THE "HIDDEN HUNGER"
Understanding the Burden and Determinants of Anaemia among Women in Ethiopia

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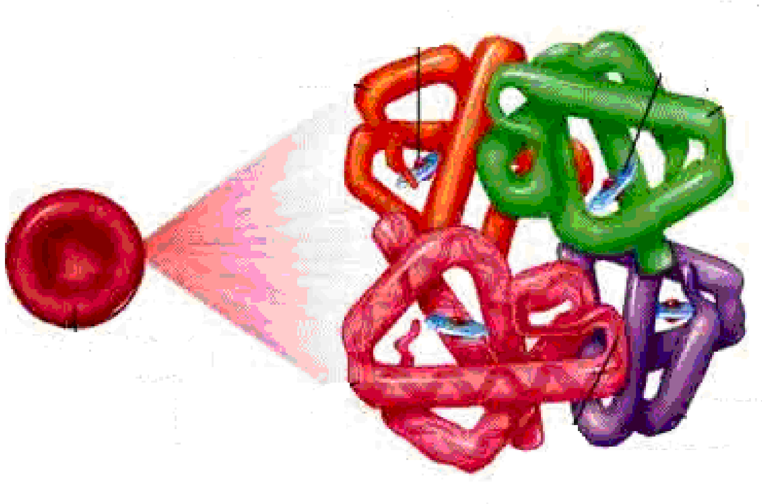

Masters in International Health (September 7, 2009-September 10, 2010)

KIT (Royal Tropical Institute); Development Policy & Practice

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A thesis submitted in partial fulfilment of the requirement for the degree of Masters of Science in International Health

By

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Declaration:

Where other people's work has been used (either from a printed source, internet or any other source) this has been carefully acknowledged and referenced in accordance with departmental requirements.

I here by declare that the thesis "**THE "HIDDEN HUNGER": Understanding the Burden and Determinants of Anaemia among Women in Ethiopia"** is my own work.

Signature: ____________________

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Acronyms used

ANC	Antenatal care
BMI	Body Mass Index
CBR	Crude Birth Rate
CDR	Crude Death rate
CI	Confidence Interval
CPR	Contraceptive Prevalence rate
DALY	Disability Adjusted Life Years
DHS	Demographic Health Survey
FEWS	Famine Early Warning System
FMoH	Federal Ministry of Health
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
IDA	Iron Deficiency Anaemia
IDD	Iodine Deficiency Disorder
IEC/BCC	Information, Education, Communication/Behavioural Change Communication
LIC	Low Income Countries
NGO	Non Governmental Organization
OR	Odds Ratio
PHCU	Primary Health Care Unit
SNNPR	Southern Nations and Nationalities Peoples' Region
TB	Tuberculosis
TS	Transferrin Saturation
UNICEF	United Nations Children's Fund
VAD	Vitamin A Deficiency
WHO	World Health Organization

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I would like to begin my acknowledgment by thanking God for he said “every thing has beginning and end”.

My big thanks go to Huygens Scholarship programme. My studies in Europe wouldn’t have come to reality had it not been for the financial aid I received from Huygens Scholarship.

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Abstract

Introduction: Anaemia is a global public health problem associated with an increased mortality and morbidity. The highest prevalence of anaemia exists in developing world where its causes are multi-factorial. In Ethiopia large size data was collected by DHS in 2005 but the data wasn't further analyzed.

Objective: To assess the magnitude and determinants of anaemia among women of child bearing age in Ethiopia

Methodology: The magnitude and individual/household based determinants of anaemia were determined using the 2005 DHS data. Permission to download and analyze the data was granted from ORC Macro. SPSS v12.0 was used to analyze the data. Both univariate and multivariate analysis were carried out. Macro level determinants of anaemia were considered through reviewing national responses and food security situations.

Result: A total of 5960 women of child bearing age were included in the analysis. The mean haemoglobin was 127.2 g/l (95%CI 126.6, 127.7g/l). The general prevalence of anaemia was 27.7% (95%CI 26.6, 28.9). In Afar, Somali and Gambella regions anaemia was a severe public health problem. In the remaining regions it was a moderate public health problem except in the capital where it was mild public health problem. Logistic regression analysis shows that possession of toilet and use of family planning are independent predictors of prevalence of anaemia. Drought and poor health care performance were correlated with prevalence of anaemia at regional level.

Conclusion and recommendations: Anaemia is prevalent in Ethiopia with clear regional differences. Improving existing efforts for environmental sanitation, educating women and expanding maternal health care services is recommended to control anaemia.

Key words: ***anaemia, women, Ethiopia, haemoglobin***

Word count: 14, 925 *(Maximum allowed 15000)*

Introduction

As an inbred assistant lecturer in Hawassa University, I have always developed the passion to study master programme in international health. Hawassa University is among the youngest universities recently launched in Ethiopia. There I was involved in teaching control of communicable diseases to public health officers.

My interest to study anaemia commences when I was an intern student before six years (2003/4) in a district hospital. In the hospital, I used to see several mothers, both pregnant and non-pregnant, presenting to the hospital with clear clinical anaemia. The pathogenesis of anaemia, a long standing deterioration in haemoglobin level, started clicking my mind of the potential possibilities of applying preventive momentum to the declining haemoglobin so that severe types of anaemia will be halted as early as possible.

Well, there are well known scientifically proven causes of anaemia. In fact in areas where infectious diseases like HIV and AIDS, malaria and soil transmitted helminthiasis and malnutrition are prevalent, anaemia could be a common associated condition. But understanding the webs of different factors that play a pivotal role, either alone or interacting with other variables, is of paramount importance to guide prevention policies.

Though there is national nutrition program in Ethiopia, issues like who to focus and specific activities to be accomplished are lacking mainly due to absence of strong studies to understand its determinants in the context of Ethiopia to back up the policy. The various pocket of studies conducted in different parts of the country may not be able to reflect the overall disease burden of the country.

Thus, in order to disentangle this complex issue I used different methods. Primary data analysis, and literature reviews were used as source of information and I organized my material in the following way

- ***Chapter 1: General information about the country, Ethiopia***
- ***Chapter 2: Statement of the problem, objectives and methodology***
- ***Chapter 3: Result***

- ***Chapter 4: Discussion***
- ***Chapter 5: Conclusion and recommendation***

Chapter I Background Information

1.1. General Information of the Country

Ethiopia is found in East Africa. The country covers approximately 1,221,900 square kilometres and shares frontiers with Eritrea, Sudan, Kenya, Somalia, and Djibouti. The major features of the country are massive highlands, complex of mountains and plateaus. The diversity of the terrain is fundamental to regional variations in climate, natural vegetation, soil composition, and settlement patterns. Administratively the country is divided in to eleven regions out of which two are city councils[1].

Ethiopia is one of the poorest nations in the world with total population of around 74 million; 51% being females[1]. The annual growth rate is estimated at 3.2%. Majority (85%) of the population reside in rural areas [2]. Around 80% of the work force are engaged in agriculture where as the remaining 20% are either engaged in trading or industry. Agriculture contributes to 45% of GDP (Gross Domestic Product) [3].

The education system is working well recently though the elementary school attendance rate and overall literacy rate stay at figures of 57% and 43% respectively. The literacy rate similar to most developing countries is skewed to the urban. The rural are less likely to enrol and highly likely to drop from school. The same situation holds for females who are less likely to enrol and more likely to drop out of school even if they are enrolled for education [1].

1.2. Major Health Indicators and Health Problems in Ethiopia

The health and health related indicators of the country are among the worst figures in the world. The CBR (Crude Birth Rate) and CDR (Crude Death rate) are 35.7 and 15.0 per 1000 population respectively. Maternal Mortality Ratio (MMR) is also one of the highest in the world with the currently used estimate being 673/100,000 live births. Similarly, infant mortality rate stays at higher figure of 77/1000 live births[4]. Though the total fertility rate is decreasing in trend over time, its value stays at one of the highest figures in the world and it is estimate to be 5.32 births per woman in 2008[2].

Malaria is the major public health problem in Ethiopia. Around 75% of the country is malarious area putting over 50 million people at risk of the disease. Out of which an estimated 9 million cases of malaria are expected to occur throughout the country. However, only around 4-5million of patients will be treated in health facilities. The disease accounts for seven per cent of outpatient visits and represents the largest single cause of morbidity[5].

Infection with geo-helminthiasis is also very common in Ethiopia. Several studies report high prevalence of hookworm infection[6-8], for instance a study conducted in Gambella region in west Ethiopia showed hookworm prevalence rate of around 60%[7] and another study conducted in Awash valley reported hookworm prevalence of 53%[8].

Under nutrition is a common problem in the country. The latest DHS survey report shows that twenty-seven percent of women were chronically malnourished (BMI less than 18.5). Three in ten women age 15-19 and women age 45-49 are thin or undernourished [4].

Other health problems like HIV, TB, sexually transmitted infections are also prevailing problems in the country[9]. The current prevalence of HIV is estimated to be 2.2%[10]. Reproductive health issues are also in general not well addressed with low contraceptive acceptance rate (CAR), high fertility rate and low ANC service utilization rate[9].

1.3. Health System Organization in Ethiopia

The Ethiopian health system is organized using the principle of primary health care. It is a four tier system with primary health care units (PHCU) at the bottom of the tier. The primary health care units are composed of health centres, health posts and other community heath agents including the recently launched health extension workers, already scaled to full level in rural settings. The primary health care units are the segment of the system that is very close to the community. Their major responsibilities are to provide promotive and preventive services with curative services for endemic diseases. They are majorly responsible for nutrition related preventive or promotive services [9].

According to the recent report from the FMoH (Federal Ministry of Health) there are a total of around 10,000 health posts, 670 health centres and 88 government owned hospitals. Health service coverage is showing increasing trend though big discrepancies exist between urban and rural areas. Shortage of human power is another burden to the health system of the country. The recent report from the ministry of health shows that there are a total of 1,806 physicians, 792 health officers, 18,000 nurses and 17, 600 health extension workers. A significant proportion of health workers are working in private institutions[9].

The total expenditure on health per capita is very low when compared with other countries staying at a figure of 22 USD in 2006 and the total expenditure on health as percent of GDP is also far below 10% remaining at a value of 4.9% in 2006 [11].

Chapter II Statement of the Problem, Objective and Methodology

2.1 Definition of Anaemia

In simple terms anaemia is defined as lower quantity of haemoglobin in the blood. Haemoglobin is a molecule in the red blood cell that is important for carrying oxygen from the lungs to tissues. However defining the term 'lower' has been a debatable issue for years. In the first place the distribution of haemoglobin depends on various population parameters like age, sex, pregnancy and smoking status[12]. Second the concentration of haemoglobin also depends on environmental factors like altitude[13,14].

Regardless of such limitations of using haemoglobin to define anaemia WHO (World Health Organization) has set thresholds to classify individuals with anaemia at sea level, for instance a pregnant women is said to be anaemic if her haemoglobin level falls below 110g/l [12,15](see Table 1 below).

Table 1: Cut-off levels of haemoglobin to define anaemia at sea level

S.N	Age or gender group	Hemoglobin threshold (g/l
1	Children (0.50-4.99 yrs)	110
2	Children (5.00-11.99 yrs)	115
3	Children (12.00-14.99)	120
4	Non pregnant women (>=15.00 yrs	120
5	Pregnant women	110
6	Men (>=15 yrs)	130

Source: WHO, 2008[15]

The WHO's definitions of anaemia are widely used; however, other cut-offs are also available. In one literature more than eight different thresholds have been identified; for instance, Jandi recommends lower limit of 14.2 g/dl to define anaemia assuming 2.5% of a population will be anaemic. There are also debates as to the role of ethnic differences in the definition of the threshold [16].

Evidences from statistical and physiologic studies show that haemoglobin distribution again varies with smoking status and altitude. Thus, correction formulas are necessary to adjust for these two parameters [14].

Several issues might rise as to the use of haemoglobin per se to estimate the prevalence of anaemia in a population. Some scholars suggest use of two or more indices to estimate the prevalence of anaemia especially of iron deficiency anaemia. However, most researches use haemoglobin counting for screening and for estimating prevalence of anaemia. Similarly, Friere points out that the calculated sensitivity and specificity of haemoglobin count to measure anaemia are so acceptable that it can be used for screening and to estimate the prevalence of anaemia [17]. In fact there are still scholars who argue that false positives and false negatives are high and suggest that the most sensitive measurement is the transferrin saturation (TS) [18].

2.2. Prevalence, Causes and Consequences of Anaemia

2.2.1 Global Estimates

Through use of national surveys and models, it was estimated that around 1.62 billion (95% CI: 1.50-1.74 billion) people are affected by anaemia. This absolute number of cases is translated to prevalence rate of 24.8% (95% CI 22.9-26.7%) world wide. It has been also found that globally the disease tends to affect more pre-school age children and adult women. In terms of absolute numbers non-pregnant women take the lion's share, with the figure estimated at 468 million (95% CI 446-491 million) women with anaemia [12].

Table 2: Global prevalence of anaemia and number of individuals affected, 2005

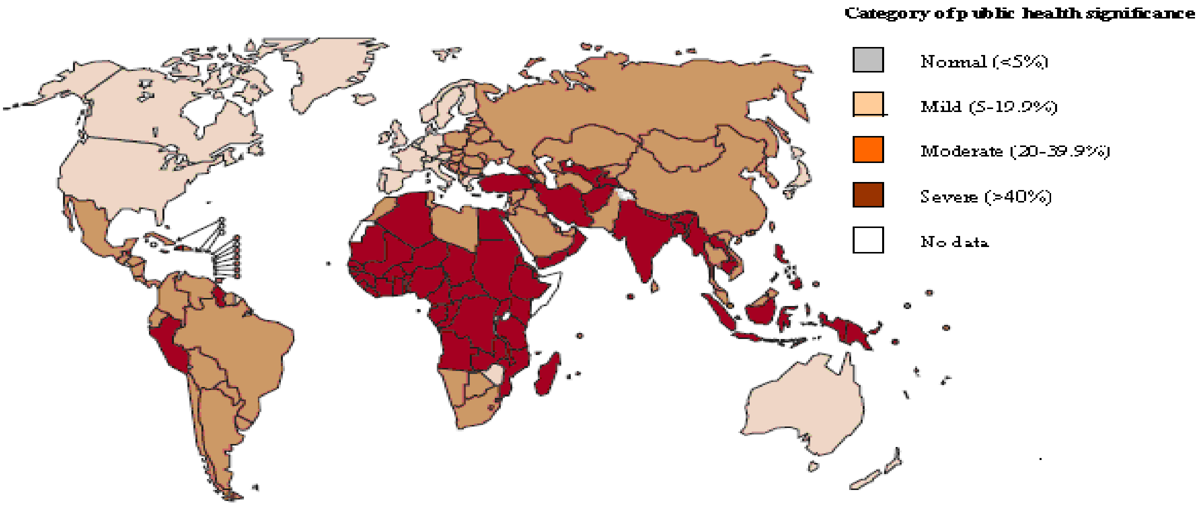
S.No	Population group	Prevalence of anemia		Population affected	
		Percent	95% CI	Number (million)	95% CI
1	Preschool-age children	47.4	45.7-49.1	293	283-303
2	School age children	25.4	19.9-30.9	305	238-371
3	Pregnant women	41.8	39.9-43.8	56	54-59
4	Non-pregnant women	30.2	28.7-31.6	468	446-491
5	Men	12.7	8.6-16.9	260	175-345
6	Elderly	23.9	18.3-29.4	164	126-202
	Total Global	24.8	22.9-26.7	1620	1500-1740

Source: WHO, 2008[15]

The degree of public health significance of anaemia in a certain population is categorized using prevalence estimates. Accordingly a population or a country can be one of the four categories: no public health problem (prevalence of Less than 5%), mild public health problem (prevalence of 5-19.9%), moderate public health problem (prevalence of 20-39.9%) and severe public health problem (prevalence of >= 40%) [12,15,19].Inline with this concept, only two countries out of 192 countries were categorized as no public health problem where as 80% of the countries have a moderate or severe public health problem of anaemia [12,15].

The highest prevalence of anaemia exists in Low Income countries (LIC). They bear more than 90% of the global burden. Africa alone shares around 40% of the global burden among pregnant women (see fig 1) [15,20].

Figure 1: Anaemia as a public health problem by country among pregnant women



Source: WHO, 2008[15]

2.2.2. Causes of Anaemia

There are many clear causes of anaemia. By far the commonest cause of anaemia is iron deficiency anaemia. And sometimes it is interchangeably used with the gross term of anaemia. More than 1 billion populations in the world are estimated to suffer from IDA. It is ranked as the third major cause of DALYs (Disability Adjusted Life Years) lost among females age 15-44 years. Iron deficiency can be caused by many reasons. First, through consumption of nutrients that are poor in iron. Second, through consumption of diets which are reach in iron but are not well absorbed. Third, through simultaneous intake of diets that is rich in inhibitors of absorption of available iron from the diet. Other major cause of anaemia especially among women of reproductive age group is blood loss during labour & delivery; heavy menstrual blood flow; and closely spaced pregnancies. Other causes of anaemia include folic acid deficiency, vitamin B12 deficiency, infectious disease like malaria, hookworm and HIV, and inherited disorders like sickle cell disease [20-22].

2.2.3. Consequences of Anaemia

Globally iron deficiency anaemia alone causes 841,000 deaths and 35,057,000 DALYs lost. "Africa and parts of Asia bear 71% of the global mortality burden and 65% of the disability-adjusted life years lost, whereas North America bears only 1.4% of the global burden". [12,15]

The consequences of anaemia extend beyond the affected patient. If we take the case of pregnant women suffering from anaemia, its effect will cross generations. In the first place it affects the mothers' well being. It makes them more vulnerable to infectious diseases, recover from diseases too slowly, highly likely to die from maternal complications like haemorrhage, sepsis and hypertension. Secondly, it will also affect the well being of the foetus. Anaemic mothers are more likely to give birth to a low-birth weight baby who will be at high risk of developing non communicable diseases later on in its life, more likely to die in the first year of life and also if becomes an adult more likely to give birth to malnourished baby[23-30].

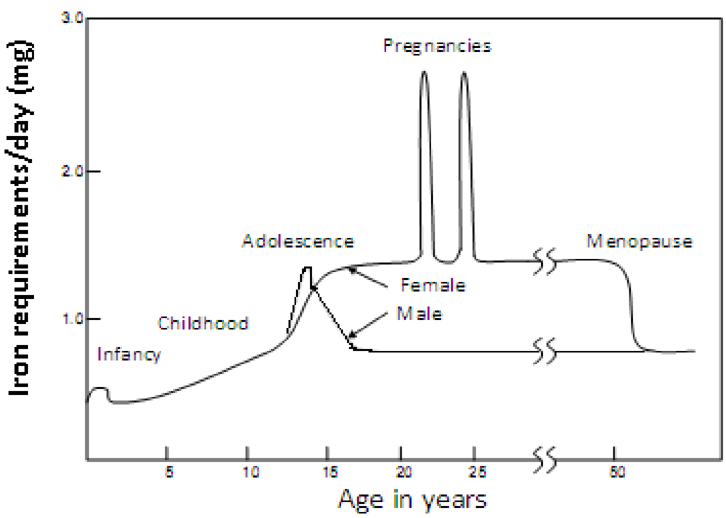
Anaemia also plays an important role in the economic development of a nation. This effect of anaemia could be because of the fact that it causes reduced school performance in children and women, causes weakness, fatigue, and reduced physical ability to work among affected individuals, 10% decrease in haemoglobin results in 15% decrease in productivity among adults[31-33].

2.3 Anaemia in women

Women are at increased risk of becoming anaemic due to several physiologic or socio-cultural factors. Significant iron loss occurs in women during menstruation. Median monthly loss of blood during menstruation has been estimated at 35 ml which is equivalent to more than 12 mg of iron[34].

