = \frac{1}{1+e^{-X\beta}} --- (1)$$

Using inverse of logit transformation of equation (1) we arrive at the following:

$$\ln\left(\frac{\pi_i}{1-\ \pi_i}\right) = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots \beta_k X_{ik} = \beta_0 + \sum_{j=1}^{n} \beta_j X_j \text{---------} (2)$$

The model given in Equation (2) is logistic regression model. The X in the expression is a vector representing the set of the independent predictor variables, x_1, x_2, . . . ,x_n. Thus, it is the constructed logistic regressions model that bounds the conditional means between 0 and 1. And β ~ (k+1) x_1, is vector of unknown coefficients. The coefficient were be interpreted as the change in the log-odds associated with a one unit change in the corresponding independent variable or the odd increases multiplicatively by e^{β} for every one unit change increases in X.

3.6.6.2 Assumptions of Logistic Regression Model

As indicated in the above sections, one advantage of the logistic regression is to give us relaxation and flexible assumptions. There are, however, other assumptions one should consider for the efficient use of logistic regression as detailed in (Hosmer and Lemeshow, 1989).

- ✓ Logistic regression required meaningful coding of the variables.
- ✓ Logistic regression assumes a linear relationship between the log of odds and the independent variables.
- ✓ The dependent variable must be categorical and the groups must be mutually exclusive and exhaustive.
- ✓ Variances need not be the same within categories.
- ✓ The independent variables need not be interval, nor bounded, nor normally distributed, or nor of equal variance within each group and no multicolinearity assumed among predictors.
- ✓ Larger samples are needed than for linear regression because maximum likelihood coefficients are large sample estimates and MLE relies on large-sample asymptotic normality. A minimum of 50 cases per predictor is recommended; otherwise in small samples one may get high standard errors.

- ✓ Logistic regression assumes linearity of independent variables.

3.6.6.3 Parameter Estimation for Logistic Regression

Now, we would fit the logistic regression model to the data. First, it is important to establish a technique for estimating the parameters. The maximum likelihood is the most computing estimation methods used in fitting logistic regression model (Hosmer – Lemeshow, 1989). Thus, the method of parameter estimation used in this study was maximum likelihood. We have constructed the likelihood function, which expresses the probability of the observed data as a function of the unknown parameters. In general, the sample likelihood function is defined as the joint probability function of the random variables. Specifically, suppose x_1, x_2,. . ,x_n be the n independent random observations corresponding to the random variable Y_i(i=1, 2, . . ., n). Since the Y_i is a Bernoulli random variable, the probability function of Y_i is:

$$f(x) = \pi_i^{y_i}[(1-\pi_i)^{1-y_i}]\ Whear\ \pi_i = \frac{e^{X\beta}}{1+e^{X\beta}}$$

Then, we can obtain the likelihood estimators of these parameters which maximize the likelihood function. In the process, the estimators which would be selected predict the observed data most closely.

The observations were assumed to be independent of each other, so we can multiply their likelihood contributions to obtain the complete likelihood function. For a set of observations in the data (xi, yi), the contribution to the likelihood function is i, where yi = 1, and 1- i where yi = 0. Then, the following equation results for the contribution to the likelihood function for the observation, (xi, yi):

$$L(\beta) = \pi_{I=1}^{N}$$

$$\mathrm{L}(\beta|Y) = \pi_{i=1}^{n} P(y_i|X_{i1}, X_{i2}, \dots X_{ik}) = \pi_{i=1}^{n} \left[\frac{e^{X\beta}}{1+e^{X\beta}}\right]^{y_i} ----------------(3)$$

Maximum likelihood estimates (MLE's) can be obtained by calculating the β which maximizes L (β). However, to simplify the mathematics, we will take the logarithm of Equation (3) before finding the value of β which maximizes the likelihood function. As shown in Equation (4), l(β) denotes the log likelihood expression.

$$l(\beta) = ln[L(\beta)] = \sum_{i=1}^{n} y_i ln[(\pi_i)] + (1 - y_i) \ln[1 - (\pi_i)] ------------- (4)$$

We employ the techniques of calculus to determine the value of β that maximizes l (β). This is done by differentiating Equation (4) with respect to β0, . . .,βj and setting the resulting derivatives to zero.

We employ the techniques of calculus to determine the value of β that maximizes l(β). This is done by differentiating Equation (4) with respect to β0, . . .,βj and setting the resulting derivatives to zero.

The objective of stating likelihood function is to get solution to the maximum likelihood estimate from the likelihood equations as:

$$\hat{\beta} = \left(\hat{\beta}_0, \dots \hat{\beta}_j\right)$$

An estimator $\hat{\beta} = \left(\hat{\beta}_0, \dots \hat{\beta}_j\right)^T$ of β which maximizes the likelihood function expressed in Equation (4). Since the likelihood equations are non- linear in the parameters, the Newton-Raphson iterative maximum likelihood estimation method expresses $\hat{\beta}$ at the $(\mathrm{u}+1)^{th}$ cycle of the iteration which is expressed as $\hat{\beta}_{u+1} = \hat{\beta}_u + \left(X'\hat{V}_u X\right)^{-1} X'\hat{V} R_u$,where u=0, 1, 2, 3, and is a diagonal matrix with its diagonal elements (Yi=1|X).

$$\hat{V} = diagonal[\pi_i(1-\pi_i)] = \widehat{cov}(Y)$$

Finally, $\hat{\beta}$ is the resultant maximum likelihood estimator of β with residual R= Y- $\hat{p}$ (Collet, 2003). Newton's method usually converges to the maximum of the log – likelihood in just a few iteration unless the data are especially badly conditioned (Greene, 1991). In fact all the parameters $\widehat{\beta}_0, \dots, \hat{\beta}_j$ and estimates P (Yi=1|X) for each subject is solved by using SPSS computer programs.

3.6.7 Assessment of the Fitting of the Logistic Regression Model

The logistic regression model has been developed through the various steps in estimating the coefficients and there are several techniques involved in assessing the appropriateness, adequacy and usefulness of the model. First, the importance of each of the explanatory variables will be assessed by carrying out statistical tests of the significance of the coefficients. Then the overall goodness of fit of the model will be tested (Agresti, 2007). And the ability of the model to discriminate between the two groups defined by the response variable is evaluated. Finally, if possible, the model is validated by checking the goodness of fit and discrimination on a different set of data from which can be used to develop the model (Bewick et al., 2005). Some of the methods used for assessment of fitting the models are discussed in detail as follows.

3.6.7.1 Goodness of Fit of the Model

The following question posed by Hosmer and Lemeshow outlines the proposed method of testing the significance of predictor variables included in the model: "Does the model that includes the variable in question tell us more about the outcome (or response) variable than do a model that does not include that variable?" Likelihood ratio test given in the following equations used:

D = -2 ln [L (β)], where statistic, D, is known as the deviance.

First, it is needed to determine the deviance of the model without any of the predictor variables (i.e. with the intercept only), and then compare this value with that of the model consisting of different combinations of variables. The deviance always decreases with the addition of more variables, but the more it decreases, the more that particular predictor variable is related to the response variable. As we add variables, we can evaluate the p-value of the deviance, which tests for the significance of that particular combination of predictor variables. A low p-value justifies the rejection of the null hypothesis, which is that all of the beta coefficients are equal to zero (i.e. the all of the predictor variables are independent of the response variable). The rejection of the null hypothesis means that the variables included in the model are significant (Sloan, 2001).

The goodness of fit or calibration of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model with that of observed values (Bewick et al., 2005). The comparison of observed to predicted values using the likelihood function based on the deviance statistic where:

$$D = -2\sum_{i=1}^{n}\left[y_i\, ln\left(\frac{\hat{\pi}_1}{y_i}\right) + (1 - y_i) ln\left(\frac{1 - \pi_i}{1 - y_i}\right)\right]$$

For purposes of assessing the significance of an independent variable, the values of D are compared with and without the independent variable in the equation as given below:

χ^2 = D (model without the variable) - D (model with the variable)

The goodness-of-fit χ^2 process evaluates predictors that are eliminated from the full model, or predictors (and their interactions) that are added to a smaller model. In general, as predictors are added or deleted, log-likelihood decreases or increases.

3.6.7.2 Likelihood-Ratio Test

The likelihood ratio test statistic (G^2) is the test statistic commonly used to assess the overall fit of the logistic regression model. An alternative and widely used approach to test the significance of a number of explanatory variables is to use the likelihood ratio test. This is appropriate for a variety of types of statistical models (Agresti, 1996). The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L1) over the maximized value of the likelihood function for the simpler model (L0). Then the likelihood-ratio test statistic is given by:

$$G^2 = -2log\left(\frac{L_0}{L_1}\right) = -2[log(L_0) - log(L_1)] = -2(L_0 - L_1) \sim \chi^2(1)$$

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

3.6.7.3 The Hosmer and Lemeshow Test Statistic

Another measure of model fit is the Hosmer and Lemeshow goodness-of-fit statistic, which measures the correspondence between the actual and predicted values of the dependent variable. The Hosmer and Lemeshow test is a commonly used test for assessing the goodness of fit of a model and allows for any number of explanatory variables, which may be continuous or categorical.

The test is similar to a χ^2 goodness of fit test and has the advantage of partitioning the observations into groups of approximately equal size, and therefore there are less likely to be groups with very low observed and expected frequencies. In this case, better model fit is indicated by a smaller difference in the observed and predicted classification (Bewick et al., 2005).

