FACTORS ASSOCIATED WITH DIETARY IRON INTAKE AND PREVALENCE OF ANAEMIA AMONG WOMEN AGED 15-45 YEARS IN GARISSA DISTRICT, KENYA

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DECLARATION

I, Mohamed Abdi Borle hereby declare that this thesis is my original work and has not been presented for a degree in any university.

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Date: 21.12.2004

The dissertation has been submitted with our approval as university supervisors

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Date: 21/12/04

DEDICATION

This dissertation is dedicated to my honourable late grandmother, Nunei Sheikh Marshal and my mother Khadija Ahmed. I will always remember their love.

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ABSTRACT

A cross sectional study with an analytical component was conducted in Garissa district to identify the effect of some important factors associated with anaemia among women of childbearing age (15-45 years) in Garissa District. A sample of 218 households in six randomly selected sub-locations in Garissa District was used. A questionnaire was administered to gather information on demographic characteristics, socio economic status, water, sanitation and hygiene, morbidity, and food consumption patterns. Blood samples of 109 women were analysed for haemoglobin concentration and examined for malaria parasites while stool samples, were examined for helminth and other intestinal parasites to facilitate determination on the effect of parasitic infection on the anaemia status.

The study shows a high prevalence of anaemia among women of childbearing age living in Garissa District. The prevalence of anaemia was high, nearly all the women (88.1%, n=109) who were screened were anaemic. But it was even higher among the rural than in the urban group. More than half (61.5%, n=109) of the studied population who were anaemic were from the rural group. Compared to the current national prevalence, the prevalence of anaemia in Garissa District proved to be among the highest in the whole country.

Education level of the mothers showed no association anaemia status of the studied population. In fact the study showed that literate women had higher prevalence of anaemia compared to the non-literate. Slightly over a fifth of the women (22%, N=218), mostly from the rural group used multivitamins as a complementary source of iron, while slightly

over a quarter used iron tablets as a complementary source to dietary iron. The study established an association between the consumption of food of poor iron content and the use of non-dietary iron source (P=0.05), odd ratio= 1.56 (C.I=1.34-1.82). This means that those taking foods poor in iron are more likely to consume non-dietary iron supplements than those taking iron rich foods.

Higher consumption of fruits, vegetables, cereals and legumes did not significantly increase Hb level and subsequently did not have an impact on anaemia status. The macronutrients and micronutrients from the daily consumption among both the urban and the rural women did not increase the Hb level and hence had no impact on the anaemia status.

More than a quarter (26%, n=109) of the studied women had malaria parasites. The presence of malaria parasite can be associated with high level of prevalence of anaemia among women of childbearing age. There was a highly significant association between the malaria parasite infestation and the prevalence of anaemia both in the urban and the rural women (P=0.05).

Deworming programmes should be emphasized at the individual and community level, people should be taught personal and environmental hygiene through health education, washing hands before handling food, after using the toilet and cooking the meat thoroughly in order to kill the cysts. Health personal should provide routine health education in Mother and Child Health centres and community meetings on the subject of

personal and environmental hygiene. They should emphasize the importance of hygiene by use of Information Education and Communication materials such as role-plays and posters. Health and nutrition education should be given in Barazas (chief's meetings) and should encourage the community to grown vegetables and fruits. In addition, sanitation should be encouraged within these forums. To prevent malaria and parasitic infestation, improving community awareness should also be emphasized within the existing health facility programs Mother and Child Health centres in the district.

Non Governmental Organizations and Ministry of Health should implement mosquito (malaria) control programs along the bank of Tana River with community participation. Distribution of treated bed nets should be widened in the area other than provision to those who attend Mother and Child Health centres.

Given the high level of poverty, income generation program aiming at empowering women to improve their economic status should be introduced to improve the overall nutritional status including the anaemia situation considering the strong Somali social network.

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LIST OF ABBREVIATIONS:

ACC/SCN	Administrative Committee on Coordination/ Sub-Committee on Nutrition
ANP	Applied Human Nutrition
ATP	Adenosine Triphosphate
C.I	Confidence Interval
EDTA	Ethylenediaminetetra-acetic acid
FAO	Food Agricultural Organization
FE	Iron
g/l	Gram per Litre
GOK	Government of Kenya
Hb	Haemoglobin
HIV/AIDS	Human Immune Deficiency Virus/ Acquired Immunodeficiency Syndrome
IDA	Iron Deficiency anaemia
IEC	Information Education and Communication
IMR	Infant Mortality Rate
INACG	International Nutritional Anaemia Consultative Group
ITNs	Insecticide Treated Bed nets
Kshs	Kenya Shillings
MCH	Mother and Child Health Care
NGO's	Non Governmental Organizations
PCV	Packed Cell Volume
PGH	Provincial General Hospital
RBC	Red Blood Cells

RDA	Recommended Daily Allowance
Sf	Serrum Ferritin
SPSS	Statistical Package for Social Science
TIBC	Total Iron Binding Capacity
UNICEF	United Nations Children Fund
WHO	World Health Organization

OPERATIONAL DEFINITIONS

Anaemic women: Women whose haemoglobin level is less than 11 g/dl and hematocrit less than 30 g/dl

Confidence interval: is the interval or range of values within which the true population value is most likely to exist.