Because of women's greater iron requirements, and also because they usually consume less food than men, women's daily iron intake tends to be marginal, and they are therefore more likely to develop anaemia than men. This is especially true in many developing countries where the general food consumption is reduced because of poverty, unwise agricultural practices, and other reasons[35]. Based these facts certain critical periods when iron requirements are significantly increased have been identified. After menstruation starts, the iron requirements of the female exceed those of the male. A significant increase in iron requirements occur during pregnancy[35]. The following figure describes iron requirements by age, sex and pregnancy status.

Figure 2: Daily Iron requirement by age, sex and pregnancy status

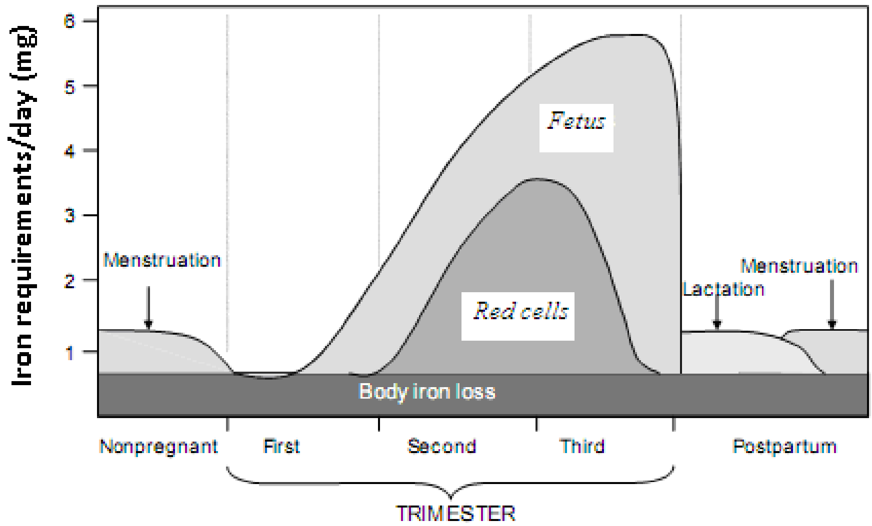


Source: Sharman (2000)[35]

Iron Losses in Pregnancy and Lactation

The iron requirement during pregnancy is the highest when compared with other life periods. The second and third trimesters of pregnancy constitute a major drain on the iron reserves of women of reproductive age[36] . The following figure illustrates daily iron requirements during pregnancy.

Figure 3: Daily iron requirements during pregnancy and after delivery



Source: Bothwell (2000)[36]

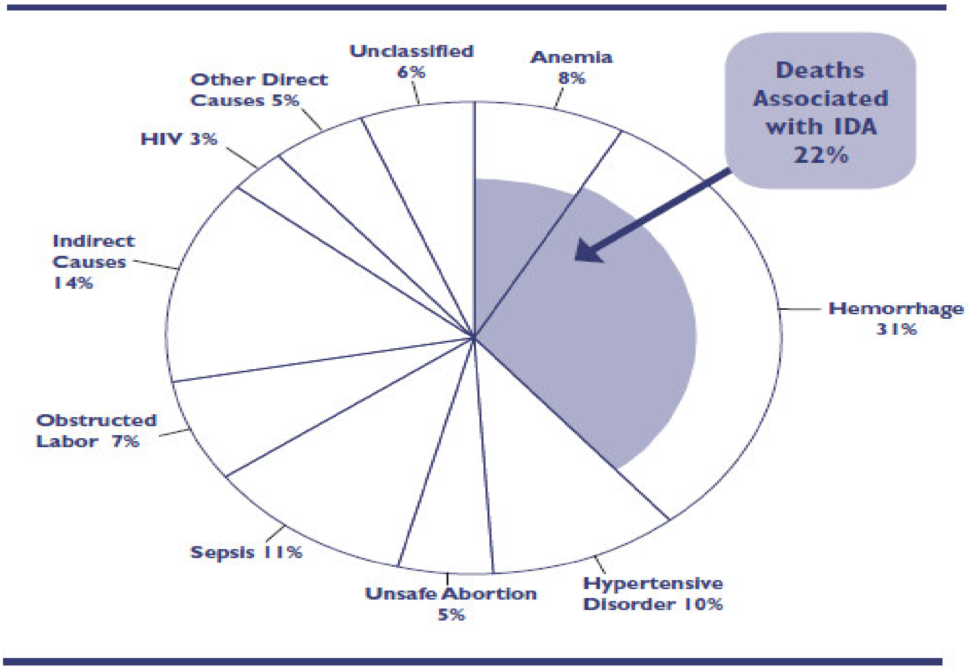
After delivery, expanded red cell mass contracts and some iron returns to reserve sites. However, despite such return, the average cost of each pregnancy in terms of iron loss is still high, approximately 680 mg. The size of iron stores at the beginning of pregnancy plays an important role. Iron requirements are higher in mothers who begin pregnancy with depleted or low iron stores [36].

2.4 Anaemia and Maternal Health

There is an established relation between anaemia and maternal mortality. Iron deficiency anaemia alone was estimated to be an underlying factor for 22% of maternal deaths around the world (see fig4 below)[22]. A community based study in Kwale district in Kenya reported anaemia related maternal deaths of 82/100,000 live births, similar or higher figures were reported from other countries in Africa and Asia[37] . Severe anaemia has been shown to be major contributor to maternal deaths though mild and moderate anaemia also increases the risk of death when compared with non-anaemic mothers [22,23,38,39].

An ecological study was also carried out with the aim of linking anaemia prevalence to MMR. In this study the investigators used data bases from WHO on the prevalence of anaemia and extent of maternal mortality. Finally they concluded that the observed correlation between these two variables was highly significant (Pearson correlation coefficient 0.561, $p<0.001$). Another interesting conclusion that they drew was the fact that exponential model best fits the data set with the coefficient of determination of around 40% [(log MMR=1.50+0.019($P_{anaemia}$), R^2=41.1%]. However, such kind of ecological studies could be confounded by several variables; for instance, high anaemia prevalence areas are usually areas with poor obstetric care. Nevertheless the finding can still give an insight in to the role of anaemia on maternal deaths [38].

Figure 4: Causes of maternal death and contribution of iron deficiency anaemia



Source: A2Z FANTA project (2006)[22]

2.5 Anaemia in Ethiopia

Anaemia has been recognized as one of the problems of public health significance for decades in Ethiopia. It is ranked among significant micronutrient deficiency problems which includes VAD (vitamin A deficiency), IDD (iodine deficiency disorders) and IDA (iron deficiency anaemia)[40]. According to estimates from WHO, anaemia is classified as severe public health problem for all the three groups: Pre School age children [75.2% (95% CI 40.7-93.1), pregnant women [62.7% (95% CI 30.1-86.7)], and among non pregnant women [52.3% (95% CI 24.9-78.4%][15]. Several public health important causes of anaemia can be described in the context of Ethiopia:

Infectious causes

Malaria: Malaria related anaemia is among leading causes of death in pregnant women and children. The primary cause of anaemia from malaria is hemolysis of Red Blood Cells (RBCs). Other mechanisms are also forwarded by experts including hypersplenism, sequestering RBCs and rupture of parasitized RBCs [20]. In areas where malaria is common, like most parts of Ethiopia, anaemia related to malaria could also be prevalent.

Hookworm: morbidity related to hookworm is primarily due to chronic intestinal blood loss. Hookworm is very common and is extremely difficult to eradicate in areas of poverty and poor environmental sanitation. Hookworm causes blood loss by releasing anti-clotting agents resulting in ongoing loss of blood in the stool. A large amount of blood is lost in the stool; for instance, *Ancylostoma duodenale* can cause 0.25ml loss of blood per worm per day[20]. Hookworm is a common infection in Ethiopia especially among rural residents.

Other infectious causes of anaemia include HIV and AIDS schistosomiasis which are also common in Ethiopia[33].

Fertility related causes

High fertility can lead to anaemia through gradual degradation of the woman's haemoglobin. The fertility rate is among the highest in Ethiopia [33].

Nutritional causes

Low intake of micronutrients like iron and folic acid are also important causes of anaemia. Diversification of diets is very uncommon in typical households of Ethiopia. This may predispose the nation to micronutrient deficiencies like anaemia [41].

In Ethiopia grains are the chief element of diet. The major grains are 'teff' (*Eragrostis tef*), wheat, barley, corn, sorghum, and millet. The first three are primarily cultivated at altitudes generally above l, 500 meters. Teff is said to be highly rich in iron. Fleming documented that daily consumption of iron in Ethiopia is the highest extreme among other countries in the tropics. The daily consumption may reach as high as 180 mg per day. It is suggested that contamination of teff with inorganic iron during preparation is one of the reasons for the high iron concentration[21]. Due to these facts researchers in the previous times were used to conclude that iron deficiency anaemia is a rare problem in Ethiopia[41]. The iron content of other common diets is put under annex 1 and 2.

Sorghum, millet, and corn are cultivated mostly in warmer areas at lower altitudes. Sorghum and millet grow well at low elevations where rainfall is less reliable. Corn is grown chiefly between elevations of l, 500 and 2,200 meters. 'Enset', known locally as 'false banana', is an important food source in Ethiopia's southern and south-western highlands. The consumption of vegetables and fruits is relatively limited, largely because of their high cost. Common vegetables include onions, peppers, squash, and cabbage [42].

The presence of such complex infectious and non-infectious conditions unfolds the fact that anaemia would be a common co-morbidity in the country. Thus, this study aims at quantifying the burden of anaemia among women, and factors determining its magnitude so that interventions sought will be based on scientifically proven evidences.

3 Objectives

3.3 General Objective

To assess the magnitude and determinants of anaemia among women of child bearing age in Ethiopia

3.4 Specific Objectives

- To analyze the distribution of haemoglobin among women of child bearing age in Ethiopia
- To identify factors which affect the distribution of haemoglobin among women of child bearing age in Ethiopia
- To assess the magnitude of anaemia among women of child bearing age in Ethiopia
- To analyze the determinants of anaemia among women of child bearing age in Ethiopia
- To assess the national responses towards anaemia among women of child bearing age in Ethiopia
- To lay down possible recommendations in order to tackle the problem of anaemia among women of child bearing age in Ethiopia

4 Methodology

Both primary data analysis and literature reviews were used. To answer the first four objectives DHS data were analysed. DHS is a national survey conducted every five years in Ethiopia and other LICs. To respond to objective number five and drought as determinant factor literature reviews were used. Detailed description will be as follows:

4.1 Sample design

The DHS 2005 sample was stratified, clustered and selected in two stages. A total of 14500 representative households were selected from 540 primarily selected clusters. Two stage sampling procedure was used; the first stage was to select the 540 clusters (145 urban and 395 rural) from the list of enumeration areas of the 1994 Population and Housing Census[1] sample frame.

In the census frame, each of the 11 administrative areas is subdivided into zones and each zone into woreda[2], the next administrative level in the country. In addition to these administrative

[1] Population and Housing Census was conducted by population and housing census commission under the office of the Central Statistics Agency of the country

[2] Woreda is an administrative local government of Ethiopia equivalent to a district.

units, each woreda was subdivided into convenient areas called census enumeration areas. Each enumeration area was either totally urban or rural and the enumeration areas were grouped by administrative woreda. Demarcated cartographic maps as well as census household and population data were also available for each census enumeration areas. The 1994 Census provided an adequate frame for drawing the sample for the 2005 EDHS. However, despite efforts to cover the settled population, there may be some bias in the representativeness of the regional estimates for both the Somali and Afar regions, primarily because the census frame excluded some areas in these regions that had a predominantly nomadic population. Between 24 and 32 households were then systematically selected from each cluster.

4.2 **Data collection**

The data collection technique used was described in the 2005 EDHS final report. The data was collected through questionnaires and blood collection. There were separate questionnaires for women and household in general. "Haemoglobin testing was done using the HemoCue system. Before the blood was taken, the figure was wiped with an alcohol swab and allowed to air dry. Then the palm side of the end of a figure was punctured with a sterile, non-reusable, self retractable lancet and a drop of blood collected on a HemoCue microvette and placed in a HemoCue photometer which displays the result". In addition for variables lacking in the data literatures were reviewed from different journals, web sites as shown in section 4.5, below.

4.3 Variables

Dependent variables [out come of interest] are level of haemoglobin and anaemia

Independent variables/issues [predicting variables] are wealth index, possession of toilet, level of parity, use of contraception, past 24 hours diet history, altitude of residential place, educational status of the women, region and type of residence, age, pregnancy status, religion and ethnicity, food security status and national responses

4.4 Data Analysis

Data was analyzed using SPSS version 12.0. The data that was downloaded were already entered and cleaned on the same software but higher version. Since version 12.0 can read and do the analysis same way no further correction was made for the data. Under few circumstances of drawing graphs the relevant data were copied to STATA version 10.0 which was used to draw certain statistical graphs and used also for double checking the results.

Both univariate and multivariate analysis were carried out. For factors that affect anaemia, logistic regression model was used and for factors affecting haemoglobin levels, linear regression model was used. For all statistical procedures applied level of significance was set at alpha of 0.05.

Before running logistic regression model variables that predict prevalence of anaemia were first identified through appropriate statistical tests. Variables which were found to have association with anaemia prevalence were then further analyzed for potential confounding using the logistic regression model. Presence of confounding was first checked after analyzing the effect of the associated variables through running stratified analysis for the potential confounder.

At elevations above 1000m, haemoglobin concentrations increase as an adaptive response to the lower partial pressure of oxygen and reduced oxygen saturation of blood. The compensatory increase in red cell production ensures that sufficient oxygen is supplied to tissues. Accordingly many kinds of adjustment curves have been set forward. However, the commonly used one is the one recommended by Centre for Disease Control (CDC) Atlanta and expressed as follows[43]:

- Haemoglobin = - 0.32 x (altitude in meters x 0. 0033) + 0.22 x (altitude in meters x $0.0033)^2$

Hence all words named 'haemoglobin' in the result section refer to altitude adjusted values.

4.5 Ethical Clearance

The data has been downloaded from the DHS website after contacting the ICF Macro international and obtaining an official password through which the data can be accessed. Permission was requested and granted separately for the women data and HIV data. Ethical issues concerning primary data collection is posted under annex part as it was used by the original data collectors. No further efforts will be made to trace back the subjects and the data will be kept confidential as per the agreement made with the ORC Macro.

4.6 Search Strategies

For the literature review different search engines including Google, Google scholar, Scopus, Pub med, etc were used. Text books and some documents from KIT library were also used to access some of the information that cannot be obtained online. The following key words, either alone or in combination, were used for the online searches: anaemia, anaemia, women, pregnant women, prevalence, associated factors, determinants, Ethiopia, malaria, hookworm, HIV/AIDS, iron/folate, health and related indicators, haemoglobin, haemoglobin, maternal mortality, perinatal outcome, delivery complications, child survival, infant survival, maternal, economic, development, demography, health, survey, malnutrition, grade, intervention, health system,

Peer reviewed articles were majorly used as references. However for key information that cannot be traced through such approach, gray literatures were used. Various international websites including WHO, UNICEF, and World Bank sites were also consulted.

4.7 Limitations

The survey was cross sectional in design hence the findings may suffer from lack of temporal relations for some analytic procedures used. In this study only haemoglobin was used to describe anaemia and the data doesn't contain cause related variables like stool examination and blood tests for malaria. Other variables like shoes wearing habits and heavy menses were lacking in the data set.

Chapter III RESULT

This chapter has three sections. The first section describes the response rate and characteristics of the respondents; the second section embarks on analysis of different determinants as predictors of haemoglobin level as an independent continuous variable and anaemia, the third section deals with drought situations and national responses as determinant factors of anaemia at macro levels.

1. Response rate and characteristics of study participants

1.1 Response rate

The 2005 DHS survey included a total of 14,070 households for interview. Haemoglobin test was planned to be conducted once in every two households for women and children. Since this analysis focuses only on women, haemoglobin result for women was selected. Accordingly 6,812 women were selected for haemoglobin test. However 6721 women were interviewed for haemoglobin testing. Consent statement was read for 6721 women out of whom 5984 women gave consent but only 5963 gave their blood for haemoglobin testing; making the total response rate of 87.5%. The data collection flow is put under annex 4.

Further analysis of the characteristics of responders and non-responders showed that there is no significant variation between the two groups. However, more than 20% of participants from Afar, Somali and Dire Dawa regions didn't give consent and blood for haemoglobin test. Grossly the rural residents responded well (88.7%) than urban residents (80.1%). Response rate linearly decreases with educational status; the well educated were less likely to give blood for the test (further description see Annex 3).

1.2 Description of the Sample Population

The median age of the respondents was 26.0 years. The range of respondents' age was 34 years with 15 years the minimum age and 49 years being the maximum age. When age was categorized in to five years group majority of the study participants belong to the age range of 15-19 years which accounts for 23.4% of the study population. Similar to the population distribution based on type of residence in the country, majority of the study population were rural dwellers; three of four women were rural dwellers in this study population. Majority of the respondents were from Oromia or SNNP regions which encompass 16.3% and 16.8% of the total study participants respectively. Approximately one in every two women was orthodox Christians. More than half of the study participants (61.0%) had no education where as only 2.3% have attended higher education level. (Table….)

Table 3: Characteristics of the study participants based on selected variables, DHS 2005

S.No	Variables		Number	Percentage
1	Age 5-year groups	15-19	1397	23.4
		20-24	1089	18.3
		25-29	1109	18.6
		30-34	725	12.2
		35-39	689	11.6
		40-44	515	8.6
		45-49	439	7.4
2	Religion	Orthodox Christian	2858	47.9
		Muslim	1895	31.8
		Protestant Christian	1023	17.2
		Others	119	2.0
		Catholic Christian	68	1.1
3	Type of place of residence	Rural	4327	72.6
		Urban	1636	27.4
4	Highest educational level	No education	3636	61.0
		Primary	1327	22.3
		Secondary	861	14.4
		Higher	139	2.3
5	Wealth index	Poorest	1212	20.3
		Poorer	951	15.9
		Middle	931	15.6
		Richer	887	14.9
		Richest	1982	33.2
		Total*	5963	100.0

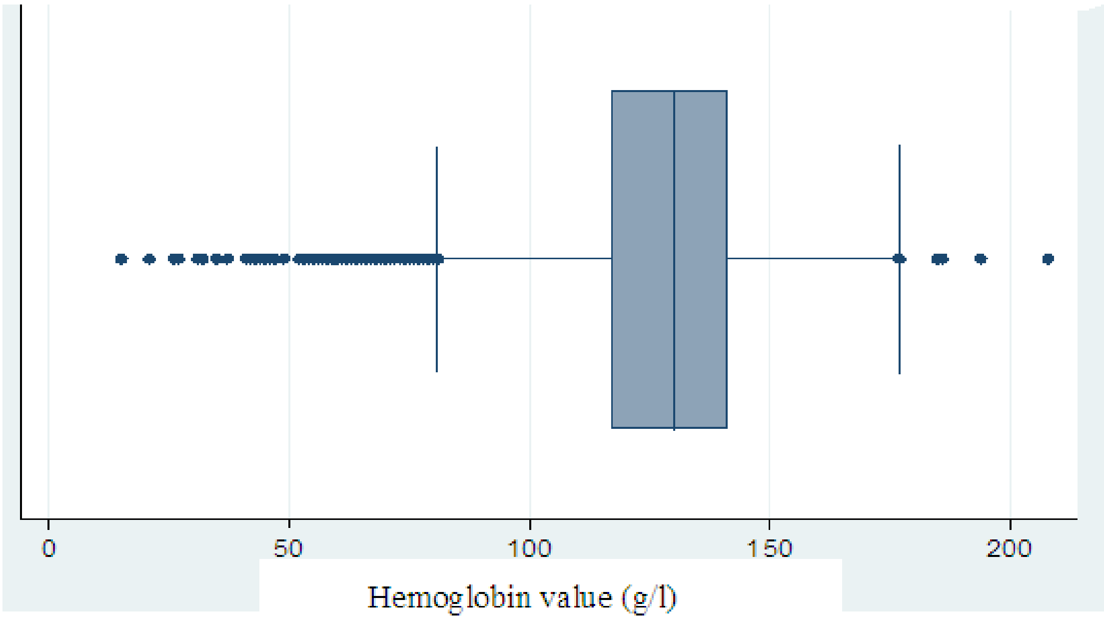
** Total is the same for all sub groups*

The data was explored for possible entry errors or missing values. Three cases were removed from the data list because of an unacceptably low hemoglobin level and were presumed to be an error in the data entry or during data collection. The hemoglobin level for the three women was 3g/l, 6g/l and 355g/l. Thus the data analysis reported here after considers 5960 study participants.