3.6.7.4 The Wald Statistic

An alternative test which is commonly used to test the significance of individual logistic regression coefficients for each independent variable is the Wald statistic. It is used to test the null hypothesis in logistic regression model that a particular logit coefficient is zero. The Wald statistic is the squared ratio of the unstandardized logistic coefficient to its standard error.

For each explanatory variable in the model there will be an associated parameter. The Wald test, described by Agresti (2007), is one of a numbers of ways of testing whether the parameters associated with a group of explanatory variables are zero. If for a particular explanatory variable, or group of explanatory variables, the Wald test is significant, then we would conclude that the parameters associated with these variables are not zero, so that the variables should be included in the model. If the Wald test is not significant then these explanatory variables can be omitted from the model. Wald χ^2 statistics can be used to test the significance of individual coefficients in the model and are calculated as follows:

$$Z^2 = \left(\frac{\hat{\beta}_J}{SE(\hat{\beta}_J)}\right)^2 \sim \chi^2(1)$$

Each Wald statistic is compared with a χ^2 distribution with 1 degree of freedom. Wald statistics are easy to calculate but their reliability is questionable, particularly for small samples. For the small sample sizes the likelihood ratio test is more reliable than the Wald test (Agresti, 2007).

3.6.7.5 R^2 Statistic

A number of measures have been proposed in logistic regression as an analog to R^2 in multiple linear regressions. The Cox and Snell measure is based on log-likelihoods and considers sample size. The maximum value that the Cox & Snell R^2 attains is less than 1. The Nagelkerke R^2 is an adjusted version of the Cox & Snell R^2 and covers the full range from 0 to 1, and therefore it is often preferred. R^2 statistics can be used to indicate how useful the explanatory variables are in predicting the response variable (Bewick et al., 2005).

$$R_{CS}^2 = 1 - exp\left[-\frac{2}{n}[D - D(model\ with\ variable)]\right]$$

The Nagelkerke measure is given as follows:

$$R_N^2 = \frac{R_{CS}^2}{R_{MAX}^2}$$

Where, $R_{MAX}^2 = 1 - \exp[2(n)^{-1}D(model\ with\ the\ variable)]$

3.6.8 Outliers and Influential for Bivariate Logistic Regression

Observations that are surprisingly distant from the remaining observations in the sample are called outlying values or outliers. Such values may occur as a result of measurement errors, employing a defective experimental procedure or just an extreme manifestation of natural variability. For binary data, an outlier occurs as a result of transcription errors, that is, when the response variable equals unity and the corresponding fitted probability is near zero or vice versa (Collet, 2003).

Cook's distance was used to assess the overall impact of an observation on the estimated parameters. Cook's distance is a measure of the influence of cases that might unduly influence our parameter estimates. It tells us how much detecting a case affects not only the residual for that case. Cook's distance depends on the standardized residual for a case, as well as its leverage. Hence the rule of thumb for Cook's distance is points for which Cook's distance greater than one considered as influential. Cook's distance D is computed as:

$$D_i = \frac{Z_i h_i}{(1 - h_i)^2} \text{ where, } Z_i \text{ is the standardized residual and } h_i \text{ is the leverage.}$$

4 RESULTS AND DISCUSSIONS

4.1 Introduction

Results in this part are presented in three separate sections. The first section looks at the characteristics of the children in the study according to the dependent variables using descriptive statistics. The second section looks at the bivariate analysis, and the interactions between variables through an investigation of the results of two-way contingency tables and chi-squared tests of association with level of significance at α=5% for both dependent and independent variables. The third one is multivariate analysis using a binomial logistic regression analysis to assesses the determinants or potential factors associated with the dependent variables (the three indices of nutritional status of under- five children).

The sample size determined for this study was **1,025** but **23** of them could not respond to the questionnaire and **5** of them did not correctly respond. Hence, the analysis was based on information and data obtained from **997**respondents.

The data were obtained from children under-five (6-59 months) of the selected woredas'. Anthropometric measurements were taken on the age, height and weight data of 997 children between 6-59 months of age and data on socio-economic, demographic, hygiene and health seeking and nutritional variable from household heads or mother/caregiver of the children were collected.

4.2 Children Characteristics

Table 4.1: *Nutrition Status of Children Under-Five Years in Chole and MertiWoreda of Arsi Zone.*

Categories of malnutrition	*Level of malnutrition*	*Number of Children*	*Percentage*	*Total (100%)*
	Normal	564	56.6%	56.6%
HAZ	Moderately stunted	330	33.1%	43.4%
	Severely stunted	103	10.3%	
	Normal	727	72.9%	72.9%
WAZ	Moderately underweight	163	16.4%	27.1%
	Severely underweight	107	10.7%	
	Normal	849	85.2%	85.2%
WHZ	Moderately wasted	107	10.7%	14.8%
	Severely wasted	41	4.1%	

Table 4.1 shows both the total number of children under consideration as well as the percentage of each category in all dependent variables included in the study. A summary statistics of nutritional status of children in the study area reveals that stunting was the most common malnutrition problem among under-five children in the woredas. There was also quite a high prevalence of wasting and underweight among under-five children given the fact that the sample of children was not large enough comparing to other results in different researches from different area of our country.

The Prevalence of stunting (< –2HAZ), underweight (< –2WAZ) and wasting (< –2WHZ) is 43.4%, 27.1 % and 14.8%, respectively. Out of 43.4% of stunted children, 33.1% were moderately stunted and 10.3 % of them were severely stunted. On the other hand, from 27.1% of underweight children 16.4% moderately and 10.7% severely underweight, respectively. On account of wasted children (14.8%), 10.7% of them were moderately wasted whereas 4.1% were severely wasted.

Table 4.2: *Levels of Malnutrition among Under-five Children by Gender.*

Nutrition Status	***Normal (>+2SD)***		***Moderately Malnourished (< -2SD)***		***Severely Malnourished (< -3SD)***		***Overall Status (<-2SD and< -3SD) Combined***	
	Male %	*Female %*	*Male %*	*Female %*	*Male %*	*Female %*	*Male %*	*Female %*
Stunted	52.2	59.5	30.1	27.6	17.7	12.9	47.8	40.5
Underweight	69.7	75.2	10.6	19.8	19.7	5.0	30.3	24.8
Wasted	86.5	84.3	8.8	4.9	4.7	10.8	13.5	15.7

On the levels of malnutrition by gender, results in the above table indicate that stunting and underweight were higher among male than female at 47.8%, 40.5%and 30.3%, 24.8% respectively. Whereas female children were slightly more wasting than their male counterparts.

Bivariate Analysis of Nutritional Status and Independent Variables of Under-Five Children in the Woredas.

As part of the bivariate analysis, the tests of association between nutritional statuses of children under age five and all the independent categorical variables with chi-square test of association were performed. The results are displayed in Tables 4.3 given below.

Table 4.3:*Chi-square Associations between Nutritional Statuses of Children under Age Five and Other Independent Variables.(Arsi Zone Selected Weredas February 2016).*

Explanatory Variable	**Total Children %**	**Stunting**			**Wasting**			**Underweight**		
		Stunted %	χ^2	**p**	**Wasted %**	χ^2	**p**	**Underweight %**	χ^2	**P**
Sex of a child			**2.011**	**0.546**		**1.235**	**0.124**		**8.236**	**0.005****
Female	591(59.3)	239(40.4)			93(15.7)			147(24.9)		
Male	406(40.7)	194(47.8)			55(13.5)			123 (30.3)		
Age of the child			**8.085**	**0.041****		**2.363**	**0.325**		**7.528**	**0.032****
<=12 months	128(12.8)	47(36.7)			9(7.0)			29(22.7)		
13-36 months	245(24.6)	93(37.9)			24 (9.8)			68(27.8)		
37-59 months	624(62.6)	313(50.2)			93 (14.9)			111(17.8)		
Morbidity status			**1.651**	**0.156**		**0.024**	**0.504**		**2.741**	**0.085**
Not suffering from diseases in the last three months	736(73.8)	236(32.1)			56(7.6)			98(13.3)		
Suffering from diseases in the last three months	261(26.2)	145(55.5)			37(14.2)			63(24.2)		
Birth order			**10.23**	**0.015****		**6.986**	**0.033****		**3.692**	**0.412**
1 – 2	126(12.6)	69(54.7)			18(14.3)			26(20.7)		
3 – 4	517(51.9)	254(49.2)			83(16.1)			157(30.4)		

5+	354(35.5)	127(35.9)			54(15.3)			98(27.7)		
Child birth weight			**3.265**	**0.145**		**12.35**	**0.002****		**5.321**	**0.096**
>3500g	100(10.0)	39(39.0)			7(7.0)			21(21.0)		
3001-3500g	193(19.4)	71(36.8)			24(12.40)			53(27.5)		
2500-3000g	553(55.5)	289(52.3)			49(8.8)			74(13.4)		
<2500g	151(15.1)	61(40.4)			29(19.2)			43(28.5)		
No. of children b/n 5-59 months in HH			**9.356**	**0.007****		**0.963**	**0.139**		**3.269**	**0.074**
<=2	248(24.9)	95(38.4)			28(11.3)			66(26.7)		
3 – 5	631(63.3)	293(46.5)			108(17.2)			185(29.4)		
More than 5	118(11.8)	57(48.4)			13(11.2)			35(29.7)		
Preceding birth interval			**1.025**	**0.196**		**5.851**	**0.092**		**18.26**	**0.011****
No preceding birth	149(14.9)	51(34.3)			18(12.1)			27(18.1)		
5 and above years	82(8.2)	43(52.4)			5(6.1)			16(19.6)		
3-4 years	316(31.7)	131(41.5)			61(19.3)			52(16.5)		
<=2 years	450(45.1)	227(50.5)			46(10.3)			139(30.9)		
Mother age at first birth			**12.36**	**0.016****		**11.25**	**0.003****		**0.645**	**0.236**
40 and above	92(9.2)	39(42.4)			9(9.8)			16(17.4)		
30-39	309(31.0)	105(34.0)			38(12.3)			71(23.1)		