Erythrocyte count: Is the number of erythrocytes per litre (lit) or cubic millilitre (mm^3) of blood.

Erythrocyte protoporphin: is a precursor of heme and accumulates in the red blood cells when the amount of heme that can be produced in limited by iron deficiency.

Ferritin: the non-haeme compound in which iron is stored in blood serum, liver, bone marrow and the spleen.

Food consumption pattern: The various food groups e.g. vitamins, minerals, proteins, carbohydrates, fats consumed over a period of time e g. per day or per week etc.

Haeme: the non-protein, iron protoporphyrin constituent of haemoglobin.

Haeme Iron: the organic form in which iron occurs in meat, fish and poultry.

Haemoglobin: It is the pigment that gives colour to red blood cells consisting of heme and protein Hb carries oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. It is measured in gm/dl.

Hematocrit (PCV): Percentage of red blood cells making up the entire volume of blood or is the volume of red blood cells in one litre or 100millilitre (ml) of whole blood.

Household: A group of people living in the same compound (fenced or unfenced), answerable to the same head and sharing a common source of food and income during the study period including unrelated servants and relatives.

Household size: it is the total number of people living in a household during the study period. This does not include guests and residents in transit.

Hypocromic: characterised by deficient haemoglobin content of red blood cells.

Low iron intake: The low intake is considered when it is <14 milligrams of iron in RDA.

Mean Corpuscular Volume: Is the average volume of red blood cells measured in ferritolitres.

Non-haeme iron: iron that is not a part of the haeme complex and that is present in foods, such as eggs, grains, vegetables and fruits and poultry

Prevalence: Quantifies the proportion of individuals in a population (women) who have the condition (Anaemia) at specific instant, provides estimate of probability that an individual will be anaemic at a point in a time.

Prevalence of anaemia in urban: Those women in urban group who have Hb <12 g dl divided by all women in the sample multiplied by 100.

Prevalence of anaemia in rural: Those women in the rural group who have Hb <12 g/dl divided women in the sample multiplied by 100.

Transferrin: Beta–Globulin Protein molecule synthesized in the liver.

CHAPTER ONE

1.0 INTRODUCTION

1.1.BACKGROUND

Worldwide, iron deficiency anaemia has been recognized as the most common micronutrient deficiency particularly in the developing countries (Plich and Sent, 1984). It is the most common type of nutritional anaemia that affects young children and women of reproductive age (Dallman et al, 1984).

The four most common forms of malnutrition in the developing world today are protein-energy malnutrition (PEM), iron deficiency anaemia (IDA), vitamin A deficiency (VAD), and iodine deficiency disorders (IDD) (Crompton et al, 1984; Stephenson, 1987)
In the past major emphases were made on general nutrient deficiency particularly the protein energy malnutrition and only in the recent couple of decades have micronutrients been given more attention. Anaemia is particularly of concern as it is widespread all over the world.

Anaemia, the subject of the present study is a manifestation of nutritional deficiencies caused by diets that lack sufficient quantities of bioavailable essential haemopoietic nutrients to meet the need for haemoglobin and red blood cell synthesis and also influenced by the environmental factors that cause excessive blood loss or haemolysis. Environmental factors that expose humans to infections, such as hookworms,

schistosomiasis, malaria, and other parasites that lead to excessive loss or competition for haemopoietic nutrients, are also of concern, particularly among populations exposed to poverty and deprived living conditions (Barbara, 2001). The national micronutrients survey in Kenya (1999-2000), revealed compelling evidence regarding unacceptability burden of micronutrients malnutrition (Hidden hunger), especially among children and women of reproductive age, provisional isoanaemias indicate that, the distribution of anaemia is heavily skewed with the low altitude, semi-arid to arid north regions of Kenya.

The anaemia that occurs may develop due to increased requirements for micronutrients, impaired absorption insufficient dietary intake or a combination of any or all these factors. The outcome of these food consumption habits among the Somali community are affected by the state of anaemia, corrective measures can take place in a number of ways. One is by nutrition education, which may prove successful and where the lack of sufficient iron and folate in the diet is mainly due to ignorance. Supplementation can also be done through an intervention scheme, where the stable foods of a community at risk are fortified with micronutrients. Dietary modification and fortification are the most effective long-term strategies for alleviating nutritional anaemia. Another way to supplement the diet of individuals at risk is to administer iron and/ or folate via the oral route, or in severe cases of deficiency via the paranteral routes.