2. Overall distribution of haemoglobin and anaemia

Haemoglobin: Grossly the mean haemoglobin concentration was 127.2 g/l (95% CI126.6, 127.7g/l) with ± 2SD of 39.6 gm/l. The gross mean is almost equal to the 5% trimmed mean which is 128.3g/l. The minimum haemoglobin value is 15g/l where as the maximum value is 208g/l making the range 340g/l. The 25th percentile is 117g/l where as the 75th percentile is 141g/l making the inter quartile range 24g/l. The following box-whisker plot depicts the variations in haemoglobin distribution.

Figure 5 : Box and whisker plot showing distribution of haemoglobin among study participants, DHS 2005



Anaemia: The altitude adjusted haemoglobin value was used to classify the different levels of anaemia. Accordingly haemoglobin value less than 70 g/l was classified as severe anaemia, 70-99 g/l was classified as moderate anaemia, 100-109g/l was classified as mild anaemia for pregnant women, 100-119g/l was classified as mild anaemia for non-pregnant women; and level more than 110 and 120g/l were classified as not anaemic for pregnant and non-pregnant women respectively.

The general prevalence of anaemia was 27.7% (95%CI 26.6, 28.9) among this study group. Out of the total 5960 women, eighty two (1.4%), and 465 (7.8%) were having severe and moderate anaemia respectively (see following table).

Table 4: General prevalence of anaemia among women in Ethiopia, DHS 2005

Anemia level	Frequency	% (95% CI)	Cumulative %
Severe	82	1.4 (1.1, 1.7)	1,4
Moderate	465	7.8 (7.1, 8.5)	9,2
Mild	1105	18.5 (17.6, 19.5)	27,7
Not anemic	4308	72.3 (71.1, 73.4)	100,0
Total	5960	100,0	

3. Univariate analysis for factors affecting levels of haemoglobin and anaemia

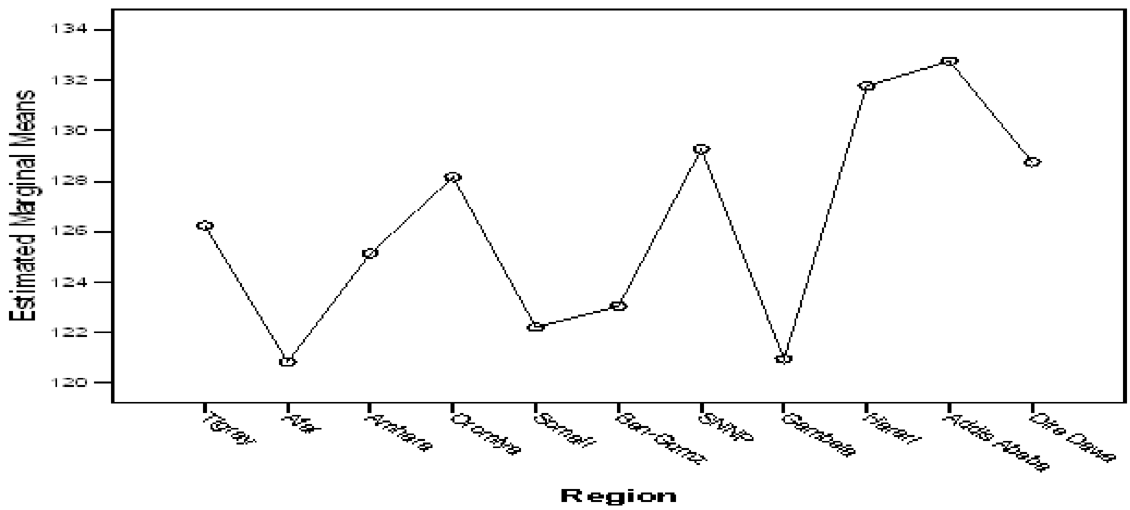
3.1. Environment related variables and age

In this section regions, type of residence, altitude categories, possession of toilet and age are considered as independent predictors of anaemia and level of haemoglobin.

Regional variations

The nine regions and the two city councils were compared in this part. Out of these regions and city councils Afar and Gambella have the lowest mean haemoglobin level. Relatively Addis Ababa and Harari regions have the highest haemoglobin levels when compared with other regions. The mean haemoglobin level for the Afar region is 120.8g/l (95% CI of 118.6 to 123.1 g/l) and that for Addis Ababa region is 132.8g/l (95% CI of 131.3 to 134.3g/l). The highest mean difference observed was the one between Afar Region and Addis Ababa city council; with the point estimate of 11.9 and 95% CI of 7.3 to 16.6 g/dl followed by the difference between Gambella and Addis Ababa with point estimator of 11.8g/dl (95% CI of 7.4, 16.2g/l).The distribution of haemoglobin by region is shown in the figure below.

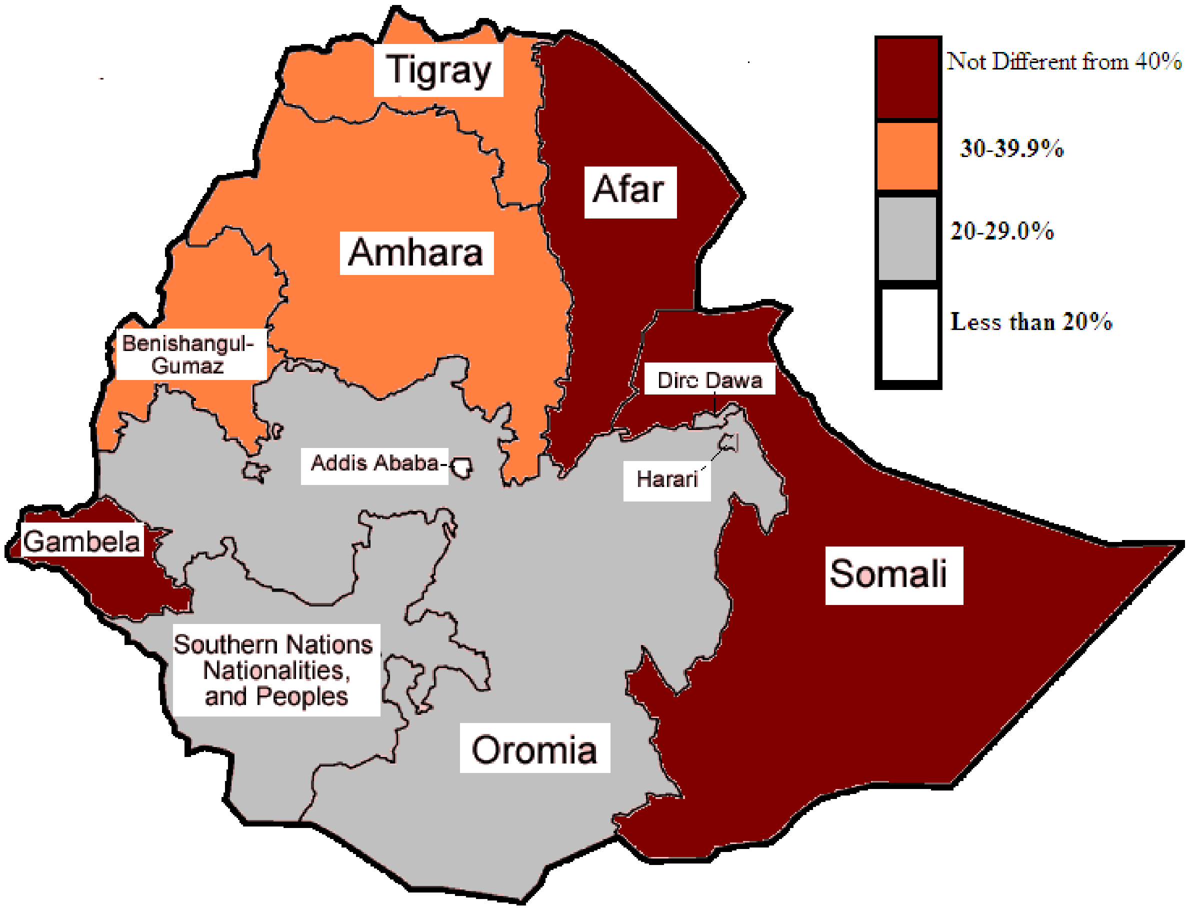
Figure 6: Estimates mean haemoglobin values among women by region, DHS 2005



When prevalence of anaemia among women was analyzed separately for each region, Afar and Gambella had prevalence of more than 40%. The prevalence in Somali region was also closer to 40%. The hypothesis test run to see weather the population prevalence among women is different from 40% showed that the true prevalence in the Somali region is not also less than 40%.

In order to simplify the regional differences regions with similar prevalence of anaemia were grouped together. Accordingly the highest prevalence of anaemia was observed in the region categorized as Afar/ Somalie / Ben-Gumuz/Gambella. The lowest prevalence was observed among the Addis Ababa/Hararie group. Numerically, the prevalence of any type of anaemia was 18.2% (95%CI 15.8, 20.6%) and 37.9% (95%CI 35.3, 40.6%) for the Addis Ababa/Hararie region and Afar/Somalie/Ben-Gum/Gambella region respectively. The odds of being anaemic in the second category was approximately three times higher than in the first category and the ratio is statistically significant OR 2.74 (95%CI 2.26, 3.33). No correlation has been observed between regional anaemia level and regional prevalence of HIV. The following figure shows the regional prevalence of anaemia.

Figure 7: Prevalence of anaemia among women by region, DHS 2005



Type of place of residence

The mean haemoglobin for the urban study population is 133.0 with +2SD of 35.0 and for the rural study population is 125.0 with +2SD of 42.0 g/dl. The Leven's test for equality of variance is not statistically significant showing that the variances are equal for the two groups and the difference between the two groups is statistically significant; the urban population in this study group had higher haemoglobin level than the rural population (p<0.0001, 95% CI for the urban rural difference 7.00-9.2g/dl). The residence based difference is consistent through different altitude groups.

Out of the total 4324 rural dwellers among the study participants 31.2% (95%CI 29.9, 32.6%) had any type of anaemia where as in the remaining urban dwellers it was 18.4% (95% CI16.5, 20.3%). The odds of being anaemic were twice as large in rural dwellers when compared with urban settings and the ratio was statistically significant OR2.02 (95%CI 1.75, 2.32).

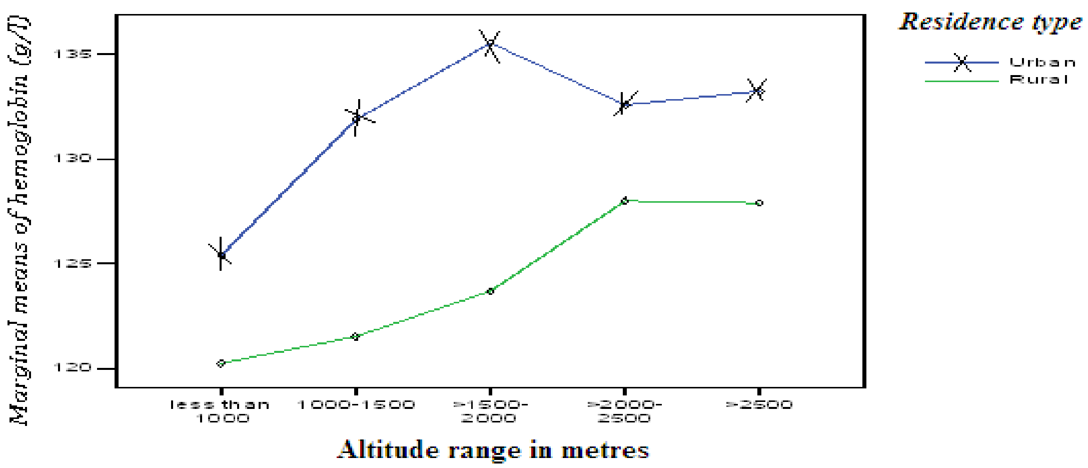
Moreover, the prevalence of severe/moderate anaemia was 11.0% among rural dwellers where as it was 4.5% among urban dwellers. The odds of being moderately/severely anaemic was two and half times higher among rural dwellers than urban dwellers it ratio was statistically significant OR 2.64 (95%CI 2.03, 3.42). When the analysis was further carried out only for pregnant women, all the 80 (16.9%) pregnant women with moderate/severe anaemia were rural dwellers; the difference was statistically significant using one sided Fischer's exact test (p=0.001)

Altitude

Cluster altitude was measured in meters during the 2005 EDHS. As it would be very difficult to assess the role of malaria directly from the data, this altitude parameter was used as a proxy to the role of malaria in the distribution of haemoglobin. Thus, the cluster altitude was grouped in to five groups ranging from less than 1000m to more than 2500m. One in three study participants were living in a cluster of altitude classified as >2000-2500m and similar figure were also living in a cluster of altitude ranging from 1500 to 2000m.

The mean haemoglobin is 121.0g/l (95% CI 119.3, 122.7 g/l) for the less than 1000metres altitude group whereas it is 130.0g/dl for the 2000-2500 meters with 95% CI of 128.8, 130.6 g/dl. The mean haemoglobin is significantly lower for the less than 1000metres altitude group than the other groups (Bonferroni test pair-wise comparison, p<0.05 for all possible pairs). Meanwhile, it's higher for the altitude ranging between 2000-2500 when compared with other possible pairs (Bonferroni test pair-wise comparison, p<0.05) except for the >2500metres where it is not significant (p=0.98). The following mean-plot shows the distribution of haemoglobin by residence and altitude ranges.

Figure 8: Mean haemoglobin values by altitude and type of residence among women, DHS 2005



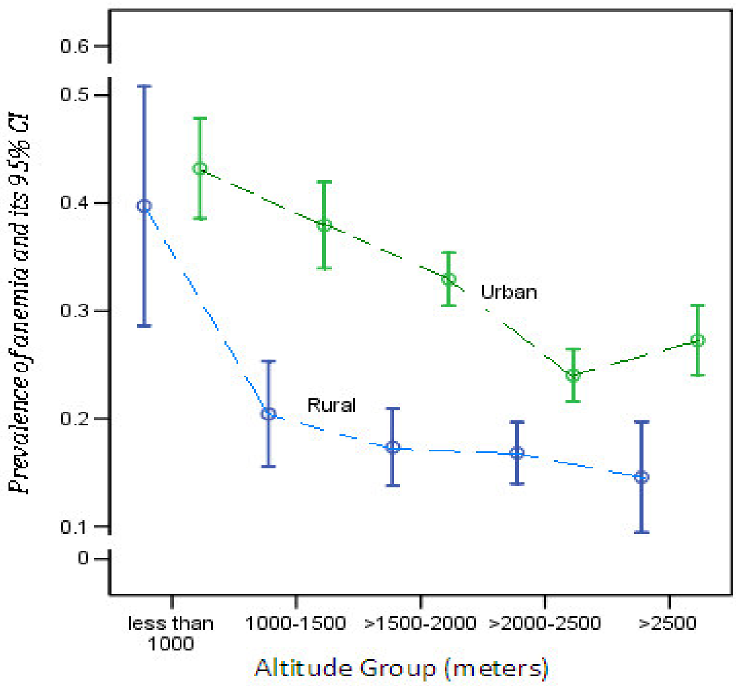
The level of anaemia also varies depending on the altitude group. High prevalence of anaemia was found in the lower altitude group when compared with the higher altitude group. Two out of five women (95%CI 38.4, 47.0) were anaemic among the lowest altitude category where as only one in every four or five women were anaemic in the two highest altitude categories (95%CI 21.0, 24.1%).

The difference is more visible and directly related to altitude for moderate and mild anaemia categories. However, the prevalence of anaemia is higher in the more than 2500m altitude group than the group between 2000 and 2500m.

The odds of being anaemic were slightly more than two and half times higher in the group living below altitude of 1000metres than the group living in the altitude range of 2000-2500metres (OR 2.70 95%CI 2.22, 3.33)**.** Similarly the odds of being anaemic is 0.64 (95%CI0.51, 0.81) and 0.56 (95%CI 0.45, 0.68) times lower in the altitude category 1000-1500metres and 1500 to 2000metres respectively when compared with the lowest altitude category (less than 1000 meters). The linear trend analysis through chi^2 test shows that there is statistically significant trend association between the category of altitude and prevalence of anaemia (chi^2 for linear trend=85.3, P<0.0001). The trend is similar even after further running cluster analysis by type of place of residence; however, rapid fall in the prevalence of anaemia was seen in the urban settings when compared with the rural setting.

The following figure describes the prevalence of anaemia and its 95%CI for the different altitude categories measured in meters clustered in to rural and urban places of residence.

Figure 9: Prevalence of anaemia among women by altitude and type of residence, DHS 2005



Possession of toilet facilities

The availability of toilet facilities was one of the questions included during the data collection. More than twenty types of toilet types were included in the interview; however, using the frequency of the type of the toilets and significance to haemoglobin distribution the variable was recoded in to dummy variable as having or not having toilet facility. Accordingly 3165 (53.1%) had no any type of toilet facilities and were using open field defecation; while the rest had either of the remaining types of toilet facilities.

The mean haemoglobin level for those who don't have any toilet facility was 124.1g/dl (95% CI 123.4, 124.8g/dl) which is significantly lower than the other group who have either types of toilet facilities [mean haemoglobin=130.6 g/dl, 95%CI (130.0, 131.3g/dl)] (p<0.0001).

Similarly, the prevalence of any type of anaemia was 33.4% (95%CI 31.8, 35.1%) and 21.2% (95%CI 19.7, 22.8%) for those who reported not having any type of toilet facility and those having any type of toilet facility respectively. The odds of being anaemic was 1.85 times higher among those not having toilet than those having any type of toilets and the ratio was statistically significant OR 1.85 (95%CI 1.66, 2.10).