20-29	474(47.5)	216(45.6)			69(14.5)			91(19.2)		
<20	122(12.2)	63(51.7)			19(15.6)			35(28.7)		
Household Size			**1.325**	**0.169**		**8.236**	**0.035****		**12.36**	**0.000****
2-3	176(17.7)	54(30.7)			6(3.4)			27(15.3)		
4-6	487(48.8)	299(61.4)			57(11.7)			123(25.3)		
7 and more	334(33.5)	161(48.2)			54(16.2)			99(29.7)		
Marital status of mother			**3.256**	**0.193**		**2.256**	**0.223**		**5.369**	**0.084**
Married	714(71.6)	315(44.2)			63(8.8)			163(22.8)		
Widowed	76(7.6)	39(51.3)			13(17.1)			15(19.7)		
Divorced	114(11.4)	59(51.7)			24(21.1)			31(27.2)		
Never married	93(9.3)	43(46.2)			14(15.1)			19(20.4)		
Mothers' occupation			**11.89**	**0.016****		**9.921**	**0.040****		**1.153**	**0.926**
Housewife	613(61.5)	213(34.7)			105(17.2)			189(30.8)		
Civil servant	206(20.7)	83(40.3)			36(17.5)			69(33.5)		
Wage labor	125(12.5)	67(53.6)			21(16.8)			22(17.6)		
Other	53(5.3)	24(45.3)			6(11.3)			16(30.2)		
Breast feeding duration			**21.36**	**0.003****		**11.86**	**0.014****		**17.54**	**0.001****
>24months	86(8.6)	33(38.4)			7(8.1)			13(15.1)		

13-24months	238(23.9)	115(48.3)			24(10.1)			62(26.1)		
6-12months	412(41.3)	207(50.2)			91(22.1)			108(26.3)		
<6months	187(18.8)	95(50.8)			24(12.8)			37(19.8)		
Never breast feed at all	74(7.4)	39(52.7)			12(16.2)			18(24.3)		
Health status of child for past 2 weeks			**2.015**	**0.258**		**1.756**	**0.658**		**4.259**	**0.084**
Healthy	592(59.4)	183(30.9)			79(13.3)			93(15.7)		
Sick some times	333(33.4)	146(43.8)			48(14.4)			106(30.8)		
Sick most of the times	72(7.2)	41(56.9)			11(15.3)			17(23.6)		
Mother's educational status			**18.53**	**0.009****		**5.296**	**0.076**		**22.36**	**0.113**
Higher education	85(8.5)	27(31.7)			10(11.7)			14(16.5)		
High school completed	169(17.0)	79(46.7)			29(17.2)			48(28.4)		
Elementary level	463(46.4)	231(49.9)			66(14.3)			151(32.6)		
No education	280(28.1)	142(50.7)			32(11.4)			83(29.6)		
Kinds of toilet			**10.32**	**0.010****		**1.69**	**0.103**		**6.32**	**0.005****
Traditional pit latrine	860(86.3)	416(48.4)			110(12.8)			234(27.3)		
No facility/bush/field	137(13.7)	77(56.3)			21(15.4)			39(28.5)		
Household source of drinking water			**5.368**	**0.072**		**3.698**	**0.091**		**2.864**	**0.019****
Pipe line	101(10.1)	35(34.7)			12(11.8)			25(24.8)		

Protected well/public tap	307(30.8)	151(49.2)			41(13.4)			68(22.2)		
Unprotected well	461(46.2)	197(42.7)			67(14.6)			153(33.2)		
Ground surface water	128(12.8)	69(53.9)			21(16.5)			35(27.4)		
Source of food for household			**3.691**	**0.213**		**1.222**	**0.605**		**4.235**	**0.207**
Own production	596(59.8)	263(44.2)			87(14.6)			149(25.0)		
Purchase	322(32.3)	147(45.7)			42(13.1)			102(31.7)		
Food aid	79(7.9)	37(46.8)			17(21.6)			23(29.2)		
Mother had pre-natal care visit			**11.36**	**0.010****		**9.598**	**0.222**		**0.648**	**0.114**
Yes	702(70.4)	307(43.8)			113(16.1)			196(27.9)		
No	295(29.6)	162(54.9)			47(15.9)			81(27.5)		
Mother had post-natal care visit			**1.365**	**0.072**		**5.231**	**0.021****		**2.874**	**0.214**
Yes	646(64.8)	295(45.7)			78(12.1)			171(26.5)		
No	351(35.2)	163(46.4)			48(13.7)			112(31.9)		

Note: figures in the parentheses are percentage value

***shows statistical significance at 95% confidence interval or α =0.05 level of significance*

Results on the relationship between explanatory variables with malnutrition among under-five children are presented in Table 4.3 above. The chi-square association table reveals that out of nineteen independent variables there are fifteen independent variables such as: Sex of child, Age of child, Birth order, Child birth weight, Number of children b/n 5 and 59 months in a family, Preceding birth interval of a child, Mothers' age at first birth, Household size, Mothers' occupation, Breast feeding duration of a child, Mother's educational status, Kind of toilet facility, Household source of drinking water, Mother had post-natal care visit and Mother had prenatal care visit, significantly associate with the dependent variables (Nutritional Statuses) of children.

As it is presented in the association table above, out of total number of children taken under the consideration, 591 (59.3%) were female and the rest 406 (40.7%) were male. On the age of a child, there was a significant relationship between age of child and stunted and underweight (p=0.041**<0.05) and (p=0.032**<0.05) respectively. There were few children underweight from 37-59 months unlike those aged 13-36 months and below as shown in Table 4.3. Also children 37-59 were more stunted and wasted than those in other categories.

Another important predictor was birth order of a child. For birth order; Table 4.3 showed that stunting was more among children of birth order 1-2 from the rest category. Also children of birth order 3-4 were more wasted than those of birth order 1-2 as well as 5 and more.

More than half (55.5%) of the children have a weight at birth 2.5 – 3 kg, children birth weight was a predictor variable which is significantly associated only with wasted nutritional status. From the association table, children with less than 2.5kg were more wasted (19.2%) than the other categories.

Number of children between 5and 59 months in a family was found to be associated with nutritional status of children under age five at α=0.05 significance level. Children who had more than five number of child between 5 and 59 in a family were more (48.4%) stunted than other counterparts.

Results also indicate that there were less stunted children whose mothers age at first birth 30-39 years (34.0%) than other age group, whereas those from mothers age at first birth less than 20 years were more stunted (51.7%)than those from mother age at first birth of twenty and more. There were more wasted children among mothers aged 20-29 years and less than twenty years at first birth unlike other age groups (Table 4.3).

Breast feeding duration of child was also associated with nutritional status of children under age five with p-value is equals to 0.003, 0.014, 0.001which was less than α=0.05 level of significance for all nutritional statuses (stunted, wasted, underweight). Based on the results in Table4.3, 52.7% and 16.2% of children who never fed breast were stunted and wasted. And also 26.3% of children, whose breast feeding duration was between 6 and 12 months, were underweight.

There was a significant relationship between mother's education level and malnutrition. On mother's level of education, most of the children had mother with primary level and mothers with no formal education. Stunting was high (50.7%) among children of mothers with no formal education. Children who were born from mother who had elementary level of education were highly underweight (32.6%) than the others counterparts at a specified level of significance and p- values.

Underweight and stunting were also associated with type of toilet facility for household members. From children whose family had no toilet facility/bush/field, 28.5% and 56.3% were underweight and stunted respectively. And also 27.3% and 48.4% were underweight and stunted respectively from children whose family had toilet facility for household members.

There was also a significant relationship between mothers occupation and malnutrition (p=0.05). More stunted children were from wage labor mothers. In the same vein, wasting and underweight was common among civil servant and house wife categories of mothers' occupation.

On the preceding birth interval, underweight was the highest (30.9%) among under-five children with birth interval of less than 2 years than those of 3-4or 5 and above years and even from no preceding birth at all. Children who had no preceding birth interval accounts the list percentage of being underweight compare to other categories. There was however a significant relationship between birth interval and malnutrition indices; underweight only.

There is a significant difference among children nutritional status depending on household size. The result in Table 4.3 reveals that, children from a family member of 7 and more were highly (16.2%) wasted than the rest counterpart. In the same manner under this category, they were more (29.7%) underweight comparing to the others.

Underweight and stunting were associated with type of toilet facility for household members. From children whose family had no toilet facility/bush/field, 28.5% and 56.3% were underweight and stunted respectively. And also 27.3% and 48.4% were underweight and stunted respectively from children whose family had toilet facility (traditional pit latrine).

The association table also exposes that there is an integration between underweight and household source of drinking water ($p=0.019^{**}<0.05$). Children from a family accessed unprotected well as a source of drinking water were highly (33.2%) underweight than the rest counterparts.

The last significant predictor variable was mother's prenatal care visit of child as p-value for stunting and wasting is 0.040 and 0.005 respectively, less than $\alpha=0.05$ level of significance. From children whose mothers had no pre-natal care visit, 48.7% were stunted and children were born from whose mothers had no pre-natal care visit, 13.7% were wasted.

4.3 Multivariate Analysis of Children's Nutritional Status

The binary logistic regression model was fitted to examine the determinants of under-five child malnutrition and the results are presented below. Furthermore, for each of nutritional status, the explanatory variables used for the analysis were those significantly associated variables we already identified by using chi-square association table above.