1.2 STATEMENT OF THE PROBLEM.

In Kenya the trends of the prevalence of anaemia three decades post independence is not clear. With changes in dominant contributory factors over time there is high probability that the prevalence and severity will have deteriorated (Republic of Kenya, 1998). Northeastern Province, Kenya, where the present study was conducted, is an arid region characterized by the typical tropical arid climate. Like in other arid regions in the tropics, unreliable rainfalls with poor inter seasonal distribution, sparse vegetation, shortage of food production and food insecurity are common features characterizing the region. Food shortage in the district has brought about low nutritional levels. (GOK, 1997-2001).

The national micronutrients survey in Kenya (1999-2000) had revealed compelling evidence regarding unacceptably high prevalence of micronutrients malnutrition (Hidden hunger) especially among children and women of reproductive age. Provisional isoanaems indicate that the distribution of the burden of anaemia is heavily skewed in the low altitude, semi-arid to arid north regions of Kenya. The largest burden was in Garissa District, in which the prevalence of moderate and severe grades of anaemia was (63%-86%) respectively. The factors, which made the Garissa Clusters worse, compared to the other regions in the country, are not clear. Unless effective and detailed study of those factors is conducted as quickly as possible appropriate intervention cannot be implemented.

1.3 JUSTIFICATION

The increasing problem of anaemia in Kenya has caused concern in seeking appropriate and affordable control and prevention strategies. The national micronutrient survey (1999-2000) revealed high prevalence of micronutrient malnutrition, especially among children and women of childbearing age in Garissa District. The factors, which made Garissa worse, compared to the other regions of the country are not clear. This study therefore will look at the factors associated with dietary iron intake and prevalence of anaemia among women aged 15-45 years old in Garissa district, Kenya

1.4 PURPOSE

The purpose of the study was to assess the prevalence of anaemia in Garissa District and to establish the factors that are associated with anaemia, secondly to create awareness on preventable anaemia and valuable information for the community and government or policy makers for intervention purposes and prevention of anaemia as well.

1.5 GENERAL OBJECTIVE

The overall objective was to determine the factors associated with dietary iron intake and their association with prevalence of anaemia among rural and urban Somali communities in Garissa District of North Eastern Province Kenya.

1.5.1 Sub-objectives

The sub-objectives of the study were:

1. To determine the characteristics livelihoods for women of childbearing age in Garissa district.
2. To determine the level of haemoglobin in blood among women aged 15-45 years.

3 To determine the presence and load of malaria and stool parasites among women aged 15-45 years.

4. To determine dietary sources of iron for women aged 15-45 years.

5. To determine non-dietary sources of iron for women aged 15-45 years.

6. To determine the food preparation and consumption pattern women in childbearing age.

1.6 HYPOTHESES

1. There is no relationship between Food types consumed and prevalence of anaemia among rural and urban women aged 15-45 years.
2. There is no association between food preparation and consumption patterns with the prevalence of anaemia among rural and urban women aged 15-45 years.
3. There is no association between malaria and helminthes infestation on the one hand and prevalence of anaemia among women aged 15-45 years.
4. There is no difference between characteristics of livelihoods on the prevalence of anaemia in rural and urban among women of childbearing age.
5. The total macronutrient intake (Fat, Protein, and Carbohydrate) does not correlate with the prevalence of anaemia both in urban and rural women.
6. The total micronutrient intake (Vitamin A, Vitamin C, Iron,Zn) does not correlate with the prevalence of anaemia both in urban and rural women.

1.7 EXPECTED BENEFITS OF THE PROJECT

The findings of this research will benefit the community particularly the women community leaders, the government and the non-governmental organizations.

- This study will increase awareness of the prevalence of anaemia for the women and hence will improve antenatal and postnatal care attendance.
- This study will be an eye opener to the community leaders, especially elders, community opinion leaders and the religious groups will trigger them to increase their involvement in health and nutrition activities in the area to help alleviate anaemia.
- This study will be used to the government, non-governmental organizations, community based organizations and policy makers in planning and targeting intervention programmes aiming at alleviating anaemia.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ANAEMIA AND IRON STATUS

2.1.1 Iron Element

Iron is one of the most investigated and best understood of nutrients (Plich, Senti 1984). It is one of the most important elements in nutrition and is of fundamental importance in life. As a constituent of non-heme iron, it consists primarily of iron salts and is found mainly in plant and dairy products. Non-heme iron is the most abundant form of iron in the diet (>85%), followed by heme iron, which consists of primarily haemoglobin, and myoglobin in meat, poultry and fish. (Ray and Dallman, 2000).

The iron compounds sub serve many vital functions, which are always present when there is sufficient amount of iron in the body. Iron is stored in a reticuloendothelial cells, hepatices and skeletal muscle cells as ferritin (2/3 of total iron) and hemosiderin (1/3 of total iron), (Murphy et al 2001). The body's iron content is very variable, reflecting the adequacy of Fe balance. Total body iron averages 3.8 gram in men and 2.3 gm in women. (Bethwell et al. 1979). Iron containing compounds in the body are grouped into two categories namely the functional (involved in metabolic or enzymatic functions) and storage (iron for storage and transport). Two-third of total body iron is functional iron, found in the form of haemoglobin within circulating erythrocytes. Other iron-containing enzymes and myoglobin makes up to 15% of the total body iron. About one- third of the total body iron in men is stored iron compared to stored iron in women, which represents only one-eighth (Ray and Dallman 2000).