Table 5: Univariate analysis considering anaemia among women as a dependent variable, environment related variables and religion as predictors, DHS 2005

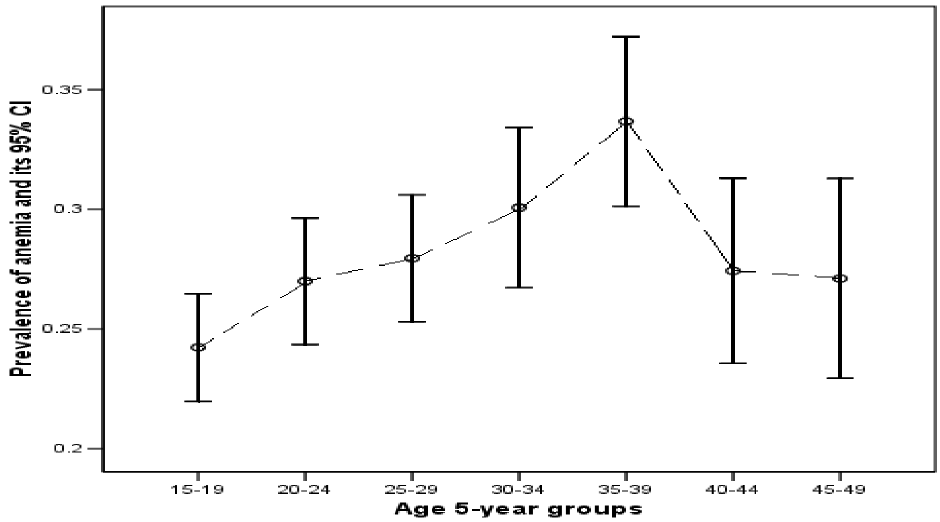
Variables	Frequency (%)	Prevalence (95%CI)	Crude OR	(95%CI)	Remark
Type of residence					
Urban	1636 (27.4%)	18.4% (16.5, 20.3%)	1.00		
Rural	4324 (72.6%)	31.2% (29.9, 32.6%)	2.02	(1.75, 2.32)*	
Possession of latrine					
Yes	2797 (46.9%)	21.2% (19.7, 22.8%)	1.00		
No, use open field	3163 (53.1%)	33.4% (31.8, 35.1%)	1.85	(1.66, 2.10)*	
Region					
Addis Ababa/Hariarie	1021 (17.1%)	18.2% (15.8, 20.6%)	1.00		
Tig/Am/Or/DD/SNNP	3663 (61.5%)	26.8% (25.4, 28.2%)	1.64	(1.38, 1.96)*	
Afar/Som/Ben-Gum/Gam.	1276 (21.4%)	37.9% (35.3, 40.6%)	2.74	(2.26, 3.33)*	
Altitude (meters)					
<1000	520 (8.7%)	42.7% (38.4, 47.0%)	1.00		Chi2 for linear trend=85.3, df=4, p-value < 0.0001
1000-1500	833 (14.0%)	32.4% (29.2, 35.6%)	0.64	(0.51, 0.81)*	
1500-2000	1822 (30.6%)	29.3% (27.2, 31.3%)	0.56	(0.45, 0.68)*	
2000-2500	1867 (31.3%)	21.4% (19.6, 23.3%)	0.37	(0.30, 0.45)*	
>2500	918 (15.4%)	24.7% (21.9, 27.5%)	0.44	(0.35, 0.55)*	
Total (similar for all sub-groups)	**5960 (100.0)**	**27.7%(26.6, 28.9%)**			

*Association is significant

Age

The age group 35-39 years had the highest prevalence of anaemia when compared with other groups. The prevalence steadily increases with age group and it plateaus at the age group of 35-39 years and then starts to go down. The prevalence of anaemia of any type was one and half times higher among this age group than the 15-19 years old age group. The ratio was statistically significant OR 1.56 (95% CI 1.30, 1.94). However, the prevalence of moderate/severe anaemia starts stabilizing at the age of 30-35 years. The prevalence of severe/moderate anaemia was around 12.0% for the age group of 30-35 years old group and then it goes down for the next age groups. The following graph shows the prevalence of any type of anaemia stratified by different age groups.

Figure 10: Prevalence of anaemia among women by age group, DHS 2005



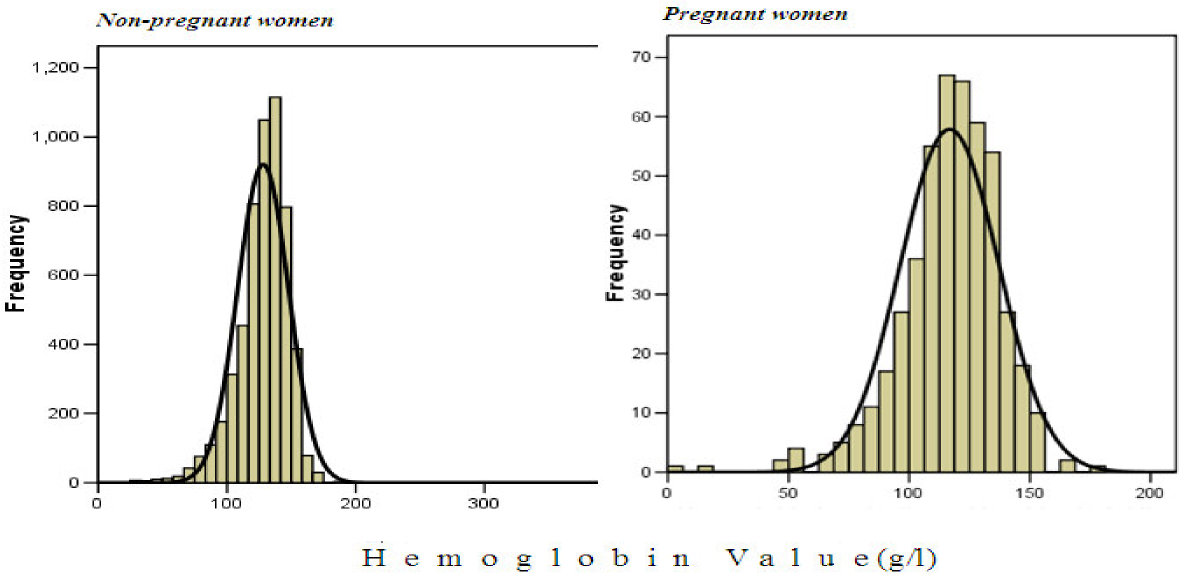
3.2. **Fertility, breast feeding and use of contraception**

In this section pregnancy status, trimesters of pregnancy, breast feeding status and use of contraception and parity will be discussed as predictors of haemoglobin level and anaemia

Pregnancy status

A total of 473 (7.9%) of women were pregnant in this study population the rest 5487 (92.1%) were either not pregnant or the pregnancy status was not known at the time of data collection. The mean haemoglobin was 116.7g/l (95%CI115.2, 118.7g/l) and 128.0g/l (95%CI 127.5, 128.6g/l) for pregnant and non pregnant women respectively. The t-test with the assumption of homogenous variance (Leven's test of homogeneity p=0.50) reveals that the mean haemoglobin is significantly higher among non-pregnant women than among pregnant women (p<0.0001). The distribution of haemoglobin level based on pregnancy status is shown in figure below.

Figure 11: Distribution of haemoglobin by pregnancy status, DHS 2005



Pregnant women were further classified according to the trimester of pregnancy. A dummy variable was created; one for the first trimester group and another for the second and third trimester group merged together. Out of the total 473 pregnant women 97 (20.5%) were in the first trimester and the rest 376 (79.5%) were either in the second or third trimester. The mean haemoglobin level was 121.5g/dl [95%CI (117.6, 125.4g/dl)] for the first trimester group and it was 115.8g/dl [95%CI (113.8, 117.7g/dl)] for the other two trimesters merged together. The mean haemoglobin for the first trimester group was significantly higher than the mean for other groups merged together [mean difference=5.72, 95% CI (1.32, 10.13g/dl)].

The prevalence of any type of anaemia was 33.0% (95%CI 28.7, 37.2%) among pregnant women where as it was 27.3% (95%CI 26.1, 28.4%) among non-pregnant women. The prevalence is significantly higher among pregnant women than among non-pregnant women (OR=1.31 95% CI 1.07, 1.61).

The prevalence of moderate/severe anaemia was 16.9% (95%CI 13.5, 20.3%) among pregnant women and it was 8.5% (95%CI 7.7, 9.35) among non-pregnant women. The odds ratio of this event was calculated to be 2.2 (95%CI 1.68, 2.85) which is statistically significant.

The prevalence of any type of anaemia was calculated separately for the three trimesters of pregnancy for women who were pregnant during the data collection. In the first trimester group the prevalence of anaemia was 28.9% (95%CI 19.8, 38.0%) and it was 32.9% (95%CI 27.1, 39.0%) and 36.4% (95%CI 27.7, 45.0) among the second and third trimester groups respectively. Though the prevalence of any type of anaemia increases by trimester the observed linear trend is not statistically significant (Chi2 for linear trend=1.36, p-value > 0.05).

The prevalence of either severe or moderate anaemia was 19.0% (95%CI 12.0, 26.0%) among women in the third trimester of pregnancy and it was 12.4% (95%CI 5.8, 19.0%) among women in the first trimester of pregnancy. Similar to the trend observed in the any type of anaemia, the prevalence tends to increase by trimester but the observed linear trend is not statistically significant again (Chi2 for linear trend=1.58, p-value > 0.05).

Past fertility and contraceptive use

Out of the total study population 1935 (32.5%) and 1307 (21.9%) had not given any birth and had ever given more than five births respectively. The mean haemoglobin value is 130.3 (95% CI 129.4, 131.1 g/dl) for the no child group and 125.2g/dl with 95%CI (124.1, 126.3g/dl) for the more than five children ever born group.

Similarly, 1607 (27.0%) of the study participants have given one birth and 1364 (22.9%) had given two or more births in the past five years. The mean haemoglobin level is 129.4 (95% CI 128.7, 130.1g/dl) for the 'no birth in the past five years group' and it is significantly higher than for the other groups (p<0.0001); 'one birth' group had a mean of 125.0g/dl (95% CI 124.0, 126.0) and for the 'two or more births' group the mean is 124.7g/dl (95%CI 123.7, 125.8g/dl).

Furthermore, 2335 (39.2%) of the study participants have given more than or equal to one birth; where as the rest didn't give any birth in the past three years. The mean haemoglobin level is 128.7 (95% CI 128.0, 129.3g/dl) for the 'no birth in the past three years group' and it is significantly higher than for the group of women who have given one or more births in the past three years (mean difference=3.91, 95% CI [2.87, 4.95g/dl).

General one-way ANOVA test shows that the mean haemoglobin value is significantly different among different groups by level of children ever borne (F-test=17.6(4), P<0.0001). Further pair-wise analysis to see the mean difference through Bonferroni test shows that the only significant pair is the one between no births against all other groups. The other pairs are not significant. The following table shows the mean distribution of haemoglobin for different groups of women based on number of children ever, last five years and last three years borne and compares the mean haemoglobin level using the no birth group as a reference population. In case of more than two levels for the independent variable Bonferroni test was used to test for significance.

Moreover, when use of family planning is used as an independent factor, the result reveals that the mean haemoglobin level is significantly lower among the group that uses family planning than those who don't use it. The mean haemoglobin level is 130.0g/dl with 95%CI of 128.8, 130.9g/dl for the group who don't use family planning method. The following figure shows the mean plot of haemoglobin based on highest educational level and use of family planning.

Table 6: Comparing haemoglobin levels among women by fertility level, DHS 2005

Variables	Groups	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound	Pair wise comparison i-x	95% CI
	None (i)	130,3	0,5	129,4	131,1	NA	NA
	One (j)	125,7	0,8	124,1	127,2	4,6	(2.8, 6.4)
Number of children ever-borne	2-3 (k)	126,0	0,6	124,8	127,2	4,3	(2.8, 5.7)
	4-5 (l)	125,9	0,7	124,6	127,2	4,3	(2.8, 5.9)
	more than 5 (m)	125,2	0,6	124,1	126,3	5,1	(3.7, 6.5)
Number of children borne [last five years]	None (i)	129.4	0.37	128.7	130.1	NA	NA
	One birth (n)	125.0	0.50	124.0	126.0	4.4	(2.9, 6.0)
	Two or more births (p)	124.7	0.54	123.7	125.8	4.7	(3.1, 6.2)
Number of children borne [last three years]	None (i)	128.7	0.3	128.0	129.3	NA	NA
	One or more births(q)	124.8	0.4	124.0	125.6	3.9	(2.9, 5.0)

Approximately one out of four women (95%CI 22.4, 25.4%) who had not given birth in the past five years was anaemic in this study population. A prevalence of 31.5% was observed among the group of women who gave birth once and two or more times in the past five years.

The odds of having anaemia was 1.47 (95%CI 1.28, 1.68) times higher among the group who gave birth once in the past five years taking the no birth group as reference. The calculated odds ration and 95%CI was similar for the group who had given two or more births in the past five years when compared with the no birth group.

The prevalence of anaemia tends to be directly related to the categorized level of fertility; it tends to increase as the fertility level increases. This observed linear trend was statistically significant (Chi2 for linear trend=35.2, p-value < 0.0001).

The prevalence of any type of anaemia was found to be 19.8% (95% CI 16.9, 22.8%) among those women who were using any type of modern contraceptives and it was 28.8% (95%CI 27.6, 30.0%) among those who were not using any type. The odds of being anaemic among non-users of family planning were 1.63 times higher than among those who use family planning. The ratio is statistically significant (95%CI 1.34, 1.98).

Breast feeding status

The current (at the time of data collection) breast feeding status of the women was also asked for the responders of the survey. At the time of the data collection out of the 5960 women 1961 (32.9%) were breast feeding while the rest 3999 (67.1%) were not breast feeding.

The mean haemoglobin level was 127.4g/l [95%CI (126.7, 128.2g/l)] for the non-breast feeding group and it was significantly higher than for the breast feeding group (p<0.005). The breast feeding group had mean haemoglobin of 125.1g/l [95%CI (124.1, 126.2g/l)].

Similarly the prevalence of any type of anaemia is higher among mothers who were breast feeding at the time of the data collection. The odds of being anaemic were 1.31 times higher among breast feeding women than those who were not breast feeding and the ratio was statistically significant (95%CI 1.16, 1.47). The following table summarizes the prevalence of anaemia and its 95% CI, and Odds ratios with 95% CI depending on the reproductive health related variables discussed above.

Table 7: Univariate analysis taking anaemia among women as a dependent variable, and fertility, breast feeding and pregnancy status as predictors, DHS 2005

Variables	Frequency (%)	Prevalence (95%CI)	Crude OR	(95%CI)	Remark
Pregnancy status					
Pregnant	473 (7.9%)	33.0% (28.7, 37.2%)	1.31	(1.07, 1.61)	
Non-pregnant	5487 (92.1%)	27.3% (26.1, 28.4%)	1.00		
Total	5960 (100.0%)	27.7 % (26.6, 28.9%)			
Pregnancy trimester					
First trimester	97 (20.5%)	28.9% (19.8, 38.0%)	1.00		Chi2 for linear trend=1.36, df=2, p-value>0.05
second trimester	255 (53.9%)	32.9% (27.1, 39.0%)	1.21	(0.73, 2.02)	
Third trimester	121 (25.6%)	36.4%(27.7, 45.0))	1.41	(0.79, 2.50)	
Total	473 (100.0)	33.0% (28.7, 37.2%)			
Number of births past five years					
No birth	2990 (50.2%)	23.9% (22.4, 25.4%)	1.00		Chi2 for linear trend=35.2, df=2, p-value<0.0001
One birth	1607 (27.0%)	31.5% (29.3, 33.8%)	1.47	(1.28, 1.68)	
Two or more births	1363 (22.8%)	31.5% (29.1, 34.0%)	1.47	(1.27, 1.69)	
Total	5960 (100.0)	27.7 % (26.6, 28.9%)			
Family planning use					
Yes	706 (11.8%)	19.8% (16.9, 22.8%)	1.00		
No	5254(88.2%)	28.8% (27.6, 30.0%)	1.63	(1.34, 1.98)	
Total	5960 (100.0%)	27.7 % (26.6, 28.9%)			
Currently breast feeding					
Yes	1961 (32.9%)	31.4% (29.3, 33.4)	1.31	(1.16, 1.47)	
No	3999 (67.1%)	25.9% (24.6, 27.3%)	1.00		
Total	5960 (100.0%)	27.7 % (26.6, 28.9%)			

3.3. Socioeconomic status

In this section educational status of the mother and wealth index of the over all hose hold where the woman lives will be discussed as independent predictors of haemoglobin level and anaemia.

Educational level

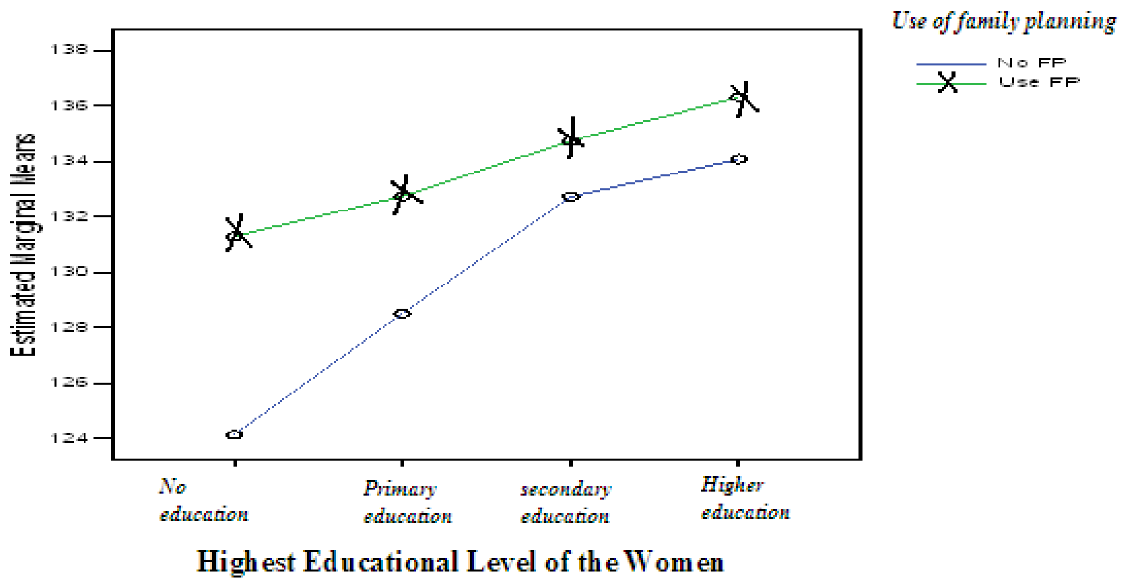
In this section the highest educational level attained by the woman and the use of family planning were analyzed for level of haemoglobin. In the study population 706 (11.8%) used either of the family planning methods for three or more years.

The mean haemoglobin level for the 'No Education' group is 127.7g/dl with 95% CI of (126.6, 129.0g/dl); where as for the highest educational level group it is 135.2 with 95% CI of (131.4, 138.9).

Using one way ANOVA test it was found that haemoglobin significantly varies among the four highest educational level attained by women (F (14.6, 3df)<0.0001. Further pair wise comparisons using Bonferroni test shows:

- The 'no education' group has significantly lower haemoglobin level than other groups paired with them (p<0.05 for all pairs)
- The 'primary' education status group has lower haemoglobin level when compared with secondary level (p=0.038) and not with the highest group (p=0.17), and
- There is no difference among the two highest educational level groups; namely 'secondary' and 'higher' group (p>0.10)

Figure 12: Marginal means of haemoglobin by educational level and family planning use, DHS 2005

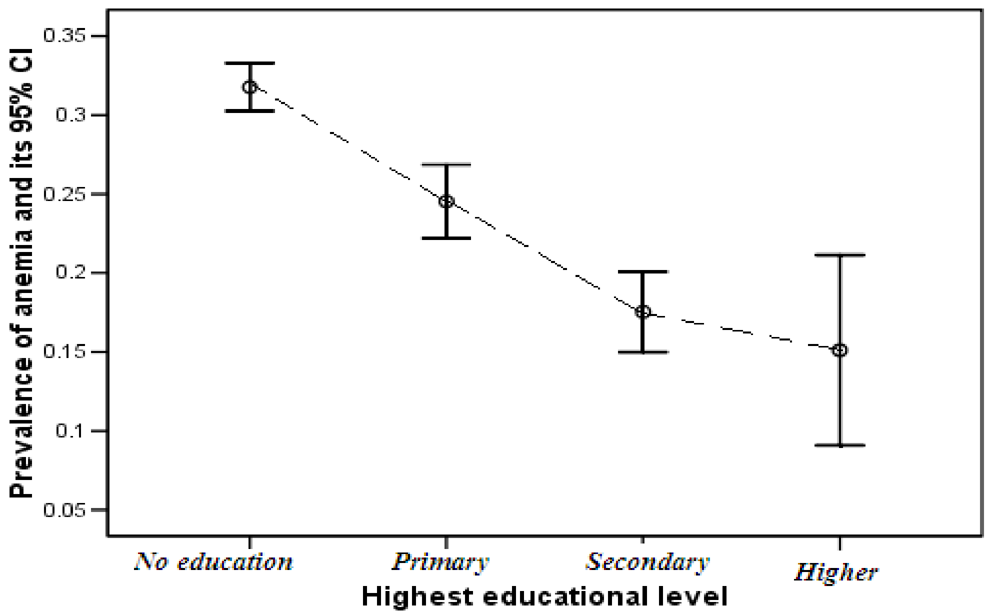


Educational status of women was also considered as a determinant factor for the prevalence of anaemia. Accordingly prevalence of anaemia was calculated separately for each educational level. Out of 3635 women who had not gone for any level of education 31.8% were having any type of anaemia (95%CI 30.3, 33.3%) where as out of 1325 women who completed primary schooling 24.5% (95% CI 22.2, 26.9%) were having either types of anaemia.