4.3.1 Results of Binary Logistic Regression Analysis for Height-for-Age (Stunted)

The main problem with any univariate approach is that it ignores the possibility that a collection of variables, each of which is weakly associated with the outcome, can become an important predictor of the outcome when taken together (Hosmer and Lemeshow, 2000). Hence, multivariate logistic regression approach that takes into account the drawback mentioned by the univariate technique is considered in this analysis.

4.3.1.1 Assessing the Goodness of Fitted Model

After fitting a model to a set of data, it is natural to enquire about the extent to which the fitted values of the response variable under the model compare with the observed values. If the agreement between the observations and the corresponding fitted values is good, the model may be acceptable. If not, the current form of model will certainly not be acceptable and the model will need to be revised. This aspect of the adequacy of a model is widely referred to as goodness of fit (model adequacy checking).

The hypothesis to test in relation to the overall fit of the model is:

H0: Null model with intercept only fits the data well.

H1: Final model fits the data well with predictors.

4.3.1.1.1 The Likelihood Ratio Test

The LR test statistic is asymptotically chi-square statistic given below, to test null model over final model, chi-square which is difference of -2 Log Likelihood has 21 degrees of freedom was computed = 105.023with p-value 0.000 less than 5% level of significance. This showed that there is no evidence to accept the null model. Therefore, the final model with predictors fits the data well, implying that the predictor variables had a significant effect (Montgomery, 2001).

Table 4.4: Summary Statistics of the Likelihood Ratio Test

Model	Model Fitting Criteria	Likelihood Ratio Tests			
	-2 Log Likelihood	Chi-Square	df	$\chi^2_{(0.05,21)}$	Sig
Null model (Intercept only)	826.250	105.023	21	32.671	0.000
Final model	741.227				

In table 4.4given above, to test null model over final model, chi-square which is difference of -2 Log Likelihood has 8 degrees of freedom was computed = 85.023with p-value 0.000 less than 5% level of significance. This showed that there is no evidence to accept the null model.

Therefore, the final model with predictors fits the data well, implying that the predictor variables had a significant effect (Montgomery, 2001).

4.4.1.1.2 Model Summary

The model summary of Cox and Snell and Nagelkerke"s R^2 provides some approximations of R^2 statistic in logistic regression. Cox and Snell's R^2 attempts to imitate multiple R^2 based on "likelihood". From Table 4.5 below, Nagelkerke"s R^2 in model summary is adjusted version of Cox & Snell R^2 =0.583, which indicates that 58.3% of the variability in height-for-age nutritional status of children is explained by the explanatory variables.

Table 4.5: Model Summary of Cox & Snell R^2 and Nagelkerke R^2

Model Summary		
-2Log likelihood	Cox & Snell R^2	Nagelkerke R^2
541.220	.287	.583

4.4.1.1.3 The Hosmer and Lemeshow Test

In Table 4.6 given below, is an alternative to model chi-square of the Hosmer - Lemeshow test which divides subjects into 10 ordered groups of subjects and then compares the actual number in each group observed to the number predicted by the logistic regression model. The 10 ordered groups were created based on their estimated probability; those with estimated probability below 0.1 form one group, and so on, up to those with probability 0.9 to 1.0. Each of these categories is further divided into two groups based on the actual observed outcome variable (normal, stunted). The expected frequencies for each of the cells were obtained from the model. A probability value was computed from the chi-square distribution with 8 degrees of freedom to test the fit of the logistic model. If the Hosmer -Lemeshow goodness-of-fit test statistic is greater than $\alpha=0.05$, we fail to reject the null hypothesis that there is no difference between observed and model-predicted values, implying that the model fits the data at an acceptable level. That is, well-fitting models show non-significance on the Hosmer - Lemeshow goodness-of-fit test. This desirable outcome of non-significance indicates that the model prediction does not significantly differ from the observed.

Table 4.6: Contingency Table for Hosmer - Lemeshow Test

Ordered group	Nourished		Stunted		Total observed
	Observed	Expected	Observed	Expected	
1	58	56.285	17	16.715	75
2	27	31.855	46	39.145	73
3	37	40.285	46	44.715	83
4	51	55.645	28	29.355	79
5	23	32.681	46	38.319	69
6	41	40.818	33	35.182	74
7	47	41.053	38	33.947	85
8	32	36.628	51	46.372	83
9	41	44.274	22	28.726	63
10	36	35.476	43	46.524	79

The values of Hosmer-Lemeshow statistic has chi-square value of 9.813 and a significance of .278, which means that Hosmer-Lemeshow test is not statistically significant and therefore our model has a good fit as it is shown in (Table 4.7); because p-value exceeds level of significance $(\alpha = 0.05)$ it shows that there is no significant difference between the observed and predicted model values and hence the model fits the data well, which has an agreement with the previous tests.

Table 4.7: Hosmer - Lemeshow Test

Chi-square	df	Sig.
9.813	8	.278

4.4.1.1.4 Classification Table

Another way of assessing the goodness of fitted model is to see how well the model classified the observed data. So we often want to look at the proportion of cases we have managed to classify correctly. On account of this, we need to look at the classification which tells us how many of the cases where the observed values of the dependent variable, height-for-age nutritional status for normal or stunted (malnourished) have been correctly predicted. The overall accuracy of the model to predict subject's status is shown in (Table 4.8). Out of the 997 sampled children under the age five 93.3% were correctly predicted in their correct nutritional status. The specificity is given by 87.5% and the sensitivity is given by 91.3%, which indicates that 87.5% of nourished children and 91.3% of stunted was correctly predicted in their respective category. The number of errors where the dependent variable is predicted to be stunted but is in fact nourished is 12.5% and the number of errors where the dependent is predicted to be nourished but is in fact stunted is 8.7%.

Table 4.8: Classification Table.

Observed		Predicted		
		Nutritional status		Percentage
		Nourished	stunted	Correct
Nutritional status	Nourished	546	71	87.5
	Stunted	59	384	91.3
Overall Percentage				93.3

4.4.1.2 Outliers and Influential Diagnostics

In addition to global examination of a model, it is also useful to examine the characteristics of individual cases in our data set. We are concerned with cases that might improperly influence our parameter estimates. Cook's distance is one way of analyzing influence statistic in logistic regression. This is the same statistic that is used as a measure of influence in multiple regressions. However, the criteria for determining that a case is influential in logistic regression differ from the criteria in multiple regressions. In logistic regression, a case is identified as influential if its Cook's distance is greater than one. According to Hosmer and Lemeshow (2000), the influence diagnostic must be larger than 1.0 for an individual covariate pattern to have an effect on the estimated coefficients. Since the minimum and maximum value of Cook's influence statistics are less than one (Table 4.9), indicating that the Cook's distance for each one of the observations in our data is less than one, so we conclude that there are no influential observations.

Table 4.9: Cook's Influence Statistics

	N	Minimum	Maximum	Mean
Analog of Cook's influence statistics	997	0.00000	0.45805	0.0272077

4.4.1.3 Estimates for Logistic Model

Fitting a model to a set of data first entails estimating the unknown parameters in the model.

In order to fit a linear logistic model to a given set of data, the k + 1unknown parameters β0, $\beta_{1,}$... ,βk have to be estimated. These parameters are readily estimated using the method of maximum likelihood. The logistic regression using the "forward stepwise (likelihood)" was run. This procedure revealed that out of nineteen (19) statistically associated variables in the bivariate analysis at 5% level of significance, only nine (9) variables; age of child, number of children b/n 5 and 59 months in a family, mothers' age at first birth, birth order, mothers' occupation, breast feeding duration of a child, mother's educational status, kind of toilet facility and mother had prenatal care visit became significant predictors of height-for-age nutritional status (Stunting). Among these predictor variables which had statistically significant association with the height-for-age of children, using forward stepwise (Likelihood Ratio) method in SPSS, only few of predictor variables were selected by the final model. These predictors were, age of a child, Breast feeding duration, birth order, mother's educational status, and mother had prenatal care visit. Results obtained by the procedures are shown in (Table 4.10) below (The final logistic regression model).

4.4.1.4 Discussion of the Final Model

The logistic regression model indicated that height-for-age nutritional status of under-five children (stunting, normal) is affected by some factors considered in the study. Based on the results on Table 4.10, the variables that found to be significant in multivariate analysis were age of a child, Breast feeding duration, birth order, occupational status of mother of child, and mother had postnatal care visit after birth were found to have significant effect at $p < 0.05$.

Since the covariates used in the model are categorical, to compute odds ratio we need to have a reference category and so as to interpret the results easily. In this case first category is considered as the reference categories. Table 4.10 presents the estimated coefficients of variables$(\hat{\beta})$, standard error $\left(\mathrm{S.E}\,(\hat{\beta})\right)$Wald statistic, degree of freedom (df), level of significance (sig.), the odds ratio of Exp (β) and a 95% confidence interval for Exp (β). All the variables have significant effect to the prediction of nutritional status of children height for- age for at least one category with respective p-value. The Exp (β) which is also called odds multiplier or odds ratio column presents the extent to which raising the corresponding measure by one unit influences the odds ratio.

We can interpret Exp (β) as changes in odds. If the value exceeds 1 then the odds of success occurring increase (being stunted); if the value is less than 1, any increase in the predictor variables leads to a drop in the odds of malnourished (stunted).