The method for 24-hr recall was appropriate for assessing the average usual intake of nutrients for a population provided that the sample is representative of the population under study and if all days of the week are proportionally included in the survey (Gibson, 1990). The lower figure in women is an indication of the more precarious balance between the amount of iron, which can be absorbed and their increased physiologic requirements. The amount of iron absorbed from food can vary from < 1 to >50%. The percentage absorbed depends on the type of food eaten and the interaction between the food and the regulatory mechanisms in the intestinal mucosa that reflect the body's physiological need for iron. (Hallberg, 1981). Nutritional iron deficiency is commonly regarded as an insufficient iron supply to meet the need for functional iron after stored iron has been depleted (Yip and Dallman 2000). The magnitude of iron deficiency anaemia in Kenya is very high and is believed to be a public Health problem particularly in Northern Eastern province. The intestinal parasites particularly Hookworms and malaria are considered to be the main contributing factors.

2.1.2 Prevalence of Anaemia

The World Health Organization estimates that about 2 billion individuals, or about 40% of the world's population, suffer from anaemia. (WHO, 2000). The population groups with highest prevalence of anaemia are: pregnant women and the elderly (about 50%), infants 1-2 years old and children (48%), school children (40%), non-pregnant women (35%), and preschoolers (25%). Anaemia affects 3 to 4 times more people in non-industrialized regions than in wealthier regions (WHO, 2000).

Little progress has been made in reducing the global anaemia. Among adult women for example, the prevalence has increased in all regions except South America, the Near East, and North Africa (UNACC/SCNS, 1990). In an attempt to increase the awareness of policy makers to the seriousness of the problem, it has been proposed that countries be classified with respect to the degree of public health significance of anaemia. An anaemia prevalence of > 40% is high; 15-40% is medium; and < 15% is low (WHO, Geneva, 1996).

2.1.3 Causes of Anaemia and Iron Deficiency

Anaemia is defined as a condition of low haemoglobin concentration or hematocrit Anaemia's of nutritional origin are acquired problems caused by diets that lack sufficient quantity of bioavailable haematopoietic nutrients to support haemoglobin and red blood cell synthesis (Barbara et al, 1985). Nutritional anaemia are unlikely to be inherent to man's existence, for instance not all nutritional anaemia's are attributed to diet and changing life styles as physiological factors may contribute to the decline in normal functions associated with aging, such as low stomach acidity which decreases the bio availability of vit B_{12} from food (Eaton's and Konner et al, 1985). Iron deficiency can result from inadequate intake of iron and failure to replace losses during menstruation and pregnancy. Iron deficiency can be due to low intake of total iron or absorbable iron and excessive iron losses due to parasitic infections (Lindsay and Jennifer, 2000).

2.1.4 Iron Requirement

The estimated daily iron requirements vary with age, gender and physiological status. The amount of iron required in mg per 1,000 Kcal is 1 for infants, 0.4mg for older

children. 0.8mg and 0.6mg for adolescent girls and boys respectively, and 0.3mg adult men. The requirements for non-pregnant women and postmenopausal women are 0.6mg and 0.4mg respectively, while for pregnant women and those in the second and third trimester are1.9mg, and 2.7mg respectively (Lindsay and Jennifer et al 1998).

2.2 HUMAN PHYSIOLOGICAL STATUS

2.2.1 Pregnancy

Pregnant women have the highest prevalence of anaemia. Iron requirements increase from 1.25mg per day in the non-pregnant women to about 6mg per day during pregnancy, because iron is transferred to the foetus and deposited in the placenta, and more maternal haemoglobin is synthesized. Women who have low iron stores at the start of pregnancy is a normal situation especially In-developing countries and they are at high risk of developing anaemia during their second and third trimesters, therefore they require iron supplements to reduce their risk of anaemia (INAAG, 1988). Short interval (less two years) between pregnancies, adolescent pregnancy and multiple births are also risk factors for anaemia (Allen, 2001).

An iron store of women during late pregnancy predicts their postpartum iron status. Breastfeeding delays the onset of menstruation and helps to protect iron stores. In general, the prevalence of anaemia is lower in the immediate postpartum months, unless blood loss during delivery was severe. After 2 to 3 months of the pregnancy the additional haemoglobin synthesized during pregnancy and iron stores fall, causing anaemia to reappear. The Iron needs during lactation depend on maternal iron status at

delivery and the duration of postpartum amenorrhoea. The childbearing years are the times when most women in developing countries are at risk of iron deficiency anaemia.