The odds of being anaemic is two and half times higher in the no education group than among the group who have attained higher educational level and it is approximately twice as large as among the group who have attained secondary educational level. The association is statistically significant OR 2.6 (95% CI 1.64, 4.17) and OR 2.2 (95%CI 1.82, 2.63) respectively.

The prevalence of any type of anaemia decreases with increase in the highest educational level attained by the women. The prevalence was 17.5% and 15.1% for the secondary and higher educational levels respectively. The linear trend analysis through chi^2 test shows that there is statistically significant trend association between highest educational level attained by the mother and prevalence of anaemia (chi^2 for linear trend=90.9, P<0.0001).

Figure 13: Prevalence of anaemia based on educational status of women, DHS 2005



Wealth index

Another socioeconomic index that is commonly used in DHS is the wealth index of the households where the women live. It was estimated using the principal components analysis. Accordingly five categories of wealth indices were set as poorest, poorer, middle, richer and richest. Further analysis of the data reveals that 1982 (33.2%) were classified as the richest group where as 1212 (20.3%) were categorized as the poorest group.

The mean haemoglobin level for the poorest wealth index group was 122.7g/dl (95% CI 121.6, 123.8) where as for the richest wealth index group it was 132.3 (95% CI 131.4, 133.2g/dl). One way ANOVA run to see the difference in haemoglobin variations among the five wealth index groups revealed that the mean haemoglobin level significantly varies among the five groups [$F_{\text{wealth index}}$, 4 df=57.4, p<0.0001]. The ANOVA table below depicts the above statement.

Table 8: ANOVA table explaining haemoglobin variations in terms of wealth index, DHS 2005

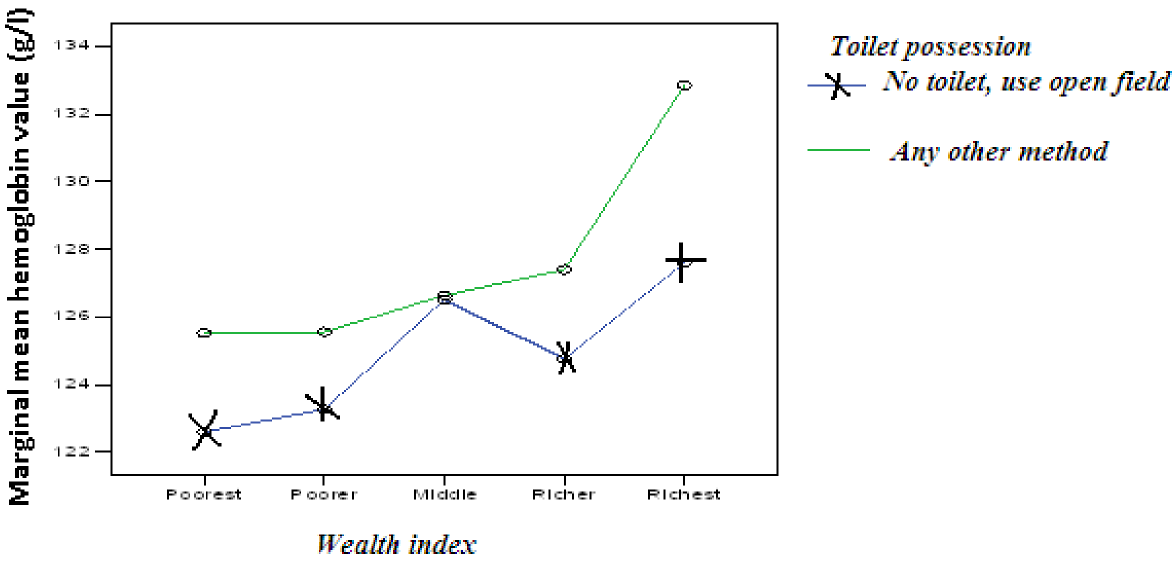
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	88745,45	4	22186,36	57,04	0,00
Intercept	86979479,71	1	86979479,71	223626,75	0,00
Wealth index	88745,45	4	22186,36	57,04	0,00
Error	2317360,28	5958	388,95		
Total	98814103,00	5963			

df= degrees of freedom

The pair wise comparisons using Bonferroni test showed that the richest wealth index group had significantly higher haemoglobin level than all other wealth index groups (p<0.0001 for all possible pairs) while the poorest wealth index had significantly lower haemoglobin than other groups (p<=0.001 for all pairs) except for the poorer wealth index group where the difference is not significant (p>0.50).

The following figure shows the relation between mean haemoglobin level, wealth index and availability of toilet facility.

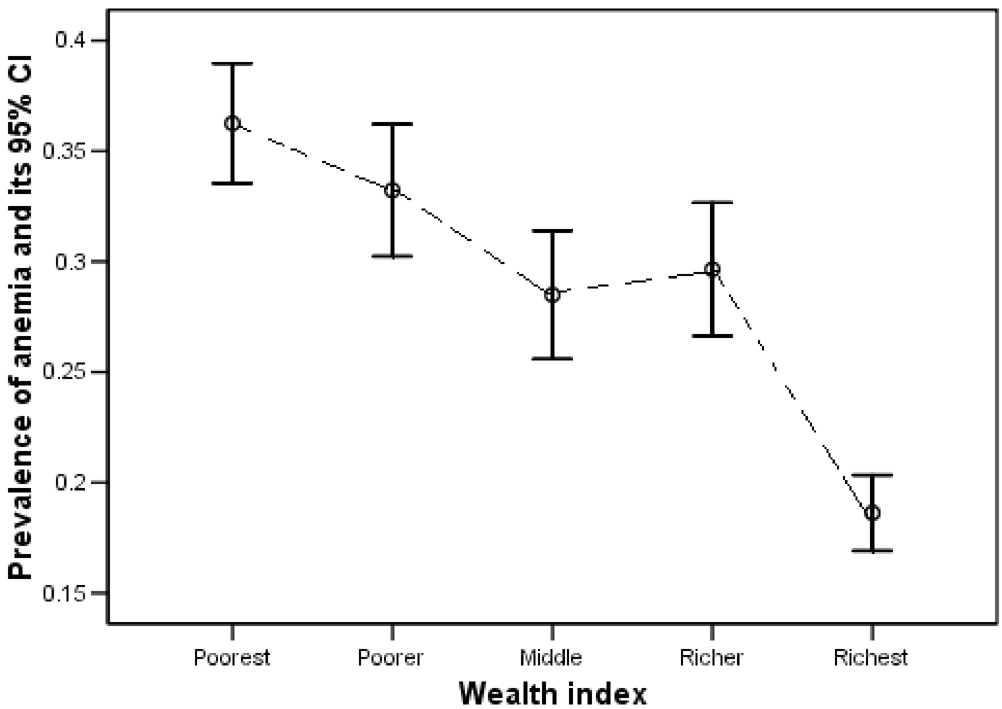
Figure 14: Mean haemoglobin values based on wealth index and possession of toilet, DHS 2005



The prevalence of anaemia varies according to the different wealth index categories. It ranges from a level of one on every three women in the poorest wealth index group to one in every five to six women in the upper fourth or fifth wealth index quintile. Numerically the prevalence was 36.3% (95%CI 33.5, 39.0%) among the poorest wealth index group where as it was 18.6% (95%CI 16.9, 20.3%) among the richest wealth index group.

The prevalence of any type of anaemia tends to decrease when moving up through wealth index categories. The risk of having anaemia is two and half times more likely in the poorest wealth quintile than the richest wealth quintile and it was statistically significant(OR=2.5, 95%CI 2.13, 2.94). The prevalence was 33.2%, 28.5%, and 29.7% among the poorer, middle and richer wealth index groups respectively. The linear trend analysis through chi2 test shows that there is statistically significant trend association between wealth index and prevalence of anaemia (chi2 for linear trend=127.1, P<0.0001). The following figure describes the prevalence of anaemia and its 95%CI for the different wealth index categories.

Figure 15: Prevalence of anaemia among women by wealth index, DHS 2005



3.4. Nutrition related variables

The last 24 hours dietary recall history was also collected to assess the type of food commonly consumed by the women. Accordingly the food types were classified as either iron rich diet or not; food items meat, organ meat, fish, poultry or eggs were classified as iron rich food items. The mean haemoglobin was analyzed only for 2512 (42.2%) women as the rest were missing values in the data file. Thus 2119 (84.2%) had not consumed iron rich diet in the past 24 hours where as the rest 399 (15.8%) consumed iron rich diet. The mean haemoglobin for the group who had consumed iron rich diet in the past 24 hours was 127.6g/l (95% CI 125.6, 130.0g/l) and it is significantly higher than the group who hadn't eaten iron rich diet in the past 24 hours [mean difference =3.0g/l 95%CI (0.80, 5.16g/l)].

Past 24 hours consumption of food made from teff was also considered as one independent variable. A total of 2517 entries were made in to the data file and the others were missing values; hence the mean haemoglobin was calculated for these groups of women. A total of 1079 (42.9%) women reported that they consumed food made from teff in the past 24 hours. The mean haemoglobin level for the group who consumed food made from teff in the past 24 hours was 126.5g/l [95% CI (125.3, 127.7g/l)] and for the other group it was 124.0g/l [95% CI (123.0, 125.1g/l)]. The first group had significantly higher mean haemoglobin level than the second group [mean difference=2.5g/l 95%CI (0.85, 4.10g/l)]. The following table shows the mean distribution of haemoglobin by religion and diet history.

Table 9: Univariate analysis taking diet history as predictors of haemoglobin level, DHS 2005

Grouping Variables	Groups	Mean	Number	Std. Error	95% Confidence Interval		Pair wise comparison	
					Lower Bound	Upper Bound	i-x	95% CI
Iron rich diet	Yes(i)	127.58	399	1.02	125.58	129.59	NA	NA
	No(j)	124.61	2119	0.44	123.74	125.47	3.00	(0.80, 5.16)*
Food made from teff	Yes(i)	126.50	1079	0.62	125.28	127.71	NA	NA
	No(j)	124.04	1438	0.54	122.98	125.09	2.46	(0.85, 4.07)*

** significant at alpha=0.05*

The prevalence of any type of anaemia was 32.1% (95%CI 30.1, 34.1%) and 27.8% (95%CI 23.4, 32.2%) for those who didn't and did eat iron rich diet in the past 24 hours respectively. The odds of being anaemic was 1.22 times higher among the first category than the second category but the ratio is not statistically significant OR 1.22 (95% CI 0.97, 1.52).

Furthermore, the prevalence of anaemia was 33.3% (30.9, 35.8%) and 28.7% (26.0, 31.4%) for those who didn't and did eat food made from teff in the past 24 hours respectively. The odds of being anaemic was 1.23 times higher among the first category than the second category and the ratio was found to be significant OR 1.23 (95%CI 1.04, 1.47).

The following table describes the prevalence and odds ratios for anaemia based on past 24 hours of consumption of iron rich diet and food made from teff.

Table 10: Prevalence of anaemia among women according to past 24 hour diet history, DHS 2005

Variables		Frequency (%)	Prevalence (95%CI)	Crude OR	(95%CI)
Iron reach diet (past 24 hours)					
	Yes	399 (15.9%)	27.8% (23.4, 32.2%)	0.82	(0.64, 1.03)
	NO	2118 (84.1%)	32.1% (30.1, 34.1%)	1.00	
Total		2517 (100.0%)	31.4% (29.6, 33.2%)		
Consumption of teff (past 24 hours)					
	Yes	1079	28.7% (26.0, 31.4%)	0.81	(0.68, 0.96)
	NO	1437	33.3% (30.9, 35.8%)	1.00	
Total		2516 (100.0%)	31.4% (29.6, 33.2%)		

3.5. Religion and ethnicity

The mean haemoglobin level was 128.7g/l (95% CI 128.0, 129.5g/l) for the Orthodox religion followers and it is significantly higher than either protestant or catholic [mean difference=2.2g/l 95%CI (0.28, 4.1g/l)] and Muslim religion followers [mean difference=3.5g/l 95% CI (1.9, 5.0g/l)].

The orthodox Christian group had prevalence of any type of anaemia of 24.9% (95%CI 23.3, 26.4%) and the prevalence was found to be significantly lower than the protestant/catholic group and the Muslim group. The odds of being anaemic among protestant/catholic group was 1.29 times higher than the orthodox group OR 1.29 (95%CI 1.11, 1.51). Protestant/catholic and the Muslim group had roughly similar prevalence of any type of anaemia of 30.0%.

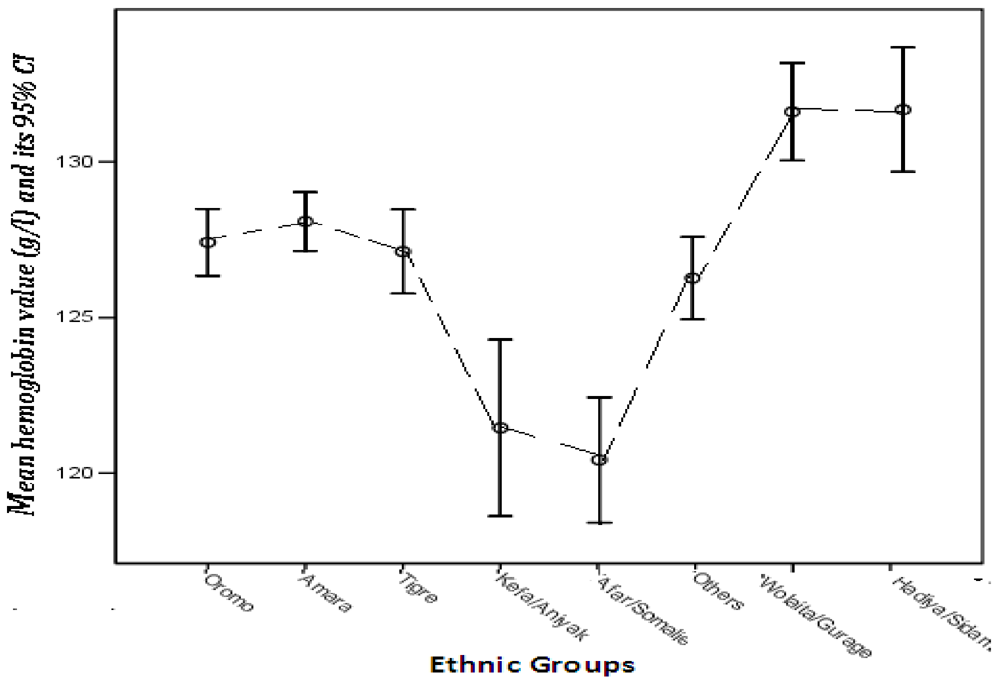
In the 2005 EDHS data more than forty ethnic groups were included for the haemoglobin testing. However, considering the adequacy of the samples from each ethnic group, the similarities in feeding habits and geographical proximities some of the ethnic groups were merged together. Finally eight major ethnic groups in single or in pairs were identified and the others were merged together as ‘others’. Accordingly, majority of the study participants were Amhara ethnic group which numbers to 1628 (27.3%) of the total study participants followed by the Oromo ethnic group which accounts for 1413 (23.7%) of the study participants. Several sub-ethnic groups were merged together as one big ethnic group in the data set; for instance, the Amhara ethnic group had around seven sub-ethnic groups.

The highest mean haemoglobin level was observed among the Hadiya/Sidamo group merged together. The mean haemoglobin for this group was 131.2g/l [95%CI (129.3, 134.1g/l)]. The group comprising of Wolaita/Gurage merged together had also a similar haemoglobin level of 130.0g/l [95% CI (128.2, 132.0g/l)]. The lowest haemoglobin level was observed among the Afar/Somalie group merged together. The mean haemoglobin level for this group is lower than the highest groups by 10g/dl; the mean value staying at 120.1g/l [95%CI (118.3, 121.9g/l)]. The Kefa/Aniyak group had also low mean haemoglobin value which is quite near to the Afar/Somalie group. The mean haemoglobin for the Kefa/Aniyak group was 121.1g/l [95%CI (118.3, 123.8g/l)].

One-way ANOVA test run to see weather haemoglobin level varies according to ethnic groups show that there is significant difference among the different ethnic groups (F_{ethnic}=17.4,df=7, $p<0.0001$). Further pair-wise comparisons using Bonferroni test shows the following results:

- The Kefa/Aniyak group and the Somali/Afar group had significantly lower mean haemoglobin value than all other possible pairs with them ($p<0.0001$ for all possible pairs) except when compared with each other where the difference is not statistically significant ($P>0.05$)
- The Wolaita/Gurage ethnic group had significantly higher haemoglobin level than all other possible pairs ($p<0.01$ for all possible pairs) except when paired with the Hadiya/Sidamo group where the difference is not statistically significant ($p>0.05$).
- The three major ethnic groups Amhara, Oromo and Tigre had statistically insignificant differences when compared pair by pair ($p>0.05$ for all possible pairs)

Figure 16: Marginal mean haemoglobin values among women according to ethnicity, DHS 2005



4. Regression analysis

4.1 Linear regression model for factors affecting haemoglobin distribution

Before running the linear regression model for the data set, different transformations were tried including log transformations, exponential transformation, ln transformations, among others. The simple linear regression models were compared among each other using the coefficient of determination (adj R^2) for the possible transformations. However, significant difference wasn't observed between the transformed value and the untransformed haemoglobin value; hence the untransformed value was used for executing the regression model.

The next table shows the regression coefficients for some selected variables. The result shows that for the simple linear regression all the variables are significant predicators of haemoglobin level. After grouping altitude in to three categories it has been observed that the adjusted haemoglobin level decreases by 3.79 units (p<0.0001) as we move down from the highest to the next category. This explains only 1.4% of the variations in haemoglobin level in the study subjects. Similarly regression coefficients for pregnancy status, duration of pregnancy, use of family planning, births in last five years, and breast feeding status were -11.11, 5.72, 6.47, -2.69, and -2.43 respectively. The maximum coefficient of determination observed was that of the pregnancy status model which explains only 2.3% of the variations in altitude adjusted haemoglobin level.