Findings indicate that there is a significant relationship between age of the child and stunting. Stunting in this study was highest in 37-59 months old children (OR=2.864) as compared to lessor equals to12 months old children. The findings below agree with similar findings in southern Ethiopia that found out that stunted had a positive linear relationship with age of a child

(Derege D., 2011& Neima E. et al., 2017) and also according to Central Statistical Agency of Ethiopia, it is concluded that the prevalence of stunting increased as the age of a child increase as this finding justified. The findings are however contrary to the study in Uganda that found out that the proportion of stunted children is lowest among children 36-59 months old and highest among those 6-8 months old (Habaasa G., 2014). Moreover, children aged 30 - 36 months were less likely to be stunted (OR=.231, CI: .583 – .996) than their counterparts who are aged 12 months and below. This means that children who were aged 12 months and below had 23.1% odds of being stunted than children aged 30 - 36 months.

Maternal education is a crucial factor for stunted nutritional status of children in the country. Children whose mothers had high school completed were 1.101 times more likely to be stunted than the children whose mothers had higher education (Ref. category). And also children whose mothers had no education were more likely to be stunted (OR=3.034, CI: .039 – 1.156) than the children whose mothers had higher education (Ref. category). This showed that children whose mother had no education were more exposed to malnutrition than children who were born from educated mothers.

Birth order also had the overall significant effect on the (HAS) nutritional status of children under age five in the woreda's. In this case, the only category which has a significant effect on stunted nutritional status was a child had 5 and more birth order with p –value of 0.011which is less than 5% level of significance. Children who had 5 and more birth order were 2.021 times more likely to significantly different nutritional status of children under-five.

Results in table 4.10 below indicated that, breast feeding duration of a child have statistically significant effect on a stunted nutritional status (HAS) of a child. Accordingly, children who had breast feeding duration of 13 – 24 months were .454 times less likely to be stunted than the children who fed breast more than 24 months (reference category). This means that children who fed breast more than 24 months had 45.4% odds of being stunted than the children who fed 13 – 24 months. Furthermore, children who had breast feeding duration of <6 months were more likely to be stunted (OR=2.572, CI: .356 – 1.223) than the children who fed breast more than 24 months (reference category).Also children who had never breast fed at all were more likely to be stunted (OR=3.012, CI: 1.258 – 3.469) than the children who fed breast more than 24 months (reference category). The results signifying that, breast feeding duration of a child had positive or direct relationship with stunted (HAS) nutritional status. This also similar with the result in a study conducted by(Tahereh S. et al., 2013) "Determinants of Nutritional Status in Children living in Mashhad, Iran.

Lastly, there appears a positive and significant (P<5%) relationship between prenatal care visit and child nutrition status measured in HAZ. This shows that in households where the mother made antenatal care visit, a child is less likely to be underweight. In other word children who born from a mothers who had not get prenatal care visit were more likely to be stunted (OR=1.687, CI: .365 – 1.090), this result is consistent with Arshad (2001).

Table 4.10*: Parameter Estimates for the Logistic Regression for* ***Height- for- Age*** *of Children under Age five (Arsi Zone Selected Weredas'September 2017).*

Covariates	Category	$\hat{\beta}$	S. E $(\hat{\beta})$	Wald	Df	P-value	Exp. $(\hat{\beta})$	95.0% CI for exp.$(\hat{\beta})$	
								Lower	Upper
Age of a child	<=12 months (Ref0			13.651	2	.001			
	13-36 months	.825	.257	21.391	1	.009*	.231	.583	.996
	37-59 months	.231	.236	18.124	1	.002*	2.864	1.383	2.567
Breast feeding duration	>24months (Ref)			10.286	4	.000			
	13-24months	.756	.246	14.384	1	.030*	.454	.258	1.995
	6-12months	-1.586	.425	18.321	1	.208	.651	.069	.816
	<6months	.652	.452	11.325	1	.042*	2.572	.356	1.223
	Never breast feed at all	.865	.125	13.461	1	.007*	3.012	1.258	3.469
Birth order	1 – 2 (Ref)			15.236	2	.009			
	3 – 4	-3.698	.497	10.542	1	.071	.676	1.117	2.289
	5^{+}	-3.037	.427	19.256	1	.011*	2.021	.263	.968
Mother's educational status	Higher education (Ref)			10.914	3	.010			
	High school	2.356	.342	18.050	1	.005*	1.101	.534	.987

	completed								
	Elementary level	1.461	.162	17.531	1	.130	.351	.685	1.352
	No education	3.364	.462	10.339	1	.001*	3.034	.039	1.156
Mother had pre-natal care visit	Yes (Ref)			8.369	1	.000			
	No	-.581	.725	4.016	1	.024*	1.687	.365	1.090
Constant		-2.367	.514	11.629	1	.018	1.029		

(Ref) = Reference category**, *** = Statistically significant at 95% confidence level, **Method:** Forward Stepwise (Likelihood Ratio)

4.4.2 Results of Binary Logistic Regression Analysis for weight for- height(Wasted)

Wasting is a condition that reflects a deficit in weight relative to height due to a loss of both tissue and fat mass, usually resulting from recent severe inadequate nutritional intake and/or episode of illness and it is defined as WHZ < -2. As wasting is one of the dependent variable we followed the same procedure to make an inference about wasted like that of the case of stunting. Variables found to be statistically significant at 5% level of significance were included in the final model.

4.4.2.1 Assessing the Goodness of Fitted Model

In a similar manner as stunting case, after fitting a model to a set of data, it is natural to enquire about the extent to which the fitted values of the response variable under the model compare with the observed values. The overall significance was tested using $\alpha = 0.05$ level of significant.

The hypotheses to test in relation to the overall fit of the model are:

H0: There is no difference between null model and final model.

H1: There is significant difference between null model and final model.

4.4.3.4.1 The Likelihood Ratio Test

The LR test statistic is asymptotically chi-square statistic which is the difference in the -2 Log-likelihoods between the null and final models distributed with degrees of freedom equals to the difference between the numbers of parameters estimated in the two Models. Here is given below (Table 4.11), the -2 log likelihood value for the null model or the restricted model and final model were 591.473 and 537.285 respectively. In the model chi-square has 11 degrees of freedom, the computed value of 84.188 and a probability of p-value (0.002) < 5% level of significance. In the table, the difference of deviance of the Null model and deviance of Full model, i.e. Chi – square, is greater than $\chi^2(\alpha, df)$ then there is significant difference between null model and final model which implying that the model is good fit model.

Table 4.11: Summary Statistics of the Likelihood Ratio Test

Model	Model Fitting Criteria	Likelihood Ratio Tests			
	-2 Log Likelihood	Chi-Square	df	$\chi^2{}_{(0.05,11)}$	Sig
Null model (Intercept only)	591.473	84.188	11	19.675	0.002
Final model	537.285				

In (Table 4.11) given above, to test null model over final model, chi-square which is difference of -2 Log Likelihood was computed = 54.1888 which is greater than $\chi^2{}_{(0.05,11)} = 19.675$ and p-value 0.000 less than 5% level of significance. This showed that there is no evidence to accept the null model. Therefore, the final model with predictors fits the data well, implying that the predictor variables had a significant effect (Montgomery, 2001).

4.4.3.4.2 Model Summary

The model summary of Cox and Snell and Nagelkerke"s R^2 provides some approximations of R^2 statistic in logistic regression. Cox and Snell's R^2 attempts to imitate multiple R^2 based on "likelihood". From (Table 4.12) below, Nagelkerke"s R^2 in model summary is adjusted version of Cox & Snell R^2 =.632 which indicates that 63.2% of the variability in weight for- height nutritional status of children is explained by the explanatory variables.

Table 4.12: Model Summary of Cox & Snell R^2 and Nagelkerke R^2

Model Summary		
-2Log likelihood	Cox & Snell R^2	Nagelkerke R^2
776.561	.128	.632

4.4.3.4.3 The Hosmer and Lemeshow Test

In (Table 4.13) given below, is an alternative to model chi-square of the Hosmer - Lemeshow test which divides subjects into 10 ordered groups of subjects and then compares the actual number in each group observed to the number predicted by the logistic regression model. The 10 ordered groups were created based on their estimated probability; those with estimated probability below 0.1 form one group, and so on, up to those with probability 0.9 to 1.0. Each of these categories is further divided into two groups based on the actual observed outcome variable (normal, wasted). The expected frequencies for each of the cells were obtained from the model. A probability value was computed from the chi-square distribution with 8 degrees of freedom to test the fit of the logistic model. If the Hosmer -Lemeshow goodness-of-fit test statistic is greater than α=0.05, we fail to reject the null hypothesis that there is no difference between observed and model-predicted values, implying that the model fits the data at an acceptable level. That is, well-fitting models show non-significance on the Hosmer - Lemeshow goodness-of-fit test. This desirable outcome of non-significance indicates that the model prediction does not significantly differ from the observed.

Table 4.13: Contingency Table for Hosmer - Lemeshow Test

Ordered group	Nourished		Wasted		Total observed
	Observed	Expected	Observed	Expected	
1	63	59.583	32	29.325	95
2	47	50.645	41	49.355	88
3	50	49.675	28	24.534	78
4	46	41.264	21	19.224	67
5	34	32.354	38	35.243	72
6	51	55.698	25	28.135	76
7	37	31.563	30	23.523	67
8	52	46.462	41	32.252	93
9	43	40.614	32	28.356	75

10	39	42.231	34	34.522	73

The values of Hosmer-Lemeshow statistic has chi-square value of 4.653 and a significance of .095, which means that Hosmer-Lemeshow test is not statistically significant and therefore our model has a good fit as it is shown in (Table 4.14); because p-value exceeds level of significance $(\alpha = 0.05)$ it shows that there is no significant difference between the observed and predicted model values and hence the model fits the data well, which has an agreement with the previous tests.