2.2.2 Menstruation

About half of the iron requirement by the menstruating women is targeted to cover the loss of iron during the menstrual period. Menstruation explains why the iron requirements of women, expressed as mg/1000kcal, are almost twice those of men, and why iron deficiency is much more common in women. The median amount of iron lost in menstrual flow averages about 0.48 mg iron per day over the month. Women with heavier menstrual losses are considerably at higher risks of developing anaemia and the intrauterine devices are said to double menstrual losses (Gill et al 1976).

2.2.3 Infancy

Because of the large amounts of iron deposited during rapid growth, the iron requirements of infants per 1,000 kcal are particularly high (Lindsay et al 2000). During the first 4 months of life, the total body iron is fairly constant, and half of the stored iron is mobilized for the production of haemoglobin, myoglobin, and enzymes. The amount of iron in breast milk is quiet low and recent reports suggest that it might not be absorbed as efficiently as previously thought (Lindsay et al 2000). After about 4 to 6 months of age it is believed that infants need more iron than can be supplied by breast milk alone (Lindsy, et al 2000). In industrialized countries, this situation is avoided by iron fortification of complementary foods, recommended for all infants starting at around 6 months. After the age of 2 years, the prevalence of anaemia tends to fall because iron requirements are lower and the children start to consume a more varied diet.

In developing countries, about half of the infants are anaemic by one year of age (National Academy Press, wash DC, 1990). Low birth weight, which is common in some developing regions, is clearly a risk factor for anaemia in early infancy. Infants with low birth weight are born with reduced iron stores, which are depleted by two to four months of age (INAAG, 1998).

2.2.4 Adolescence

The prevalence of iron deficiency and subsequent anaemia increases at the start of adolescence (Dallman et al 1992). In girls, this is caused by increased requirements for growth and exacerbated a few years later by the menstruation. In boys, the incremental amount of iron deposited in muscle mass is larger than that in girls. This explains why the prevalence of iron depletion is similar for both genders in many regions. (Dallman et al 1992).

2.2.5 Infections and Parasites

Infections and parasites contribute to anaemia by increasing nutrient losses especially iron due to Plasmodium Falciparium (Yib, 1994). In tropical Africa, anaemia derived from plasmodium Falciparium infection constitutes the largest out patient and inpatient health problems for many health centres (Mendez et al 1997). Also, HIV infection is highly associated with anaemia, particularly in Africa, and having either one condition increases the risk of developing the other (Brain, 1997)

Hookworms infect approximately one billion individuals, and cause blood loss from the intestinal mucous (Stephan, et al 1987). The amount of blood loss is proportional to the

number of worms (INAAG 1998). Worm loads are typically accumulated slowly. The amount of blood loss due to worms is largely dependent on the number of worms present in the human host. The size of the worms burden is usually estimated indirectly by determining the concentration of eggs per gram in excreta (Andrew et al, 2001).

Schistosomiasis, especially Schistosome Haemotobium, causes urinary iron loss through damage to the urinary track. Mean iron losses in heavily infected children can be 0.7mg per day, and a strong association b/w iron status and urinary Schistosomiasis has been reported in sub-Sahara Africa (Stephenson, et al 1985).

2.3 NUTRITIONAL FACTORS

The main cause and determinant factors of Iron Deficiency Anaemia (IDA) are low dietary intake of iron and its poor bioavailability. The best sources of iron are meat, fish and poultry because they are relatively high in iron. The heme iron they contain has high bioavailability such that about 20% is absorbed. The bioavailability of the non-heme iron in most plants sources, including cereals and legumes is only about 2-5% (Garissa, et al 1999). Factors that enhance the absorption of iron are vitamin C obtained from fruits and vegetables, meat, poultry and fish and fermented foods. Factors that inhibit iron absorption are phytates, found in high amounts in maize, wheat, brown rice and legumes. Others are polyphenols in legumes, tea, nuts and coffee, and oxalate in spinach (Lindsay et al, 2000).

2.4 ENVIRONMENTAL FACTORS

Environmental pollution such as lead, copper, aluminium and cadmium also precipitate the Iron Deficiency Anaemia (IDA) through substitution of the iron in heme molecule (Garrow and James, 1993).

2.5 SOCIAL-ECONOMIC AND CULTURAL FACTORS

High poverty levels, in accessibility and unaffordability of health care services, and inadequate knowledge and skills to reduce risk of developing anaemia in the general population are fundamental issues in eradication of anaemia. Other activities that mitigate against Iron Deficiency Anaemia (IDA) include use of insecticide treated bed nets (ITN's) and de-worming. However, food security is probably the most closely associated factor in the nutrition matrix, food taboos, dietary and culinary practices, and have the potential to drastically lower the risk of developing anaemia.