Table 11: Simple linear regression coefficients for altitude and reproductive health related variables, DHS 2005

Model independent variables	No (%)	Mean (95%CI) [g/l]	Regression analysis coefficient B	Std. Error	P-value for the coefficient	Adj R2
Altitude						
<1000m	520 (8.7)	120.1 (118.9, 122.3)	-3.79	0.41	<0.001*	0.0140
1000-1500m	833(14.0)	124.8 (123.5, 126.1)				
>1500m	4607 (77.3)	128.3 (127.8, 128.9)				
Pregnancy status						
Pregnant	473 (7.9)	116.9 (115.2, 118.7)	-11.11	0.94	<0.001*	0.0230
Not pregnant	5487 (92.1)	128.0 (127.5, 128.6)				
Duration of pregnancy						
1st trimester	97 (20.5)	121.5 (117.6, 125.4)	5.72	2.24	0.01*	0.0120
2nd or 3rd trimester	376 (79.5)	115.8 (113.8, 117.7)				
Family planning use						
Yes	706 (11.8)	132.9 (131.4, 134.3)	6.47	0.79	<0.001*	0.0110
No	5254 (88.2)	126.4 (125.9, 126.9)				
Births in the last five years						
None	2990 (50.2)	129.5 (128.8, 130.2)	-2.69	0.31	<0.001*	0.0120
One birth	1607 (27.0)	125.0 (124.0, 126.0)				
Two or more births	1363 (22.8)	124.6 (123.5, 125.6)				
Currently breast feeding						
Yes	1961(32.9)	125.5 (124.7, 126.4)	-2.43	0.54	<0.001*	0.0030
No	3999 (67.1)	128 (127.3, 128.6)				

*Coefficient is significant

The following table also shows regression coefficients for environment related variables and ethnicity. The result shows that the coefficients are significant for all the variables. The coefficient is -8.02 (p<0.0001) for the grouped altitude variable showing that the mean altitude adjusted haemoglobin value is 8.02 units lower for the rural group when compared with the rural group. This model explains only 3.3% of the overall variations in altitude adjusted haemoglobin values. Similarly the regression coefficients for region, highest educational level, ethnic group, consumption of iron reach diet in the past 24 hours, possession of toilet facilities were -5.43, 4.40, -5.42, 3.09, and 6.56 respectively. Region and highest educational level had similar coefficient of determination which stays at 2.9%.

Table 12: Simple linear regression coefficients for environment related variables, ethnicity and religion, DHS 2005

Model independent variables	No (%)	Mean (95%CI) [g/l]	Regression analysis coefficient		P-value for the coefficient	Adj R2
			B	Std. Error		
Type of place of residence						
Rural	4324 (72.6)	125 (124.4, 125.5)	-8.02	0.56	<0.0001*	0.0330
Urban	1636 (27.4)	133 (132.0, 133.9)				
Region						
Addis Ababa/Harari	1021 (17.1)	132.4 (131.2, 133.6)	-5.43	0.41	<0.0001*	0.0290
Tig./Oro./Am./SNNP/DD	3663 (61.5)	127.6 (127.0, 128.20				
Af./som./Ben/Gu./Gam.	1276 (21.4)	121.7 (120.6, 122.7)				
Highest educational level						
No education	3635 (61.0)	124.7 (124.0, 125.3)	4.40	0.33	<0.0001*	0.0290
Primary	1325 (22.2)	129.3 (128.2, 130.3)				
secondary/higher	1000 (16.8)	133.4 (132.2, 134.6)				
Ethnic group						
Had./Sid./Wol./Gur.	758 (14.8)	131.7 (130.3, 133.1)	-5.42	0.51	<0.0001*	0.0210
Oro.Am./Tig.	3661 (71.5)	127.7 (127.0, 128.3)				
Kefa/Ani./Af./Som.	704 (13.7)	120.7 (119.3, 122.2)				
Consumed iron reach diet (last 24 hrs)						
Yes	2118 (84.1)	127.6 (125.6, 129.5)	3.09	1.09	<0.0001*	0.0030
No	399 (15.9)	124.5 (123.6, 125.3)				
Possession of toilet						
Yes	2797 (46.9)	130.6 (129.9, 131.4)	6.56	0.51	<0.0001*	0.027
No, use field	3163 (53.1)	124.1 (123.4, 124.8)				

* coefficient is significant
Tig=Tigray, Oro=Oromiya, Am=Amhara, DD=Dire Dawa, SNNP=Southern Nation's Nationalities People, Af=Afar, Som=Somalie, Ben/Gu=Benishangul-gumuz, Gam=Gambella, Had=Hadiya, Sid=Sidamo, Wol=Wolaita, Gur=Gurage, Ani=Aniyak

4.2 Logistic regression for factors affecting level of anaemia

Because of the fact that different cut offs are being used for defining anaemia, the logistic regression model was run separately for pregnant women and non-pregnant women. in the following sections the findings from regression model will be presented separately for non-pregnant and pregnant women.

4.2.1 Predictors of anaemia among non-pregnant women

The enter method was used to run the model. All the variables which were found to be significantly associated with anaemia and other variables that are potential confounders were considered as covariates. The result shows that use of family planning, altitude and possession of toilet were independent and significant predictors of any type of anaemia. The other variables that were significant under the univariate analysis showed similar direction of associations but they lost significance. The following table shows the adjusted odds ratio for the variables

Table 13: Logistic regression analysis taking anaemia as dependent factor among non-pregnant women, DHS 2005

Variables		Adjusted OR	95% CI
Type of residence	Urban	1.00	
	Rural	1.15	(0.89, 1.49)
Possession of latrine	No, use open field	1.00	
	Yes	0.83*	(0.70, 0.98)
Altitude (meters)	<1000	1.00	
	1000-1500	0.83	(0.64, 1.08)
	1500-2000	0.73*	(0.56, 0.95)
	2000-2500	0.52*	(0.39, 0.69)
	>2500	0.55*	(0.40, 0.76)
Family planning use	No	1.00	
	Yes	0.72*	(0.58, 0.89)
Number of births past five years	No birth	1.00	
	One birth	1.21	(0.98, 1.48)
	Two or more births	1.10	(0.85, 1.41)
Educational status	No education	1.00	
	Primary	0.90	(0.76, 1.07)
	Secondary	0.82	(0.64, 1.05)
	Higher	0.72	(0.43, 1.2)

*Association is significant, adjusted for all variables that showed significance in the univariate analysis

4.2.2 Predictors of anaemia among pregnant women

The same enter method was used also to model prevalence of anaemia in pregnant women. The result shows that possession of toilet retains its significance level; women who live in house holds where there is no any type of toilet were two times more likely to be anaemic than those who do not have any type of anaemia.

The remaining variables that were significantly associated with prevalence of any type of anaemia in the univariate analysis have shown similar trends as of the univariate analysis but lost to attain the level of statistical significance. The odds of being anaemic is 1.26 times higher among pregnant women in the third trimester than in the first trimester but the ratio is not statistically significant OR 1.26 (95% CI 0.72, 2.21) and it is 1.27 times higher among pregnant women in the third trimester than in the first trimester but the ratio is again not statistically significant OR 1.27 (95% CI 0.67, 2.39).The following table shows the adjusted odds ratio and its 95% CI for some selected variables.

Table 14: Logistic regression analysis taking anaemia as dependent variable among pregnant women, DHS 2005

Variables		Adjusted OR	95% CI
Pregnancy trimester	First trimester	1.00	
	second trimester	1.26	(0.72, 2.21)
	third trimester	1.27	(0.67, 2.39)
Type of residence	Urban	0.74	(0.14 3.80)
	Rural	1.00	
Possession of latrine	No, use open field		
	Yes	0.46*	(0.26, 0.83)
Altitude (meters)	<1000	1.00	
	1000-1500	1.45	(0.58, 3.62)
	1500-2000	0.62	(0.24, 1.58)
	2000-2500	0.47	(0.17, 1.30)
	>2500	0.88	(0.31, 2.52)
Number of births past five years	No birth	1.00	
	One birth	1.64	(0.92, 2.93)
	Two or more births	1.23	(0.63, 2.40)
Educational status	No education		
	Primary	0.69	(0.39, 1.25)
	Secondary	0.17	(0.02, 1.66)
	Higher	0.52	(0.04, 6.99)

*Association is significant, adjusted for all variables that showed significance in the univariate analysis

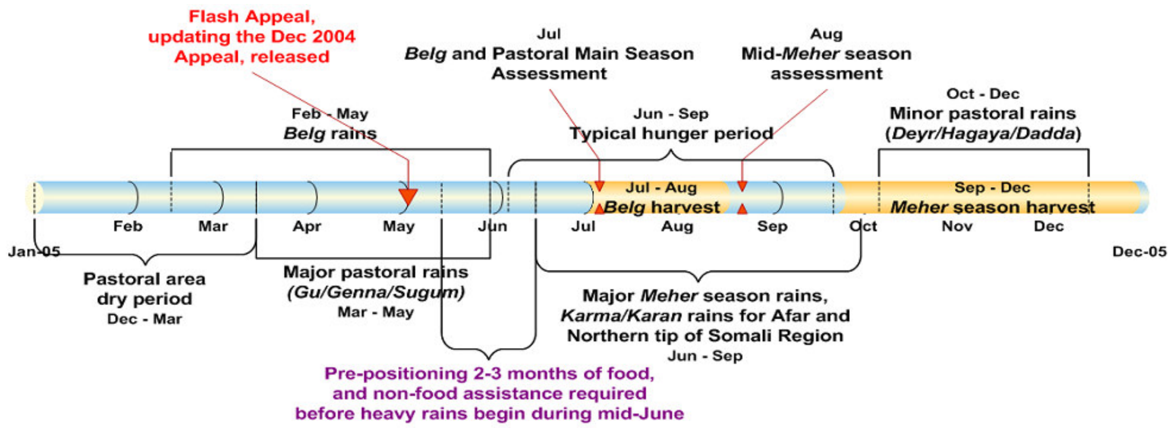
5. Food insecurity as a determinant factor

In order to facilitate triangulation of information, the drought condition in the year 2005 will be discussed in this section.

Ethiopia, as a poor country has been highly struck by different bouts of classical droughts and starvation. Literally one would expect the country to be endemic to ranges of nutrition related problems. Malnutrition and food insecurity continues to be a big problem in the country majorly affecting the rural and the impoverished urban areas[40].

The seasonal timeline of the country indicates that the month ranging from June to October is the typical hunger period [44]. The following figure describes the seasonal timeline and the season when food insecurity is most probable.

Figure 17: Seasonal time line of harvesting and hunger periods in Ethiopia



Source: FEWS NET 2005[45]

According to the December 2004 FEWS report, there would be more than seven million people in need of humanitarian assistance in 2005. Around thirty percent (2.2 million) of this population would require assistance through emergency food aid programmes. The remaining seventy percent (more than five million) were considered chronically food insecure and were expected to be in need of assistance through the productive safety net programme. The major insecure regions identified were Tigray, Afar and southern and eastern parts of SNNP regions. Poor rainfall performances were also recorded in the north eastern and eastern pastoral areas resulting in increased livestock mortality rates, and reduced livestock prices in all affected areas [44].

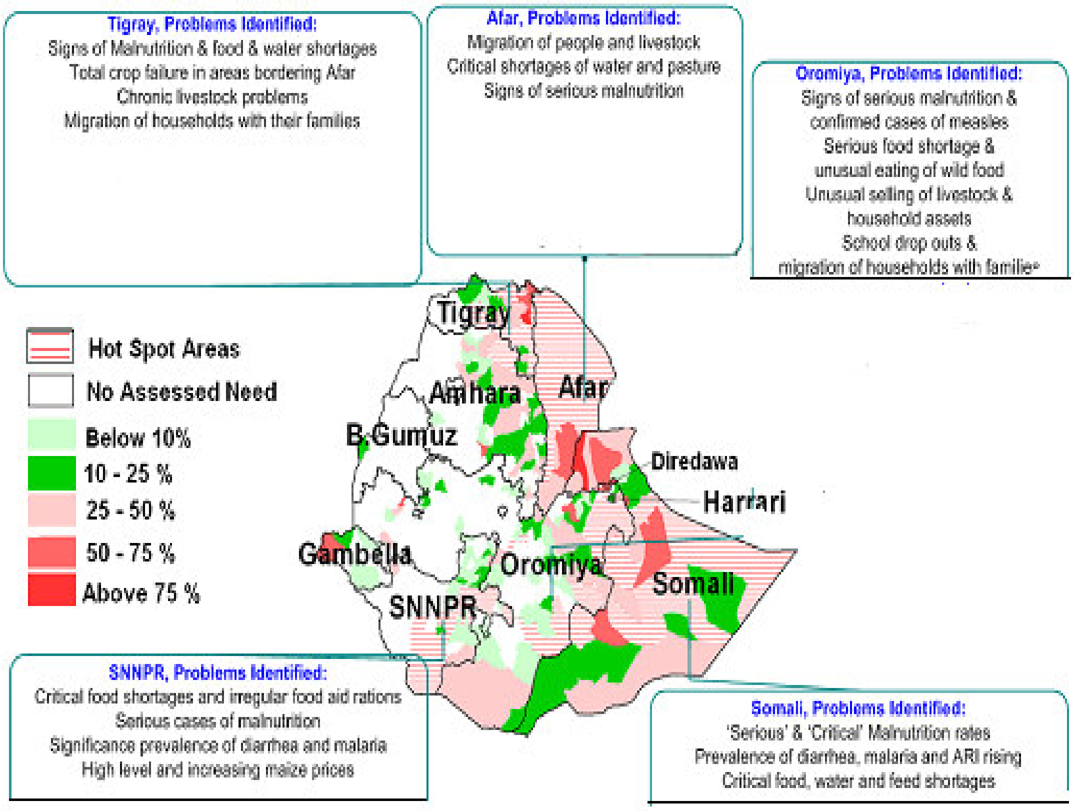
The next report of FEWS in April 2005 revealed a worsening situation of food crisis; majorly because of poor response to chronic and emergency food needs. Another additional half million pupation were in need of food assistance in this month report. In addition to the regions mentioned above east and west Zones of Hararge in Oromia region, and Boricha and Humbo in the SNNP regions were identified as emerging areas of concern. “Pastoralist regions of Afar and

Somali, where the most human impacts of the drought were observed, continued to be hot spot areas"[46].

The remaining two reports of the year 2005 also showed aggravating situations of the food insecurity status of the country. However the well performing humanitarian assistance missions on food distribution and financial transfer schemes in July coupled with overall good rain performance in the months from March to May have eased at least extreme food insecurity situations. Accordingly from the month August to December only 3.3 million people were identified as in need of food assistance. Majority of this population were from low land crop dependent and pastoralist areas [45,47].

The epicentres of food and health crisis remained similar through out the four reports made in the year 2005 [44-47]. The following figure shows the areas of concern in the year 2005, identified problems and percentage of population needing assistance.

Figure 18: Food insecurity situation of Ethiopia in 2005



Source: FEWS NET (2005)[47]

6. National anaemia control and prevention efforts

It was in the 1970s and 1980s that scientists and international organizations including WHO and UNICEF started to advocate the problems of micronutrient deficiencies. Though the twentieth century was marked as the time for elimination and control of micronutrient deficiencies, they still continue to be problem of public health importance in many developing countries [48].

Three major micronutrient deficiencies obtained worldwide attention in the early times. They obtained such big attention due to their grave heath, social and economic consequences. They are VAD, IDD and IDA. Fortunately, there are scientifically proven cost effective intervention for these deficiencies. In fact other micronutrients like zinc, vitamin B and folate have also gained attention recently [49].

The Ethiopian government, as member state of international organizations, also formulated its own strategic paper and launched a national programme on the control of micronutrient deficiencies in 1995. The MoH adopted the Essential Nutrition Action approach to intervene malnutrition. The approach focuses on promoting seven major intervention areas out of which one was control of iron deficiency anaemia. Most of the intervention areas are attached to the health care delivery sector [50].

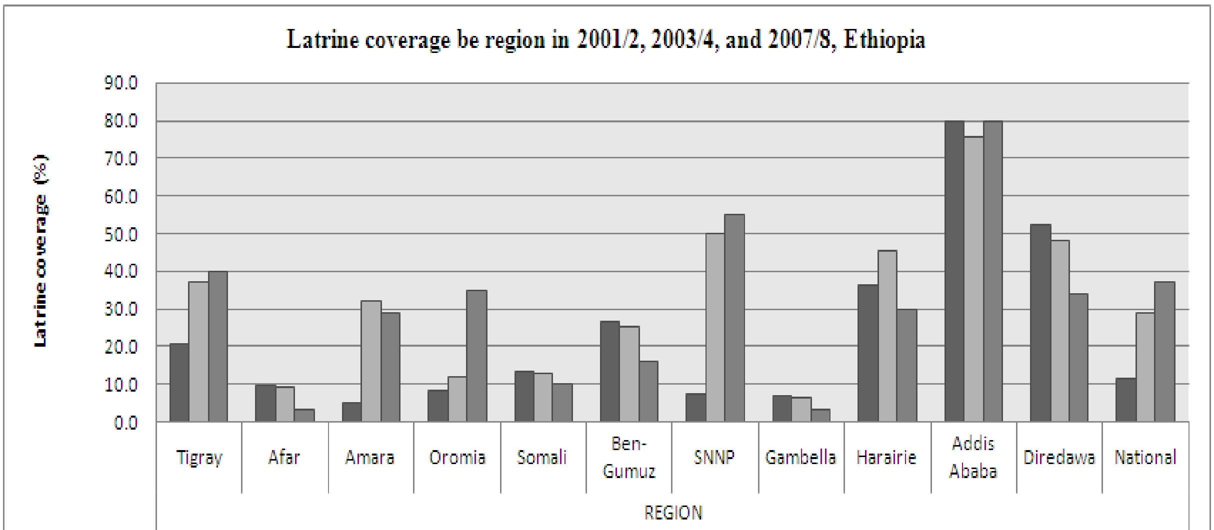
Before 2004 the magnitude and severity of anaemia was not well studied in the country and certain intervention activities like supplementation programmes were very sporadic and based in the health facilities. Diagnosis and treatment of cases with anaemia was carried out as general out patient and in patient services for all age groups [50].

The Ethiopian national guideline for control and prevention of micronutrient deficiencies has formulated the goal of virtual elimination of iron deficiency anaemia and set the objective of reducing prevalence of anaemia among women of reproductive age group from 26.6% to 15.0% [51].

Multifaceted strategies were set forward to achieve the objective. The main strategies selected were: supplementation of iron and folic acid, treatment of severe anaemia, dietary diversification (increased production and consumption of locally available iron rich foods), and fortification of foods with iron and control of malaria, helminthiasis and schistosomiasis. The strategic paper also puts the currently existing health extension program as an opportunity to facilitate promotion of food diversification. Though food fortification was put as a strategy to combat iron deficiency anaemia, clear action plan has not been set and the paper describes the difficulty of fortifying food with iron in the Ethiopian context as there is no widely consumed staple diet in the country. Promotion of use of impregnated mosquito net, immediate access to malaria treatment, and environmental hygiene and anti-helminthiasis were selected actions for control of infection related anaemia [50-52].

Since the formulation and implementation of the goal, objectives and the strategies to control iron deficiency anaemia, several progresses have been made. Thousands of health extension workers have been trained and deployed to the community. Different international and local NGOs have also partnered towards achieving the goals. One good example would be to see the sanitation status of the country. Since 2005 the latrine coverage has linearly increased at the national level though there are differences in progress with in regions. The latrine coverage was 11.5% in 2001/2 and it increased to 37.0% in 2007/8. The following figure describes the latrine coverage by region in three different years [53-55].

Figure 19: Latrine coverage of three years in Ethiopia by region



	Tigray	Afar	Amara	Oromia	Somali	Ben-Gumuz	SNNP	Gambella	Harairie	Addis Ababa	Diredawa	National
Year 2001/2	20.4	9.5	5.0	8.2	13.3	26.6	7.1	7.0	36.3	80.0	52.2	11.5
Year 2003/4	37.0	9.1	32.0	12.0	12.6	25.3	50.0	6.6	45.2	75.5	48.2	28.9
Year 2007/8	40.0	3.0	29.0	35.0	10.0	16.0	55.0	3.0	30.0	80.0	34.0	37.0

Source: Analysed from the MoH three years reports[53-55]

Similarly promising progresses have been made on coverage of family planning, ANC and health services coverage since 2005. Contraceptive acceptance rate has increased from 23.0% in 2003/4 to 50.9% in 2007/8. Similarly ANC coverage increased from 40.8% in 2003/4 to 59.4% in 2007/8. However, significant regional differences exist in these two services coverage; for instance in 2003/4 family planning coverage was only 2.82% and 7.08% in Somali and Afar regions respectively. At regional level ANC coverage, latrine coverage and contraceptive prevalence rate (CPR) strongly predict prevalence of anaemia of any type [53-55]. The regional prevalence of anaemia in 2005 would be calculated using the following predicting equation (Regional prevalence= 42.1-0.28*CPR-0.3*ANC coverage-0.02*latrine coverage) which shows a decreasing prevalence of anaemia as the three coverage increase. The equation has coefficient of determination of 81.2%, explaining most of the variations in prevalence of anaemia by region.