Table 4.14: Hosmer - Lemeshow Test

Chi-square	Df	Sig.
4.653	8	.095

4.4.3.4.4 Classification Table

Another way of assessing the goodness of fitted model is to see how well the model classified the observed data. So we often want to look at the proportion of cases we have managed to classify correctly. The classification table helps us to assess the performance of our model by cross tabulating the observed response categories with the predicted response categories. Our model showed, out of the 997 sampled children, 914 (91.7%) were correctly classified in their respective status. Specifically 95.0% nourished and 85.8% wasted were correctly predicted in their corresponding categories. The number of errors where the dependent variable is predicted to be wasted but is in fact nourished is 5% and the number of errors where the dependent is predicted to be nourished but is in fact wasted is 14.2%.

Table 4.15: Classification Table.

Observed	Predicted	
	Nutritional status	Percentage

		Nourished	Wasted	Correct
Nutritional status	Nourished	672	21	95.0
	Wasted	71	242	85.8
Overall Percentage				91.7

4.4.3.5 Outliers and Influential Diagnostics

In logistic regression, a case is identified as influential if its Cook's distance is greater than one. According to Hosmer and Lemeshow (2000), the influence diagnostic must be larger than 1.0 for an individual covariate pattern to have an effect on the estimated coefficients. Since the minimum and maximum value of Cook's influence statistics are less than one (Table 4.16), indicating that the Cook's distance for each one of the observations in our data is less than one, so we conclude that there are no influential observations.

Table 4.16: Cook's Influence Statistics

	N	Minimum	Maximum	Mean
Analog of Cook's influence statistics	997	0.00021	0.59340	0.12531

4.4.3.6 Estimates for Logistic Model

In order to fit a linear logistic model to a given set of data, the k + 1unknown parameters β0, $\beta_{1,\ldots}$, βk must be estimated. The logistic regression using the "forward stepwise (likelihood)" was run. This procedure revealed that out of nineteen (19) statistically associated variables in the bivariate analysis at 5% level of significance, only seven (7) variables; Birth order, Child birth weight, Mother age at first birth**,** Household Size**,** Mothers' occupation, Breast feeding duration and Mother had post-natal care visit becomes significant predictors of **weight-for-height** nutritional status (**wasting**). Among these predictor variables which had statistically significant association with the weight-for-height of children, using forward stepwise (Likelihood Ratio) method in SPSS, only few of predictor variables were selected by the final model. These predictors were, **Child birth weight, Mother age at first birth, Household size, Mothers' occupation, and Mother had pre-natal care visit**. Results obtained by the procedures are shown in (Table 4.17) below (The final logistic regression model).

Table 4.17: *Parameter Estimates for the Logistic Regression for* **Weight –for-Height** *of Children under Age five (Arsi Zone Selected Weredas' September 2017).*

Covariates	Category	$\hat{\beta}$	S. E $(\hat{\beta})$	Wald	d. f	P-value	Exp.$(\hat{\beta})$	95.0% CI for exp.$(\hat{\beta})$	
								Lower	Upper
Household size	2-3 (Ref)			11.235	2	.010			
	4-6	2.325	.564	5.328	1	.082	1.203	.258	.987
	7 and more	1.027	.421	7.351	1	**.011***	**1.568**	.561	1.025
Child birth weight	>3500g (Ref)			8.364	3	.000			
	3001-3500g	.153	.086	8.365	1	.091	2.356	.218	1.698
	2500-3000g	-3.110	.351	13.274	1	.165	1.450	.986	2.356
	<2500g	.812	.863	10.983	1	**.003***	**1.219**	.768	.965
Mother's age at first birth	40 and above (Ref)			17.235	3	.003			
	30-39	5.358	.964	14.258	1	.062	1.589	.897	1.235
	20-29	.987	.256	11.346	1	**.030***	**.876**	.258	.875
	<20	4.125	.537	8.954	1	**.008***	**2.791**	.854	1.222
Mother's occupation	Housewife (Ref)			7.364	3	.009			
	Business/ Civil servant	-1.258	.365	11.253	1	**.021***	**.052**	.865	1.235

	Wage labor	-2.153	.992	4.269	1	**.040***	**2.463**	-1.766	.856
	Other	.684	.126	10.864	1	.081	1.054	.897	1.521
Mother of a child had post-natal care visit	Yes(Ref)			18.256	1	.005			
	No	2.158	.989	11.023	1	**.023***	**1.064**	2.684	5.362
Constant		-2.521	.946	7.256	1	.108	3.269		

(Ref) = Reference category**, * =** Statistically significant at 95% confidence level, **Method:** Forward Stepwise (Likelihood Ratio)

4.4.3.7 Discussion of the Final Model

Table 4.17 showed the results of the parameter estimates of the binary logistic regression coefficients of weight-for-height nutritional status of children under age five. All the variables selected by the final model have significant effect to the prediction of nutritional status of children weight-for-height for at least one category with respective p-value.

Odds of being wasted for children born from household size 7 and more were 1.568 more than children in the reference category (children who were born from household size of 2-3). Age of mother's at first birth has significant result with weight-for-height nutritional status of children. Children born from the mother gave first birth between 20-29 years old were **.876** times less likely to be wasted than children born from mothers gave first birth 40 and above years old (p=0**.030** 0.034 less than α = 0.05 significance level). In the other hand, Children who born from the mothers who have age at first birth of less than 20 years were **2.791** times more likely to be wasted than children born from mothers gave first birth 40 and above years old with P-value equals **.008** which is less of our significance level. The results regarding to mothers age at first birth is in contradict with the results of the finding which is done by Dereje D. at SNNPR Hawassa Zuria woredas with similar population (under-five children).

Findings indicate that there is a significant relationship between woman's occupation and wasting among under-five children (p=0.09) in Chole and Merti Woreda. Children whose mothers were Business/ Civil servant (OR=0.052) were less likely to be wasted unlike their counterparts whose mothers were housewife (reference category). Mothers engaged in Business/ Civil servant are believed to supplement the nutrition value of their children which consequently reduces the risk of wasting unlike housewife and wage labor. The result also reveals that child from mothers who were wage labor had an increased risk of wasting 2.463 times more likely to be wasted than their counterparts. Because they rarely get time to care for their children hence end up leaving them under the care of elder siblings or inexperienced maids. In another study, it was found out that some mothers especially wage labors in most cases fail to provide supplementary feeding to their children because they cannot afford (Olwedo, etal… 2008).

Another categorical variable that had statistically significant effect on weight-for-height nutritional status of children was birth weight of a child. In these categories, children who had <2500g birth weight at birth were 1.219 times more likely to be wasted than children who had birth weight of >3500g in the reference category. Another report in Butajira, SNNPR showed that low birth weight was one of the factors affecting infants' nutritional status (G. Medhin, C. Hanlon, M. Dewey et al., 2010).

Post-natal care visit of mother of a child was another important variable which had statistically significant effect on weight-for-height nutritional status of children. Odds of being wasted for children whose mothers had no post-natal care visit with index children was 106.4% more than children whose mothers had post-natal care visit.

4.4.4 Binary Logistic Regression Analysis for Weight-for-Age (Underweight)

The third nutritional status of under-five children is underweight. Among the categorical variables who had statistically significant association with weight-for-age nutritional status, age of the child, preceding birth interval, household Size, breast feeding duration, mother's educational status, kinds of toilet were selected by the final model at 5% level of significance.

4.4.4.1 Assessing the Goodness of The Fitted Model

The hypothesis to test in relation to the overall fit of the model:

H0: There is no difference between null model and model with predictor variables.

H1: There is significant difference between null model and model with predictor variables.

4.4.4.1.1 The Likelihood Ratio Test

The LR test statistic is asymptotically chi-square statistic which is the difference in the -2 Log-likelihoods between the null and final models distributed with degrees of freedom equals to the difference between the numbers of parameters estimated in the two models.

Table 4.18: Summary Statistics of the Likelihood Ratio Test

Model	Model Fitting Criteria	Likelihood Ratio Tests			
	-2 Log Likelihood	Chi-Square	Df	$\chi^2_{(0.05,15)}$	Sig
Null model (Intercept only)	932.521	93.015	15	24.996	0.000
Final model	641.301				

In (Table 4.18) given above, to test null model over final model, chi-square which is difference of -2 Log Likelihood has 8 degrees of freedom was computed = 73.015 with p-value 0.000 less than 5% level of significance. This showed that there is no evidence to accept the null model. Therefore, the final model with predictors fits the data well, implying that the predictor variables had a significant effect (Montgomery, 2001).

4.4.4.1.2 Model Summary

Cox and Snell's R^2 attempts to imitate multiple R^2 based on "likelihood". From (Table 4.19) below, Nagelkerke‟s R^2 in model summary is adjusted version of Cox & Snell R^2 =0.741, which indicates that 74.1% of the variability in weight-for-age nutritional status of children is explained by the explanatory variables.

Table 4.19: Model Summary of Cox & Snell R^2 and Nagelkerke R^2

Model Summary		
-2Log likelihood	Cox & Snell R^2	Nagelkerke R^2
863.421	.576	.741

4.4.4.1.3 The Hosmer and Lemeshow Test

In (Table 4.20) given below is the Hosmer - Lemeshow test which divides subjects into 10 ordered groups of subjects and then compares the actual number in each group observed to the number predicted by the logistic regression model. Each of these categories is further divided into two groups based on the actual observed outcome variable (normal, underweight). The expected frequencies for each of the cells were obtained from the model. That is, well-fitting models show non-significance on the Hosmer - Lemeshow goodness-of-fit test. This desirable outcome of non-significance indicates that the model prediction does not significantly differ from the observed.