2.6 IRON METABOLISM

Three main factors affect iron balance and metabolism: namely intake, stores, and loss (Dallman, 1986). Iron absorption is influenced by dietary Iron content, bioavailability of diet iron, amount stored iron, and rate of erythrocytes production (Kikne et al 1984). Non-heme iron consists of iron salts, found mainly in plants and Dairy products, and accounts for the most of the iron in the diet (85%). The Heme iron comes from Hb and myoglobin in meat, poultry and fish and accounts for the smaller proportion of iron in the diet than non-heme iron (Charlton et al, 1983)

The absorption of iron in the food may be influenced by the presence of other foods. Meat increases the absorption of iron from a number of sources, including maize, black

beans and inorganic iron salts. Cysteine has been shown to be one of the substances responsible for this enhancing effect (Bothwell et al, 1964). Before iron can be absorbed in the upper part of the small intestine, it is fast separated from organic material such as proteins, into solubilised form.

Transport of iron from the breakdown of haemoglobin or from the intestine to the tissues is accomplished by the plasma transport protein, transferrin. Transferrin delivers iron to the tissues by means of cell membrane receptors specific for tranferrin (Huebers and Finch, 1987). When a cell needs iron, it produces more transferrin receptors and is thus able to collect more iron from the circulatory supply. If the amount of iron absorbed from the diet and obtained from the break down of RBC is insufficient to meet the body's needs, iron is removed from the storage sites and transported to the demand sites, and bound transferrin molecules. Iron is stored in the body in the form of ferritin, in the bone marrow, liver, spleen and kidneys. The symptoms of iron deficiency appear only when the body's stores of iron are depleted (Guthrie and Piciano 1995)

2.7 IRON EXCESS AND TOXICITY

The term iron potential is derive from its two-oxidation states: namely Fe 3+ (Ferric form) and Fe 2+ (Ferrous form). A number of health disorders are related to short-or long-term exposure to iron in amounts exceeding the physiological requriments. This pathological conditions range from acute iron poisoning to organ damage due to chronic iron overload (Yip, 1995). Present evidence indicate that supplementary iron at recommended doses to women of reproductive age groups, cause minor side effects such

as constipation, abdominal pain, nausea, vomiting and faecal discoloration in less than 5% of the women (Charlton, 1978).

2.8 BIOCHEMICAL AND PHYSIOLOGICAL FUNCTIONS

Iron is an integral part of heme and is needed for the following functions:

➢ Co-Factors of Enzymes and Other Proteins

The iron containing heme group is also part of the several proteins involved in the release of energy during the oxidation of nutrients and the trapping of that energy within Adenosine Tri-phosphate (ATP). Also iron on its own is a co-factor bound to several non-heme enzymes required for the proper functioning of cells (Dallman, 1986). The foremost iron storage compounds are ferritin and hemosiderin, which are present in the lives, reticuloendothelial cells and bone marrow. (Hershkoc, 1977). Some of the other process that depend on the activities of iron containing enzymes are conversion of beta carotene to the active form of Vitamin A, formation of carnitin for synthesis of collagen, detoxification of drugs and other toxic compounds in the liver, and synthesis of neurotransmitters (Guthrie and Pisceans, 1995).

Iron compounds that serve major biological functions are haemoglobin for oxygen transport, myoglobin for muscle storage of oxygen and citochromes for oxidative production of cellular energy in the form of ATP (Ray and Dallman, 1996).

➢ Formation of Red Blood Cells

Since the iron containing protein haemoglobin is a major component of red blood cells (RBC), iron is required for the formation of these cells, which are formed in the bone marrow (Guthrie and Piciano, 1995)

➢ Transport and Storage of Oxygen

Iron in its ferrous state within the metalloproteins haemoglobin and myoglobin can bind to oxygen molecules and transport them through the blood or store them within the muscles.

2.9 CONSEQUENCES OF IRON-DEFICIENCY

Unless the anaemia is severe, the clinical manifestations of iron deficiency tend to be subtle. As the essential iron compounds become depleted, the degree of functional impairment increases (Dallman, 1982).

2.9.1 Anaemia

Anaemia is by far the best-known manifestation of iron deficiency. Very severe anaemia, which may result from iron-deficiency in combination with other diseases, is associated with increased childhood and maternal mortality (WHO, 1992).

2.9.2 Work Performance

Anaemia causes a substantial reduction in work capacity; even in its mild degree form, and can decrease physical performance during brief and intense exercise (Viteri and Tourn, 1974).

2.9.3 Behaviour and Intellectual Performance

Mounting evidence points to impaired psychomotor development and intellectual performance as well as changes in behaviour, resulting from iron-deficiency (Lozeff, 1988). The abnormalities are most profound in children (19-24 months), whose iron-deficiency is presumed to have existed for the longest time. (Lozoff, Britten, et al, 1982). The rapid growth and differentiation of brain cells during infancy might be expected to make the brain particularly vulnerable to deficiencies in the supply of nutrients. Even though there is good evidence that the developmental deficits can be connected with iron treatment, other studies suggest that abnormalities are not fully associated (Lozoff, 1988)

2.9.4 Body Temperature Regulation:

Body temperature abnormalities are said to be associated with decreased secretion of thyroid stimulating hormone-TSH and thyroid hormone (Beard et al. 1984). These hormones are involved in the regulation of body temperature.