Malaria control activities have also been intensified with significant number of distribution of ITN. Thanks to international aids, over 20 million ITNs have been distributed to more than 10million households in malaria prone areas of Ethiopia since 2005[56].

Chapter IV DISCUSSION

Anaemia is one of the major health problems affecting the health of women in the world. It affects the reproductive health status of women especially in developing countries where the condition is more prevalent. Anaemia, mainly in its worst forms as moderate or severe form, has been shown to contribute a lot to maternal mortality. It also contributes significantly to low birth weight among newborns which in turn is an important risk factor for infant mortality. Cognizant of these facts some scholarly articles put anaemia as a major issue that need to be addressed in the millennium development goals.

It is a common health problem among women of child bearing age and children in the tropics including Ethiopia. The direct causes for anaemia are usually multi-factorial, including nutritional and non-nutritional factors. Other contributing factors are also as important as the direct causes of anaemia. In this paper more emphasis is given to the social determinants of anaemia and levels of haemoglobin and little part on nutrition related aspects.

The analysis of DHS 2005 data reveals that the prevalence of anaemia among pregnant and non-pregnant women is by far lower than the figures estimated by WHO. Even though the 95% confidence interval limit set from WHO for prevalence of anaemia among pregnant and non-pregnant women include the prevalence calculated in this paper, the point estimate is by far bigger than the one obtained through this analysis. The estimates from WHO are almost twice as that calculated from this survey for both groups. This might have happened due to the fact that the models that WHO uses to estimate prevalence of anaemia is prone to overestimate the prevalence of anaemia. In addition, other small scale studies conducted in different parts of the country have always reported overall prevalence rate that is lower than 30% [19,41,57-60]. One facility based study among pregnant women showed prevalence rate of 38.0% with only sample size of 168 pregnant women [61].

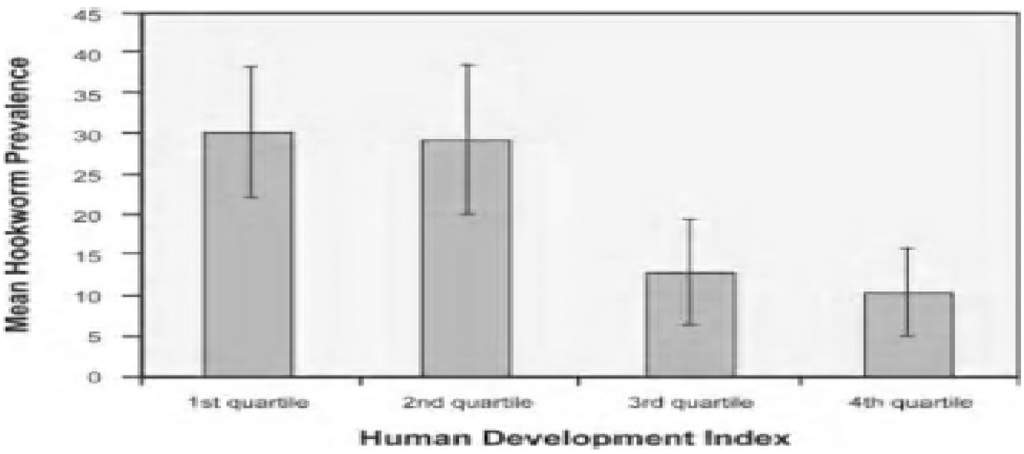
Anaemia is a significant public health problem in all the eleven regions and city councils; all the regions had prevalence rate of above 5%. In this study it is observed that anaemia is severe public health problem in the regions Afar, Somali and Gambella, where as it is a moderate public health problem in the remaining regions except Addis Ababa where it is mild public health problem using the WHO criteria to estimate the degree of public health significance of anaemia. However; the analysis can’t be taken further to the next administrative level because of the small sample sizes that may affect representativeness.

These regional differences in prevalence of anaemia could be attributed to the altitude difference. Most of the residents in the regions Afar, Somali and Gambella live in the low land areas categorized as below 1000 meters; for instance 60.8% of the study participants from the Afar region live in this altitude range. In line with this the other variable that is interlinked with this observation and the difference in rural and urban prevalence of anaemia is the wealth index. In regions where the prevalence of anaemia is very low the wealth index exhibits high weights for the upper quintiles. In Addis Ababa and Dire Dawa where the prevalence of anaemia was relatively low the richest quintile wealth index accounted for 98.1 and 74.5% respectively. On the contrary, the low-land inhabitants in the regions of Afar, Somali and Gambella the highest weight was shared by the poorest quintile wealth index groups. Similarly around 90% of the urban participants live in households where the wealth index is in the highest quintile where as only around 15% of the rural participants live in the highest wealth index category.

What direct causes of anaemia can relate those demography related variables to anaemia? One possible hypothesis is to see the link between hookworm infections and malaria with these distant variables. In general those regions with high prevalence of anaemia are lowlands and coastal regions where the soil is sandy. Sandy soils are known to allow greater hook warm mobility. The high temperature at low lands is also another environmental factor that supports the hookworm life cycle. Due to these facts residents of such low land places can exhibit high hookworm endemicity[62,63]. In addition agriculture is still main source of living for this population especially in the rural areas. Historically hookworm has been a major occupational hazard for agricultural labourers due to the fact that they are highly in contact with soil which is a requirement for the transmission of the parasite[63].

Several studies have also confirmed a significant association between wealth index and hookworm infection. It has been observed after multi country study that the prevalence of hook warm is negatively associated with the wealth index [64]. The following graph shows the relation between hookworm prevalence and wealth index.

Figure 20: Prevalence of hookworm by wealth index



Source: Hotez P, et-al [64]

Possession of toilet that retained its significance even after running logistic regression model could also be associated with the variations in the haemoglobin and anaemia level by region. The proportions of women who live in households with any type of toilet range from 12.4% in Afar to 32.7% in Gambella among the highly affected regions. Though possession doesn't necessarily translate to appropriate utilization of toilet it can still give an insight to disposal mechanisms of human wastes that could play important role in the transmission of the worm. Inadequate sanitation and the deposition of human faeces on soil propagate the life cycle of hookworm[63,65,66]. In fact lack of access to toilet can also predispose to other soil-soil transmitted helminthiasis and schistosomiasis which can also lower haemoglobin level.[63] Though shoes wearing weren't considered as a variable in the analysis it can also contribute to high prevalence of hookworm infection [67].

The other hypothesis is to look at the effect of altitude on the prevalence of malaria. In general the situation in Ethiopia is that the *Dega zones* [3](altitude above 2500 meters) with a mean annual temperature of 10-15 degree Celsius and much of the *Woinadega* zones[4] (altitude 1500-2500 meters) are malaria free Malaria usually occurs below altitude of 2000 meters with short lived transmission following the rains. A linear decrease in the prevalence of malaria was also observed in another study conducted in Oromia, Amhara and SNNP regions [68].

According to UNICEF malaria map the three regions Afar, Somali and Gambella are subject to seasonal malaria with stable transmission of more than three months, leading to acquired immunity among people; such kind of transmission can gradually result in degraded haemoglobin level [5,69]. In fact the capital city Addis Ababa where anaemia prevalence is the lowest is malaria free area. Though altitude can be used to describe the general distribution of malaria other variables of importance are humidity, rainfall and temperature[70].

The third reason could be the household food security status of the population living in those regions. According to the figure described on the result section, food insecurity levels were also very high in these three regions in 2005 according to the FEWS net report of the year. Major rural parts of Afar and Somali regions were identified as hot spot areas and Gambella had proportion in need of food assistance of more than 75%.

The link observed between type of residence and severity of anaemia is another perplexing issue. In this study it was observed that almost all women with severe or moderate anaemia reside in rural areas. In the previous sections we have seen the direct link between this type of anaemia and maternal mortality. This situation coupled with the poor health seeking behaviour, poor transportation facilities and weak health system that is not able to expand its services to the rural areas might worsen the role of anaemia on maternal mortality. The ethnic differences in mean haemoglobin values and prevalence of anaemia might call for further researches to ascertain weather it can be attributed to feeding behaviours or only geographical variations or genetic differences. In this study it was observed that the Hadiya/Sidamo and Gurage/Wolaita ethnic group had the highest haemoglobin values where as the ethnic group Kefa/Aniyak and Afar/Somalie had the lowest haemoglobin values.

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[3] Dega zone is cool and humid agro climatic zone in Ethiopia

[4] Woinadega zone is cool semiarid agro climatic zone in Ethiopia

Another interesting association observed in this analysis was the link between age, fertility, haemoglobin level and anaemia. The prevalence of anaemia linearly increases till the age group 35-39 years and starts declining for the remaining age groups. Similar trend was observed for the mean haemoglobin values but on the opposite direction. This trend of prevalence of anaemia by age could be explained by the effect of previous fertility levels by the women. Though the iron requirement peaks at the age of 15-19 for women and plateaus then after through out their life[35], the effect of multiple child birth might lead to a degraded haemoglobin level. This explanation is supported by the fact that women in the age range of 35-39 years old had given more births in the past five years than any other age groups. Similar finding was also observed in some other countries but there exists controversies as to whether it is a universal truth or not. Similar explanations can be applied to the effect of use of family planning on the haemoglobin level and anaemia. However, use of IUD has been known to increase the risk of anaemia. This effect of IUD was not observed in this study as the number of women using this method of contraception was negligible among the study participants.

In general lower haemoglobin levels are expected among pregnant women than among non pregnant women. This is mainly due to the delusional effect of the expanding plasma volume on the haemoglobin concentration. This explains the lower cut-off level of haemoglobin to define anaemia. Moreover anaemia is also very common in such physiologic state due to the increasing iron demand for the growing foetus, umbilical cord and the placenta. The second and third trimester contribute a major drain on the iron stores of pregnant women [36]. Though statistical significance was not attained, the haemoglobin level tends to linearly decrease from the first to the third trimester among these study participants. Breast feeding also affects the level of haemoglobin and anaemia. Lactating mothers had high prevalence of anaemia when compared with non-lactating women. This fact is supported by the fact that during lactation women loses about 0.5 to 1mg of iron per day. In fact because lactating women are amenorrhic, the other loses through menstruation is lacking hence the iron requirement is almost equivalent to a menstruation women [35]. However, due to the extended breast feeding for more than 6 months, when menstruation already commences, lactating mothers had higher prevalence of anaemia.

Though diet related variables in the past twenty four hour has been considered as potential predictors of the out comes (haemoglobin level and anaemia), the finding should be interpreted cautiously. Flaws could be introduced to this kind of data and analysis as there could be response biases and past 24 hours consumption doesn't really translate in to usual feeding habits of the women. Consumption of iron rich diet could facilitate replacement of the mineral iron in to the body system and hence the haemoglobin level could be higher. But in this study, this variable has no statistically significant role for the prevalence of anaemia. One of the reason could be the invalidity of reflecting past 24 hours food consumption to the overall consumption level. Past 24 hours consumption of teff also decreases level of anaemia. Teff (Eragrostis tef), a rich source of iron that is easily absorbed by the body, is a staple food usually consumed in the form of Injera (flat bread prepared using a range of cereal [21,71].

The linear trend observed between anaemia prevalence and educational status of women has been repeatedly observed in several studies [61,72-75]. This might be happening because educated women are likely to have better income, to consume diversified diets, more likely to utilize the health system for early treatment of diseases than uneducated women. The living environment and access to health facilities by educated women might also contribute to the observed differences.

Chapter V Conclusion and recommendation

1. Conclusion

Based on the formulated objectives and the results found the following conclusion can be made:

- The overall mean level of haemoglobin in this study was found to be 127.2g/l. Twenty five percent of the study participants were found to have haemoglobin value less than 117g/l. Several factors that affect variations in haemoglobin were identified. In general lowlanders, the poor, the uneducated women were found to have low haemoglobin levels when compared with the respective corresponding groups.

- Anaemia, using the WHO cut-off level, was shown to be common in the country with clear different geographical patterns. Around twenty seven percent of women among study participants were anaemic. In the regions Afar, Somali and Gambella, anaemia was found to be severe public health problem. The other regions had moderate level of the condition except Addis Ababa where it was mild public health problem. The rural residents were disproportionately affected when compared with urban dwellers. Pregnant women living in rural areas highly suffered from severe or moderate anaemia which contributes a lot to maternal mortality. Possession of toilet facility was found to be a strong independent predictor of anaemia. This might reflect the importance of environmental sanitation in the efforts to control anaemia. In general the poor, the uneducated, women with history of many child births were found to have high levels of anaemia than their respective opposite groups.

- In addition, in the regions where anaemia was problem of public health importance, it was observed that there was relatively low latrine coverage, ANC coverage and family planning acceptance rates. Those regions were also hot spot areas for food aid in the same year when the data was collected. This might unfold the contribution of food insecurity and health services accessibility and utilization towards anaemia in the country.

- The government of Ethiopia launched strategy for the control of micronutrient deficiencies, including IDA, in 1995. Several promising achievements have been made though impact assessments have not been well documented. Since the initiative latrine coverage, ANC coverage, contraceptive acceptance rates and distribution of mosquito nets to control malaria have been intensified and the indicators are on the increase; however, there are still visible regional differences. Supplementation of iron folate tablets was included under the strategies. Fortification was listed in the strategic plan of the country but the implementation has been severely hampered mentioning the difficulties of tracing universal food item to fortify in the country.

2. Recommendation

Based on the above findings the following measures are recommended to relevant sectors working on control and prevention of micronutrient deficiencies in the country. The relevant sectors are policy makers, implementers and researchers:

- ***To policy makers***

  - The national nutrition program need to see to it that there is clear need differences by region and should give priority to regions highly affected namely Somali, Afar and Gambella regions for the control of anaemia

  - Consider that the disease is affecting the disadvantaged section of the population in terms of education, wealth and access to health facilities. Meanwhile fortification of local food items with iron can also be sought as a solution. It might be difficult to trace factories for specific food item in the country as a whole but common regional foods especially in areas where anaemia is severe problem might be considered.

  - The currently existing health extension programme is working well on some aspects of control of anaemia and need to be sustained and strengthened in order to meet the set objective of anaemia control

  - Strengthen drought forecasting system of the country so that areas in need of food will be reached as early as possible. Use of iron fortified cereals/flours during food aid interventions should also be considered as short term intervention.

  - Efforts should be made to equitable allocate resources including community works like environmental sanitation by region and type of residence and should be based on the disease burden to address those in urgent need

  - Use mass medias at the macro level to educate the public of the importance of dietary diversification, environmental sanitation, child spacing, educating women and utilizing the formal health care services especially during pregnancy

  - Facilitate financial and logistic facilities for surveillance of the magnitude of anaemia and its causes

- ***To implementers***

  - Need to integrate the fact that the disadvantaged section of a community are real sufferers of anaemia and extend their services to the community to identify those suffering or at increased risk of having anaemia

- Facility based services can't address this 'hidden malnutrition' as women usually don't know their status and those suffering from the condition do have most likely poor health seeking behaviour
- Health education programmes on food diversification and availability of supplements, environmental sanitation and control of malaria should be intensively given in the community. The existing health extension program of the country is a potential opportunity to address these issues
- Conduct surveillance on the prevalence of anaemia, any trend changes and causes of anaemia

➢ ***To researchers***

The following research gaps were identified and need to be addressed in order to assist the implementation of control efforts

- The role of malaria and hookworm on the prevalence of anaemia
- The perception of the community towards anaemia and its prevention and treatment
- The role of anaemia on maternal mortality in the context of Ethiopia
- The type of anaemia that is more prevalent in the country
- The role of HIV on the distribution of anaemia
- Exploring factors that affect utilization of reproductive health related services like contraceptives, ANC and factors that might influence adherence to iron tablets
- The link between ethnicity and anaemia: assessing weather it is linked to genetic factors or local food items
- Monitor and evaluate trends in the prevalence and causes of anaemia

➢ ***To the community at large***

- Without full involvement and commitment of the community, no intervention activities can be effective. Hence the community needs to align with the above agencies in order to ameliorate the problem of this 'hidden malnutrition'. Community participation in part depends on the degree to which the above agencies motivate the public through health education, and information dissemination

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ANNEXES

Annex 1: Zinc, iron, calcium and phytate content (mg/100 g fresh weight) and Phytate: Fe molar ratios of selected raw cereals, legumes and oleaginous seeds in Ethiopia

Food type (n)	Zinc (mg/100 g)	Iron (mg/100 g)	Calcium (mg/100 g)	Phytate (mg/100 g)	Phytate: Fe
1. Cereals					
Barley, white flour: roasted, milled with cardomen	3.57	8.4	45	370	3.7
Barley, white flour: roasted, milled	3.29	9.4	46	452	4.1
Barley, white flour: roasted with fenugreek	3.54	10.4	40	553	4.5
Red tef: whole grain	4.02	450.0	155	675	o0.4
Mixed red and white tef: whole grain	3.86	450.0	147	528	o0.3
Red teff: enjera	-	14.7	50	-	-
White tef: whole grain	2.86	37.7	124	842	1.9
White teff: enjera	-	7.0	56	-	-
Maize, white: whole dried kernels	4.04	4.4	16	1443	27.8
Maize, white: 95% extraction flour	2.15	4.9	12	661	11.4
Latryrus sativus; Guaya, dried	-	108.2	336	-	-
2. Legumes					
Broad beans: whole, dried	1.83	5.0	101	478	8.1
Chickpeas: whole, dried	3.35	13.4	213	305	1.9
Fenugreek, white: roasted and powdered	3.76	18.5	179	480	2.2
Haricot beans, white: whole, dried	2.92	10.8	78	604	4.8
Kidney beans, red: whole, dried	4.75	12.2	126	716	5.0
Lentils: whole, dried	3.84	38.4	42	561	1.2
Peas, field: whole, dried	4.13	5.0	90	235	4.0
3. Oleaginous seeds					
Sesame seed: whole	2.48	64.2	359	1525	2.0
Niger seed: whole	2.73	58.4	291	1690	2.5
4.Vegetables					
Mustard greens; Senafich, raw	-	225	527	-	-
5.Oils, fats, oil seeds and nuts					
Ethiopian kale seed boiled; gomen zer	-	20	217	-	-
Ethiopian kale seed, roasted	-	40	314	-	-
Ethiopian kale seed, dried	-	392	368	-	-

Source: EHNRI (1997)[76], Abebe Y(2007)[77]

Annex 2: Median (1st, 3rd quartile) zinc, iron, calcium and phytate contents (mg/100 g fresh weight) of perishable prepared foods from Sidama, Ethiopia

Food type (n)	Moisture (g/100 g)		Zinc (mg/100 g)		Iron (mg/100 g)		Calcium (mg/100 g)		Phytate (mg/100 g)	Phy : Fe
1. Enset starchy foods										
Kocho, fresh: pulp	85	(82, 86)	0.09	(0.08, 0.15)	1.1	(0.8, 1.6)	52	(46, 60)	7 (6, 9)	0.9
Kocho, fermented: pulp, baked	36	(26, 44)	0.52	(0.32, 0.72)	6.2	(3.6, 10.1)	162	(140, 226)	n.d.	
Bulla: desiccated juice from enset pulp	57	(54, 58)	0.07	(0.05, 0.09)	4.8	(3.6, 6.5)	44	(40, 47)	n.d.	
Amicho: decorticated tuber before fermentation	76	(71, 77)	1.33	(1.03, 1.61)	0.7	(0.6, 1.1)	25	(24, 29)	0.9 (0.2, 13.0	0.6
2. Cereals										
Tef dough unfermented	57	(35, 66)	1.38	(1.19, 1.96)	6.8	(6.7, 26.4)	65	(51, 91)	139 (136, 144)	0.6
Injera: from fermented white tef dough	71.6		1.11		6.8		36		102	1.3
Injera: from fermented white and red tef dough	67.8		0.93		7		35		36	0.4
Injera: from fermented red tef dough	56.5		1.75		70.9		76		117	0.1
Corn bread, unleavened	35	(29, 49)	1.66	(1.36, 1.84)	3.4	(3.0, 5.5)	14	(12, 20)	394 (366, 442)	5.4
3. Legumes										
Kidney beans, red: whole, dried, boiled	38	(34, 59)	1.52	(1.23, 1.94)	2.7	(2.4, 4.3)	69	(55, 96)	219 (176, 253)	6.0