Table 4.20: Contingency Table for Hosmer - Lemeshow Test

Ordered group	Nourished		Underweight		Total observed
	Observed	Expected	Observed	Expected	
1	53	60.362	12	9.264	65
2	38	35.869	15	16.232	53
3	61	58.465	23	44.715	84
4	44	45.231	36	39.241	80
5	25	22.305	42	39.653	67
6	51	50.654	30	32.345	81
7	39	41.205	28	30.753	67
8	43	38.356	21	16.542	65
9	57	54.423	19	20.486	76
10	29	25.673	53	56.524	82

The values of Hosmer-Lemeshow statistic has chi-square value of 7.685 and a significance of .098, which means that Hosmer-Lemeshow test is not statistically significant and therefore our model has a good fit because p-value exceeds level of significance $(\alpha = 0.05)$ it shows that there is no significant difference between the observed and predicted model values and hence the model fits the data well, which has an agreement with the previous tests.

Table 4.21: Hosmer - Lemeshow Test

Chi-square	Df	Sig.
7.685	8	.098

4.4.4.1.4 Classification Table

On account of assessing the goodness of fitted model, we need to look at the classification which tells us how many of the cases where the observed values of the dependent variable, weight-for-age nutritional status for normal or underweight have been correctly predicted. The overall accuracy of the model to predict subject's status is shown in (Table 4.22). In our model, out of the 997 sampled children under the age five 908 (91.1%) were correctly predicted in their respective status. The specificity is given by 96.6% and the sensitivity is given by 93.8%, which indicates that 96.6% of nourished children and 93.8% of underweight was correctly predicted in their corresponding category. The number of errors where the dependent variable is predicted to be underweight but is in fact nourished is 3.4% and the number of errors where the dependent is predicted to be nourished but is in fact underweight is 6.2%.

Table 4.22: Classification Table.

Observed		Predicted		
		Nutritional status		Percentage
		Nourished	Underweight	Correct
Nutritional status	Nourished	612	24	96.6
	Underweight	47	296	93.8
Overall Percentage				91.1

4.4.4.2 Outliers and Influential Diagnostics

We are concerned with cases that might improperly influence our parameter estimates. Cook's distance is one way of analyzing influence statistic in logistic regression. In our regression model, a case is identified as influential if its Cook's distance is greater than one. According to Hosmer and Lemeshow (2000), the influence diagnostic must be larger than 1.0 for an individual covariate pattern to have an effect on the estimated coefficients. Since the minimum value 0.00000 and maximum 0.80432 value of Cook's influence statistics are less than one it indicating that the Cook's distance for each one of the observations in our data is less than one, so we conclude that there are no influential observations.

Table 4.23: Cook's Influence Statistics

	N	Minimum	Maximum	Mean
Analog of Cook's influence statistics	997	0.00003	0.41040	0.02860

4.4.4.3 Estimates for Logistic Model

In order to fit a linear logistic model to a given set of data, the k + 1 unknown parameters β0, β_1, …, βk have to be estimated. These parameters are readily estimated using the method of maximum likelihood.

Logistic regression using the "forward stepwise (likelihood)" was run. This procedure revealed that out of nineteen (19) statistically associated variables in the bivariate analysis at 5% level of significance, only seven (7) variables; Sex of child, Age of child, Breast feeding duration, Preceding birth interval, Mother's educational status, kind of toilet facility and Household size became significant predictors of Weight-for-Age nutritional status (Underweight). Among these predictor variables which had statistically significant association with the Weight-for-Age of children, only few of predictor variables were selected by the final model. These predictors were, Sex of the child, Age of a child, Breast feeding duration, preceding birth interval, Household size, Kind of toilet and Mother of a child had prenatal care visit. Results obtained by the procedures are shown in the final logistic regression model (Table 4.24) below.

Table 4.24: *Parameter Estimates for the Logistic Regression for* ***Weight- for- Age*** *of Children under Age five (Arsi Zone Selected Wereda's December 2016).*

Covariates	Category	$\hat{\beta}$	S.E $(\hat{\beta})$	Wald	Df	P-value	Exp.$(\hat{\beta})$	95.0% CI for exp.$(\hat{\beta})$ Lower	Upper
Sex of child	Female (Ref)			8.235	1	.010			
	Male	.843	.136	2.137	1	**.007***	**1.321**	.678	1.969
Age of a child	<=12 months (Ref0			5.432	2	.001			
	13-36 months	-2.825	.365	11.284	1	.108	.743	1.258	2.926
	37-59 months	.584	.351	8.625	1	**.042***	**4.823**	.783	1.432
Breast feeding duration	>24months (Ref)			6.286	4	.000			
	13-24months	.369	.052	11.625	1	.061	.323	.974	1.595
	6-12months	-2.276	.762	10.562	1	.307	.834	.173	.854
	<6months	.932	.231	13.860	1	**.005***	**1.634**	.846	1.093
	Never breast feed at all	.547	.104	9.682	1	**.014***	**3.603**	1.973	2.385
Kind of toilet	Traditional pit latrine (Ref)			11.514	1	.000			
	No facility/bush/field	3.215	.631	9.567	1	**.030***	**1.542**	1.304	2.111
Preceding birth interval	No preceding birth (Ref0			10.658	3	.000			
	5 and above years	-4.867	.565	14.532	1	.122	.586	.974	1.885
	3-4 years	.768	.196	9.867	1	.072	.857	.744	.995
	<=2 years	.556	.353	11.629	1	**.002***	**3.102**	1.256	1.998

Household size	2-3 (Ref)			12.584	2	.002			
	4-6	1.526	.857	7.685	1	.071	.586	1.834	2.683
	7 and more	.869	.666	3.625	1	**.042***	**1.130**	.875	1.665
Household source of drinking water	Pipe line (Ref)			13.775	3	.004			
	Protected well/public tap	-1.391	.421	10.236	1	.108	2.685	.728	.999
	Unprotected well	3.235	.789	6.561	1	**.026***	**1.356**	1.964	3.254
	Ground surface water	.887	.326	8.236	1	.0966	3.845	1.756	4.284
Constant		2.192	.514	3.629	1	.072	9.029		

(Ref) = Reference category, * = Statistically significant at 95% confidence level, **Method:** Forward Stepwise (Likelihood Ratio)

4.4.4.4 Discussion of the Final Model

From Table 4.24 Above sex of a child had significant effect on the nutritional status of children and male children were more likely to become underweight (OR=1.321) than female children. One of the studies done in our country has also shown an increase in malnutrition with increase in age of the child (Yimer, 2000). Here also the findings are similar in Chule and Merti woreda's where children aged 37-59 months were 4.823 times more likely to be underweight than their counterparts aged less than or equal 12 months.

A study conducted by Nguyen and Kam in Vietnam found out that the risk of malnutrition increases with age of a child. Children in the youngest age group 0-11 months had significantly lower risk of being underweight than children in the older age groups (Nguyen and Kam., 2008). The low risk to malnutrition may be due to the protective effect of breastfeeding since almost all children are breastfed throughout the first year of life. Higher rates of malnutrition after the 12 months are linked to inappropriate food supplementation during the weaning period.

Among other important demographic variables, household size is also found to be significant determinant of the child nutrition status measured WAZ. Unexpectedly, the coefficients of the variable are found to be positive and statistically significant for WAZ. In other words, a child in households with large family (7and more) is relatively more underweight than a child in a household with few members in a family.

The findings also indicate that there is a significant relationship between preceding birth interval and underweight among under-five children ($p<0.05$) in the woredas. As a result, children whose preceding birth interval was less than two years were 3.102 times more likely to be underweight than children who were born without any presiding interval (First order born).

Another noteworthy finding of this study is the positive and significant relationship of the kinds of toilet and child nutrition status measured WAZ. Children with a family which have no facility/bush/field were more likely (**p =.030 < 0.05 and OR = 1.542**) to be underweight than their counterparts those having traditional pit latrine (Ref). The result is in harmony with the results of Rhoda Azikoyo N. and Samuel Kuria M. in Kenya (2012). Also the result is agreed with similar findings conducted in SNNPR by Derege D. (2011).

Sure enough, this study proved that incidence of breast feeding (like >24months, 13-24months, 6-12months, <6months and never breast feed at all). As shown in Table 4.24 above, the variable is found to be highly significant (at <5%). Children who had less than six months breast feeding duration were 1.634 times more likely to be underweight than children who fed breast milk for more than 24months (Ref). The odds of being underweight for children who never breast feed at all were 3.603 times more likely to be underweight than children in the reference category.

Furthermore, safe water sources play particularly important role in determining child nutritional status, as expected. Specifically, the estimation result shows that children from households, who use safe water sources, are less likely to be underweight. The odd ratio test indicates that the probability of the child to be underweight can be more likely (OR=1.356) times when their family use unprotected well as a drinking water source. This empirical finding is also consistent with Christiansen and Alderman (2004) and Silva (2005).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the findings

The results from the study show malnutrition is one of the major challenges affecting under-five children in the selected woredas. The common forms of malnutrition were stunting, wasting and underweight. Among those forms of malnutrition stunting was the most common problem among under-five children in the woredas.

The Prevalence of stunting, underweight and wasting was 43.4%, 27.1 % and 14.8%, respectively. On the levels of malnutrition by gender, the analyses indicate that stunting and underweight were higher among male than female children at 47.8%, 40.5%and 30.3%, 24.8% respectively. Whereas female children were slightly more wasting than their male counterparts.