2.9.5 Immunity and Resistance to Infection:

Decreased resistance to infection in human and experimental animals has been associated with iron deficiency.

2.10 ASSESSMENT OF NUTRITIONAL ANAEMIA

The initial detection of iron deficiency anaemia in an individual is usually realised through laboratory assessment. Once the presence of anaemia has been established, tests are then done to establish whether it is as a result of iron deficiency. However, it must be stressed that haemoglobin concentration varies considerably in normal subjects, such that

low iron deficiency will go undetected if it is the only test used (INAAG, 1982). When iron deficiency anaemia is caused by impaired iron balance, a sequence of well-defined changes occurs in iron storages, iron transport and eventually the metabolic functions that are dependent on iron. The earliest evidence of iron deficiency is characterised by depletion of stored iron.

At this stage there are no functional disturbances, although there are no iron reserves to meet future physiological or pathological requirements. At the next stage, the laboratory testing reveals sub-optimal rate of iron delivery to the bone marrow and other tissues, although there is still no detectable anaemia (to the early functional iron deficiency traditionally called iron deficient erythropoiesis). The third stage is characterized by a decrease in functional iron, with the onset of anaemia and its associated clinical symptoms or iron deficiency anaemia.

Table 2.1: Indicators of iron deficiency at various iron status stages

Indicator	Normal	Storage depletion	Early functional Iron deficiency	Iron defi anemia
Serum ferritiri (µg/l)	130(m) 35(F)	<12	<12	<12
TIBC (µg/dl)	330	360	390	410
Transferriri saturation (%)	35	30	<15	<15
FP (µg/dlrbc)	30	30	100	200
STfR (µg/l)	5.5	5.5	10	14
Erythrocytes (Haemoglobin, haemotocrit, rbc indices)	Normal	Normal	Normal	Microcyti hypo cl anaemia

Source Data from Bothwell et al. 1979, Brittenhan, 2000, and Lookers et al. 1991.

2.11 GAP OF KNOWLEDGE

The national anaemia survey of Kenya (1999) showed that the prevalence of anaemia among the mothers in the district was the highest compared to the other clusters drawn from other districts. However, the associated factors of this problem were not well articulated in the report.

CHAPTER THREE

3.0 STUDY SETTING AND METHODOLOGY

3.1 BACKGROUND INFORMATION ON THE STUDY AREA.

3.1.1 Position and size

Garissa district is one of the four districts forming North Eastern Province. The district borders Wajir District to the North, Tana River District to the West, Isiolo Districts to the Northwest, the Republic of Somalia to the East, and the newly created Ijara District to the South. The district lies approximately between Latitude $0^{0}58'$N and $0^{0}2'$ and Longitudes $38^{0}34$E and 41^{0} 32E. It covers an area of 33,620 km^{2}, which is about 7.5% of the total area of the country. The length (North to South) of the district is approximately 333 km and its width (East to West) is approximately 248km. The distance between Garissa and Nairobi is 370 km.

3.1.2 Topography and Climate

Garissa is a low land, with altitudes ranging between 70m and 400m above sea level and is devoid of any mountains, hills or valleys. The Tana River, which runs along the Western boundary of the district, is the only permanent river. Rainfall distribution tends to be even within the district but due to the coastal winds the Southern divisions of Hulugho, Masalani and Bura receive relatively more rainfall than the Northern divisions. The mean annual rainfall ranges between 23.6mm and 34.2mm. Given the arid nature of the district and low altitudes, its temperatures are generally high most of the year ranging

between 20.5°C and 38°C. Frequent droughts and unreliable rains do not favour the growth of pasture for livestock rearing and agricultural activities.

3.1.3 Administrative Boundaries and Political Units

The district is sub-divided into eleven administrative divisions, forty-two locations and sixty sub-locations **(Table 3.1)**. The inhabitants comprise pastoral and nomadic communities.

Table 3.1 Administration Units and Area by Division

Division	No of locations	No of sub-location	Area in km2	Population
Balambala	3	9	1,900.3	24,623
Bura	4	5	5,775.2	17,419
Central	5	6	858.7	71,510
Sankuri	4	7	1,808.3	8,007
Dadaab	7	6	3,536.0	12,952
Jarajila	4	4	8,859.9	5,346
Liboi	3	5	3,242.6	10,266
Shanta-abaq	3	4	3,592.8	14,633
Modogashe	3	4	2,075.0	16,842
Benane	3	2	850.4	5,650
Danyere	3	7	1,900.3	6,234

Source: District Commissioner's Office, Garissa, 2001

The district administrative set up is unique in that most of the locations are the same as sub-locations meaning that the chief and their assistants share the same boundaries. This set up is necessitated by the vastness of the units and inadequate infrastructure. This district has three constituencies, namely Dujis, Laghdera and Fafi, that constituencies are vast and sparsely populated. There are 45 wards in two local authorities namely Garissa Municipal and County Council. The Municipal Council has six elective wards in part of the Central Division while Garissa County Council has 39 elective wards. The elective

wards are based on the existing location boundaries apart from the Municipal council, which has six wards and three locations. The County Council wards are too many compared to the council's resource base, which is mostly from livestock sales fee collected in the Garissa Market.