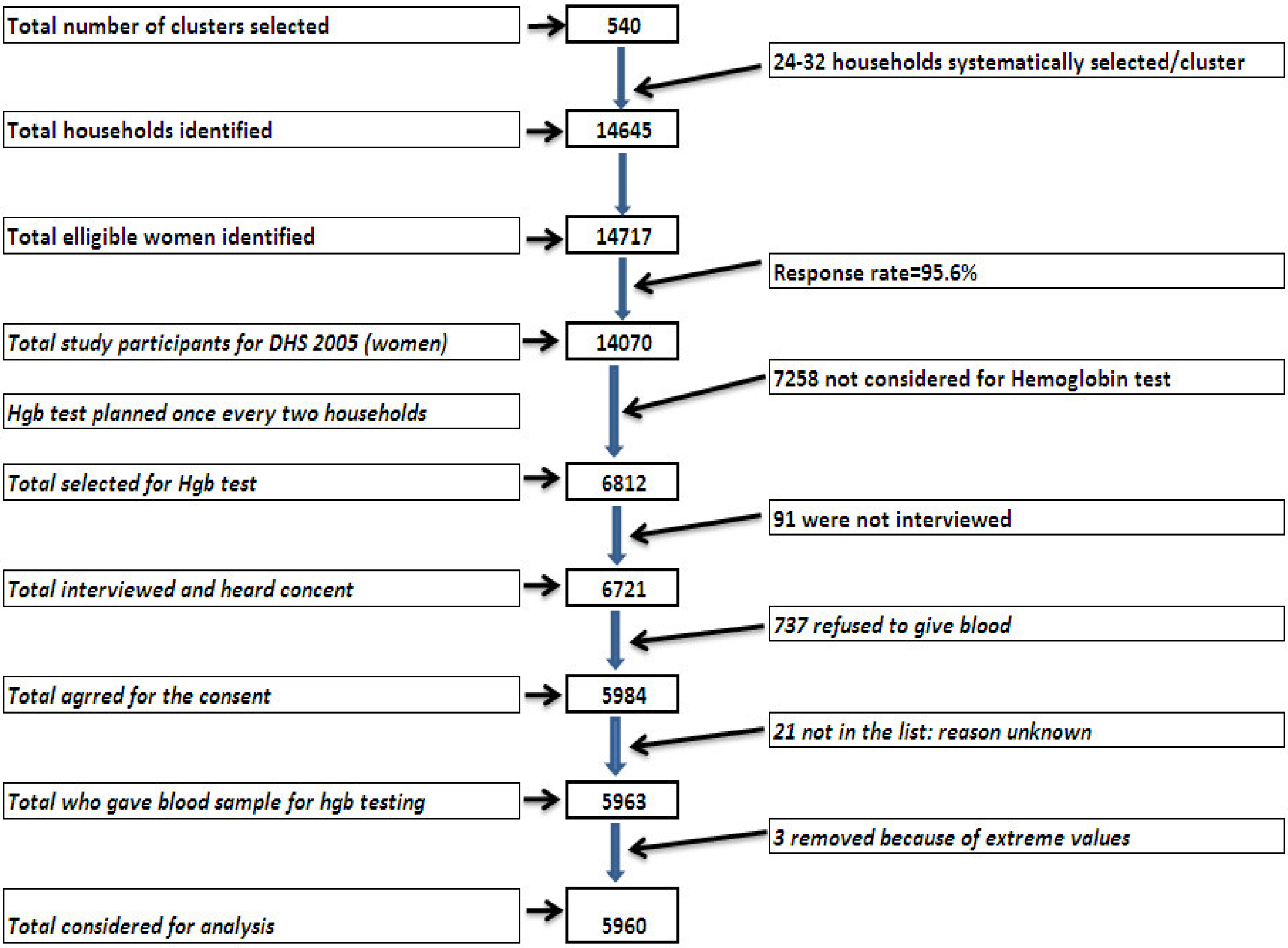
Source: EHNRI (1997)[76], Abebe Y (2007)[77]

Annex 3: Characteristics of responders and non-responders for haemoglobin test

S.No	Variables		Result of measuring (Haemoglobin)				Total	
			Measured		Not measured			
			Number	Percent	Number	Percent	Number	Percent
1	**Age 5-year groups**	15-19	1397	89,0	172	11,0	1569	100,0
		20-24	1089	87,2	160	12,8	1249	100,0
		25-29	1109	89,1	135	10,9	1244	100,0
		30-34	725	89,0	90	11,0	815	100,0
		35-39	689	89,0	85	11,0	774	100,0
		40-44	515	89,6	60	10,4	575	100,0
		45-49	439	88,7	56	11,3	495	100,0
		Total	**5963**	**88,7**	**758**	**11,3**	**6721**	**100,0**
2	**Region**	Tigray	566	94,3	34	5,7	600	100,0
		Afar	283	78,2	79	21,8	362	100,0
		Amhara	827	90,6	86	9,4	913	100,0
		Oromia	971	93,1	72	6,9	1043	100,0
		Somali	257	79,1	68	20,9	325	100,0
		Ben-Gumz	398	94,5	23	5,5	421	100,0
		SNNP	1003	96,3	39	3,7	1042	100,0
		Gambela	339	90,6	35	9,4	374	100,0
		Harari	345	80,2	85	19,8	430	100,0
		Addis Ababa	676	81,7	151	18,3	827	100,0
		Dire Dawa	298	77,6	86	22,4	384	100,0
		Total	**5963**	**88,7**	**758**	**11,3**	**6721**	**100,0**
3	**Type of place of residence**	Urban	1636	80,1	406	19,9	2042	100,0
		Rural	4327	92,5	352	7,5	4679	100,0
		Total	**5963**	**88,7**	**758**	**11,3**	**6721**	**100,0**
4	**Highest educational level**	No education	3636	90,4	387	9,6	4023	100,0
		Primary	1327	90,0	146	10,0	1475	100,0
		Secondary	861	82,6	181	17,4	1042	100,0
		Higher	139	76,8	42	23,2	181	100,0
		Total	**5963**	**88,7**	**758**	**11,3**	**6721**	**100,0**
5	**Wealth index**	Poorest	1212	89,1	148	10,9	1360	100,0
		Poorer	951	92,6	76	7,4	1027	100,0
		Middle	931	95,1	48	4,9	979	100,0
		Richer	887	94,4	53	5,6	940	100,0
		Richest	1982	82,1	433	17,9	2415	100,0
		Total	**5963**	**88,7**	**758**	**11,3**	**6721**	**100,0**

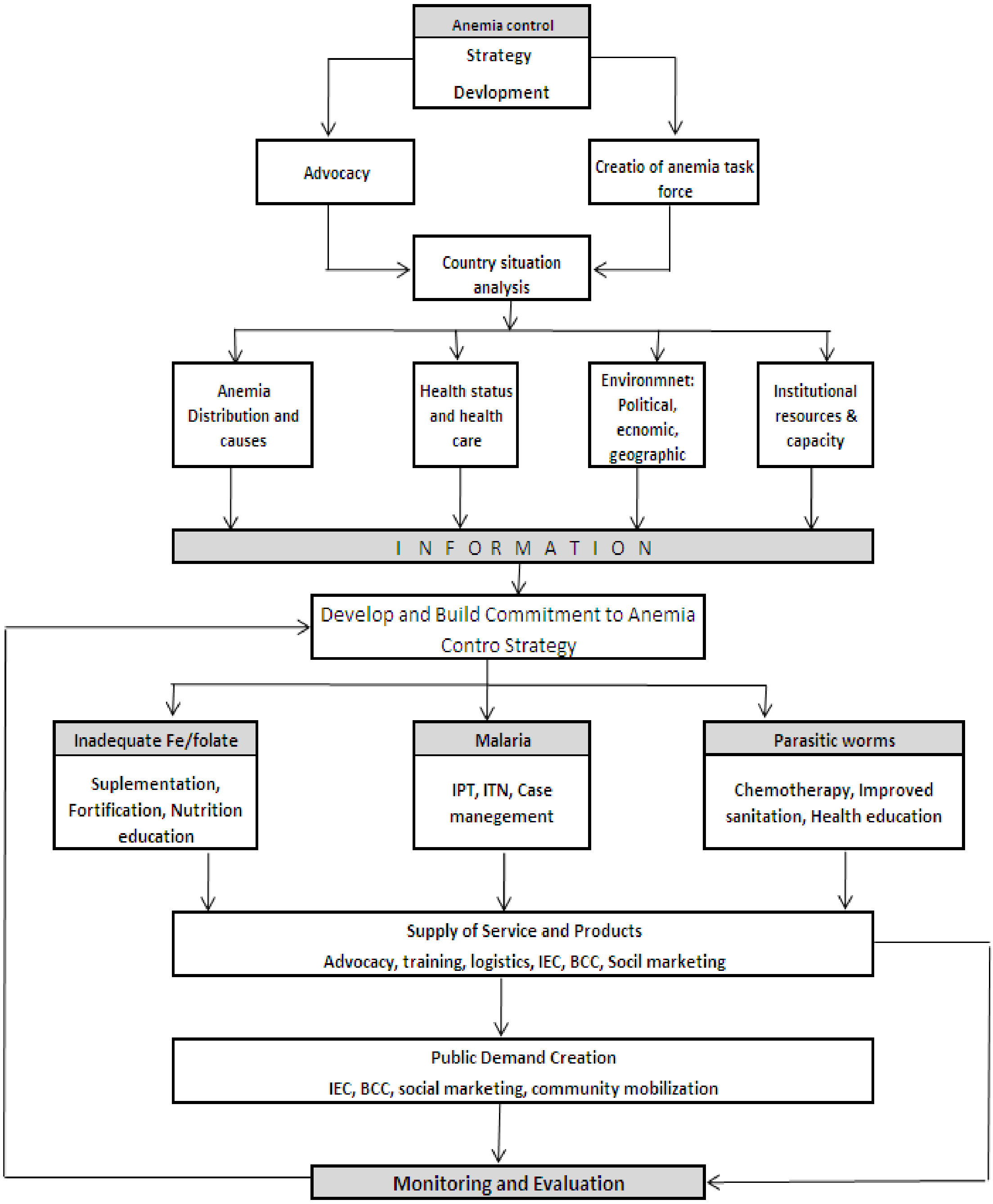
Annex 4: Flow of procedures used for recruiting subjects for haemoglobin testing, DHS 2005

Figure: Flow of the procedure for recruiting subjects for hemoglobin testing



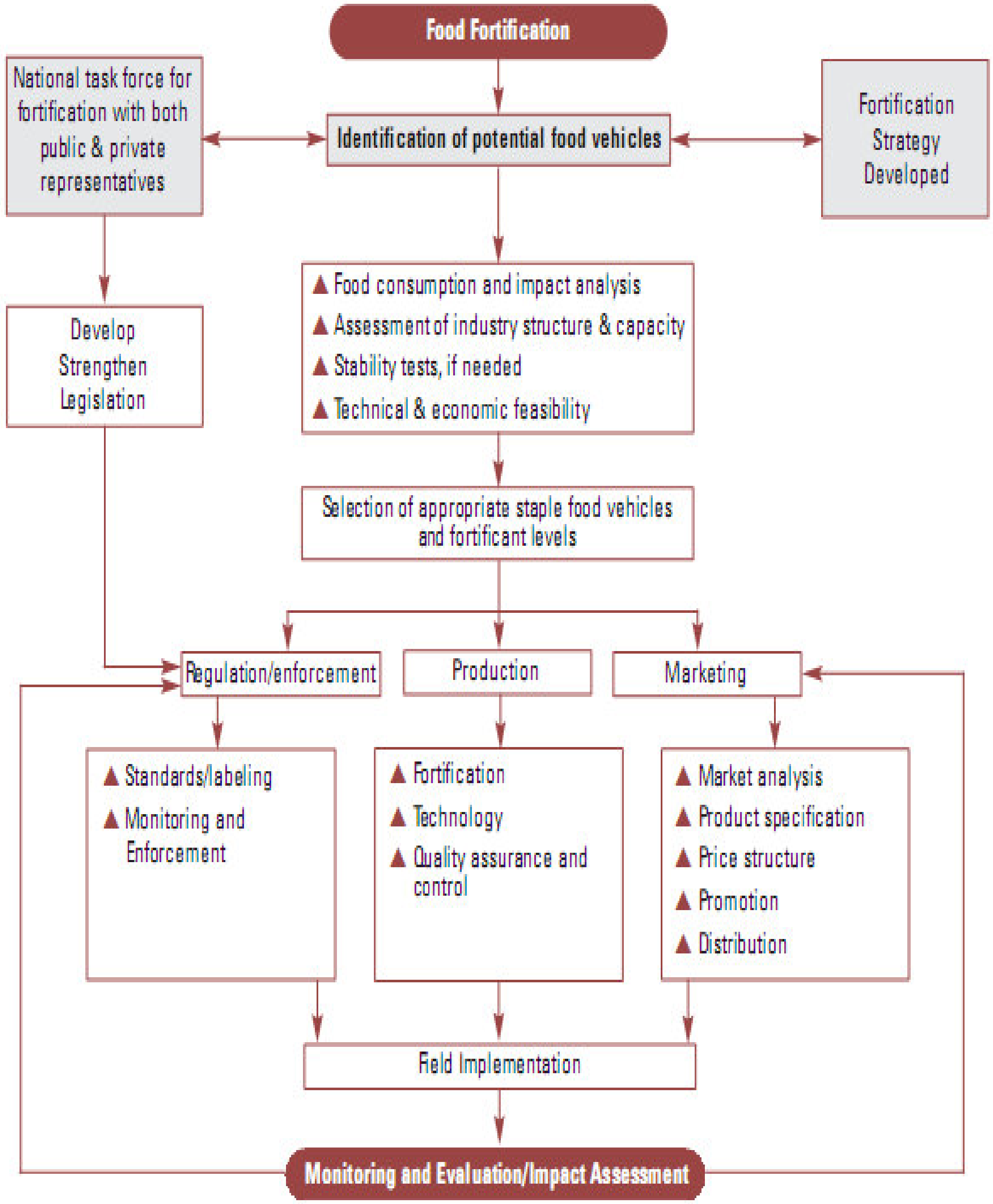
Data collection period: April 27-August 30, 2005

Annex 5: Anaemia Control Program Model



Source: MOST (2004)[78]

Annex 6: Fortification Programme Frame Work



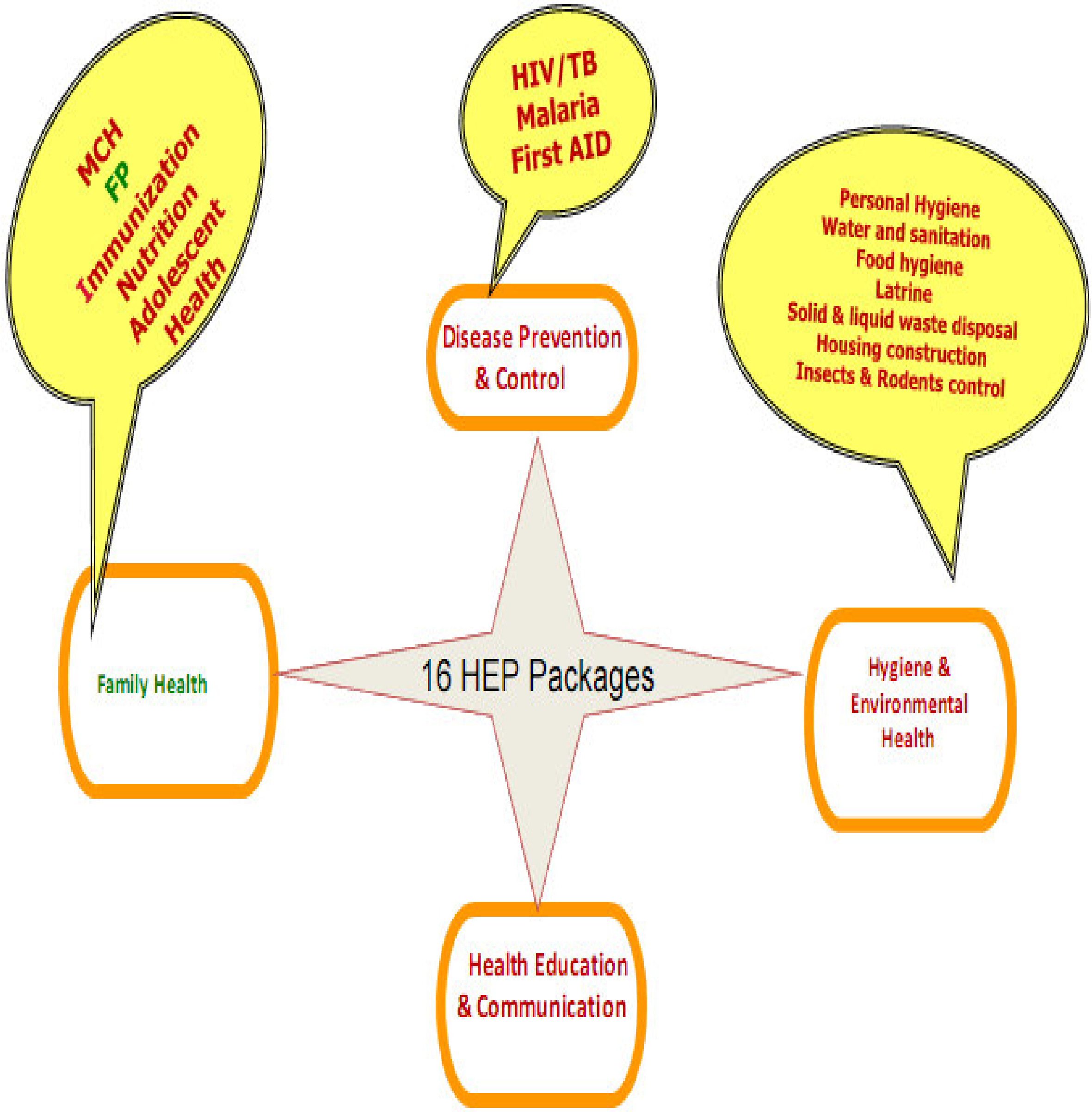
Source: MOST (2004) [78]

Annex 7: Basic Assumptions Underlying Anaemia Control Strategies

- Unless otherwise documented, iron deficiency causes about 50-80% of all anemia cases in LICs
- Wherever malaria and parasitic worms (mostly hookworm) are significant public health problems, they are likely to make an important contribution to anemia prevalence
- *In countries where other micronutrient deficiencies exist, particularly hose of vitamin A and C, folate, riboflavin, and B12, these deficiencies may play a defined although not yet quantified contribution to anemia in those countries*
- *Therefore, anemia's multiple causes call for integrated public health and cross sectional strategies, with multiple interventions to address factors in addition to iron deficiency*

Source: MOSTP (2004)[78]*, and Sharman (2000)*[35]

Annex 8: Areas where health extension workers can involve in the control of anaemia



Source: Linkages(2003)[33]