The empirical results of the overall findings underlines that the key determinants of child nutrition status are complex and interrelated, requiring a multilayered and all rounded interventions for improving the severity and ultimately alleviating the problem.

5.2 Conclusion

The main objective of this study was to identify main factors having an effect on nutritional status of under-five children in the selected woredas by using binary logistic regression model. Results from binary logistic regression showed that age of a child, sex of a child, breast feeding duration, birth order, mother's educational status, mothers' occupation, household size, source of drinking water for household, kind of toilet, preceding birth interval of child, mother's post natal care visit, mother's prenatal care visit, age at first birth of mother of a child and child birth weight were predictor variables contributing statistically significant effect in determining nutritional status of children under the age five in the woredas.

According to the results, age of a child, breast feeding duration, birth order, mother's education, and mother of a child had prenatal care visit were determinants of nutrition status measured HAZ of children. Maternal illiteracy had a negative effect on children's mean z scores of height-for-age. This result was confirmed by other studies which indicate that women's educational status are important underlying determinants of the nutritional status of children Smith LJ, Haddad L (1999). This may be due to the fact that illiterate mothers may be unaware about the nutritive value of feeding and hygiene practices. They may fail to prepare breakfast or lunch, and only send their children to school with bread. Many reports have indicated that schoolchildren who suffered under-nutrition, cannot benefit fully from formal education, and do not develop skills and abilities. Consequently, these children suffer further in terms of productivity and employment prospects, with implications for the economic development of the community.

Stunting in this study was highest in 37-59 months old children as compared to less or equal to 12 months old as it is related to the ages at which many children cease to be breastfed and are exposed to contamination from water, food and the environment. The prevalence of stunting is high for the child who never breast feed at all. A child who feed breast milk for 13-24 months was less likely to be stunted than the reference category (>24 months).

Children who were born from mothers had pre-natal care visit had lower probability to be stunted than children from whose mothers had no pre-natal care visit. Since the overall aim of antenatal care is to produce a healthy mother and baby at the end of pregnancy, taking antenatal visits may help the mother and child to have better health and knowledge of child caring practice. Further, this result suggests the importance of use of health facilities/services in reducing the incidence of Stunting (Malnourished).

Household size was independently associated with poor nutritional status both measured WHZ and WAZ. In this study it is found that children from larger households were more vulnerable to malnutrition. This could be because food for each household was limited and children were easily affected. Child birth weight was also one of the significantly associated factors with nutritional status measured WHZ of children. With a decrease of birth weight of children, increase risk of being undernutrition. This means, children born with a lower weight had a higher chance of being wasted compared to those of higher birth weight.

Among other important explanatory variables, a source of drinking water is also found to be significant determinant of the child nutrition status measured WAZ. Specifically, the estimation result shows that children from households, who use safe water source, are less likely to be underweight than those who do not use safe water sources for drinking purpose.

Another important factor, which was anticipated to influence child nutrition status measured WAZ, is the use of latrine. As expected, children from households who use pit latrine have significantly higher WAZ score. From the odd ratio test, it can be noticed that the probability of the child being underweight increases by 154.2%, with no facility/bush/field. The possible explanation is that the use of latrines may confirm the numerous health benefits associated with hygiene. Moreover, sex of a child, age of a child, breast feeding duration, and household size improved children's nutritional status measured WAZ.

In connection with the maternal factors, mother's age at first birth and mother's occupation were also found to be significant determinants of child nutrition status measured WHZ. Wasting was higher in mother who age is less than 20 years compared to other age category. The result also reveals that child from mothers who were wage labor had an increased risk of wasting than their counterparts.

The logistic regression analysis showed that children born at shorter years after the preceding birth interval were significantly underweight compared to children who had more than 2 years preceding birth interval. Longer intervals between births may allow more time for the allocation of sufficient family resources for the provision of food for additional needs of these children.

Furthermore, the findings of this study showed that age of a child and breast feeding duration were the main causes for both underweight and stunting. In the other side household size was the only factor that affect both wasting and underweight. This analysis found that the source of drinking water was strongly associated with malnutrition in children and it is believed that any water borne bacterial cause diseases had increased probability of being under nutrition (Underweight).

5.3 Recommendations

Based on results obtained from this study, we observed that the dominant predictors of children nutritional status were associated with demographic factors, toilet facility, source of drinking water, mother's occupation, household size, breast feed, birth related factors, non-utilization of the health services and lack of maternal education specially. Thus, based on our analysis the following recommendations are drown along these predictors.

Since children in older age category were highly prevalent to under nutrition, as analysis of this study showed, they should be given special care and support as much as possible. Mothers' age at first birth was one of the influential factors affecting children nutritional status especially when mothers' have less than twenty years old during first birth. Hence, awareness creations have to be made toward early marriage (effect of early marriage on under-nutrition).

Malnutrition is not only health related problem but it is also leading problem to enormous human potential. Therefore, government as well as the woreda health office should give due attention to the factors those contributing higher risk of under nutrition in children under age five. Moreover, use of family planning among mothers to increase birth intervals and reduced family size can result in significant reductions in childhood under nutrition.

More attention needs to be given to problematic area in accessing health facilities for lactating and pregnant mothers in the woredas, especially pre-and post-natal care service should be facilitated as well.

The government should be taking community-based interventions by giving priority to the poor households. Multi-sectorial partnership and networking are important for health promotion and minimizing child's under-nutrition. Zonal Health Department and Woreda Health Office should be strengthening the health extension program to improve and provide necessary education on nutritional program, environmental sanitation, hygienic practice, breast feeding duration, and weaning practices. And allow mothers to attain their highest level of education and therefore improve the socio-economic status of mothers by giving them a good opportunity to have a better occupation.

Moreover, given high correlation between low sanitation coverage (related to latrine use and unsafe water sources) and child malnutrition, government intervened investments into improvements of environmental health and supply of safe water should be considered immediately.

Finally, further findings should be incorporating for additional findings on risk factors which are associated with children nutritional status and influential factors which are not considered in this finding.

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Eastern Hararghe Zone, Ethiopia Tadiwos Zewdie and Degnet Abebaw

Appendix: Questionnaire

Adama Science and Technology University

Applied Mathematical Program

School of Applied Natural Science

A Questionnaire on the determinants of nutritional status among under-five children in Merti and Chole Woredas of Arsi Zone.

Dear Respondent,

This questionnaire is designed for academic research intended to assess the determinants of malnutrition among under-five children in the districts of Merti and Chole Woreda of Arsi Zone.

The purpose of this study and its findings is purely academic. We are kindly request for your assistance by sparing some of your precious time to participate in this study. All information provided will be handled and treated with utmost confidentiality.

By Desta Nigussu and **Birhanu Betela** (Lecturers in Applied Mathematics Program)

Thank you!

Instruction: Please provide your responses by making (√) on your choice box and by writing on the blank spaces provided.

Respondent relationship to the child________________________

Number of children below 5 years living in the household ________________________

INFORMATION ON CHILD FACTORES		
No	**Questions**	**Response**
1	Sex of the child	▢ = Female 1 = Male
2	Age of the child	________________________months
3	Birth order of the child	▢ = 1st 1= 2nd ▢3rd

		▢4th and more
4	Birth interval between the child and older sibling (if any)	________________ Year
5	Child birth weight	________________ Kg
6	Did the child get very ill in the last 3 months that you thought he/she could die?	▢ Yes ▢ I do not know ▢ No
7	Health status of child for past two weeks	▢ Sick Most of the time ▢ Sick some times ▢ Healthy all the time
8	Did the child get any of the following illnesses in the last 3 month's?	Diarrhea (▢Yes ▢ No) Malaria (▢Yes ▢ No) Typhoid (▢ Yes ▢ No) Measles (▢ Yes ▢ No) Other (Specify ____________________) No sickness (▢ Yes ▢ No)
9	Breast feeding duration of child	▢ Never breast feed ▢< 6 months ▢ 6-12 months ▢ 13-24 months ▢> 24 months
10	Food feeding frequency of child in a day	▢ Once ▢ 2-3 ▢ 4^+
INFORMATION ON MATERNAL FACTORS		
11	How old was the child's biological mother at birth?	______________________
12	Marital status of mother	▢ Never Married ▢ Widowed ▢ Divorced/ Separated ▢ Married
13	Mothers' educational status	▢ Uneducated ▢ Primary School ▢ Secondary School Completed ▢ Higher Education
14	Mothers' occupation	▢ Wage Labor ▢ Peasant Farmer ▢ Civil Servant ▢ Merchant ▢ Home-Wife
15	Mother had pre-natal care visit with pregnancy of child	▢ No ▢ Yes
16	Mother had post-natal care visit after given birth of child	▢ No ▢ Yes

INFORMATION ON HOUSEHOLD RELATED FACTORS		
17	How many members are there in this household?	____________________
18	Is the child's biological mother alive?	▢ No ▢ Not known ▢ Yes
19	Is the child's biological father alive?	▢ No ▢ Not known ▢ Yes
20	What is the main occupation of the household head?	Wage Labor Peasant Farmer Civil Servant Merchant Other
21	What is the educational level of household head?	Uneducated Primary School Secondary School Completed Higher Education
22	What is the main source of food for the household?	Food Aid Purchase Own Production
23	What is the source of drinking water for the household?	Surface Unprotected well Protected well Pipe
24	What type of toilet facility do members of the household use?	Open field Pit latrine
CHILD ANTHROPOMETRY		
	What is the weight of the child? (Kgs)	_____________(Kg)
	What is the height/length of the child? (m)	_____________(m)