The central division has the highest population as it has the provincial and district headquarters and is the only town in the district, which has access to the outside parts of the district, while the Southern divisions are more densely populated than the Northern divisions. The influence of Tana River and the coastal region on the South and North - West of the district, explain the higher concentration of settlements in the Southern divisions compared to the North.

Table 3.2 Political units by Divisions and Wards

Constituency	Divisions Covered	No of Wards
Dujis	Central, Sankuri, Balambala, Danyere.	18
Laghdera	Benane, Modogashe, Shantaabak, Dadaab, Liboi.	19
Fafi	Jarajila, Bura.	8
Total		45

Source: District Commissioner's Office, Garissa, 2001.

3.1.4 Population Size

The district's population census of 1999 registered a total of 368,593 people. This constituted 33.6 percent of the population of the province. Its projected population for 2008 is approximately 460,215. Urban Population: Any settlement with more than two

thousand inhabitants is regarded as an urban centre despite the lack of permanent structures and sanitation systems. Most of the urban centres within the district lack the basic infrastructure such as electricity, water, and telecommunication services.

Garissa town is the only Urban centre with developed infrastructure for industrialization. The population of the town is estimated at 65,812. Despite the nomadic way of life for the population, many of the district inhabitants have settled around the divisional headquarters where water, electricity, and security are good.

3.1.5 Health Facilities

Health services in the district are provided through 28 institutions comprising one hospital, four health centers, 17 dispensaries, five private clinics and one mobile clinic. Due to poor distribution of the population, the district is poorly covered by the existing health facilities. There are only five doctors in the district and all stationed at the Provincial General Hospital (PGH). Inadequate equipment, drugs and personnel have led to under utilization of all facilities except the Provincial General Hospital, which is over utilized.

The major causes of diseases within Garissa District are diarrhoeal diseases malaria, upper respiratory tract infection, anemia and pneumonia. Garissa town is strategically located along the high way to Wajir, Mandera and to the Republic of Somalia. Hence the increasing incidence of HIV/AIDS in the town is attributed to its location, as long distance drivers are a high-risk group. Due to the arid nature of the district the nomadic way of life of the community, vastness of the district, poor distribution of the population

and poor infrastructure, the immunization coverage is only 12.6% compared to the national level of 70%. The infant mortality rates (IMR) are estimated at 86 per 1000 in Garissa Town and 146 per 1000 in the interior. From the 1989 figures the females of childbearing age (15-45) represented 21.8% of the population. The labour force has far more men than women; this arises from the high illiteracy levels and cultural beliefs, which restricts the women to household chores.

3.1.6 Educational Facilities

There are 54 primary schools, nine secondary schools and two youth polytechnic in the district. The district has also a farmers training center and a teacher training college. Most of the educational facilities are found within Garissa Municipality in Central Division, where most of the district's population lives.

The total school enrollment for primary and secondary schools was 12,500 and 2,320 students respectively. There were a total of 408 teachers in the primary schools and 116 in secondary schools in 1995, giving a teacher pupil ratio of 1:31 and 1:20 in primary and secondary schools respectively.

3.1.7 Communication Networks

There are a total of 1651 km of classified road network in the district. Out of the total road network, less than 150 km are gravel, whereas the rest are all earth roads. On postal and telecommunication services the district is not adequately served. The district has six airstrips located that are in Garissa, Dadaab, Liboi, Ijara and Hulugho. Since 2003, the

district has introduced mobile telephone communications (both Safaricom and Kencell), and that has improved communication in the district.

3.1.8 Water Facilities

The single reliable surface source of water is the Tana River although it does not pass within the entire district. There are 11 water supplies whose source is Tana River. These water supplies serve the settlements along the river. Thirty-one operational boreholes mostly in the northern divisions of the Shanta Abaq, Liboi, and Dadaab serve the rest of the district. However water in the district is not adequate, as the volume of water in boreholes reduces during the dry season. The average distance from households to water facilities within the district is 35 km.

3.1.9 Agricultural Activities

Garissa Districts' agricultural production is concentrated mainly along Tana River through irrigation and in flood receeding zones. Further inland farming is carried out along dry river beds and in depressions where they discharge their waters. Rain fed cultivation is done in the southern divisions of Ijara, Masalani, and Hulugho, which receive higher rainfall than the rest of the district. Mostly maize, sorghum, millet and cowpeas are grown in these areas. Currently, about 1200 ha. of Horticulture farming has been developed and is currently under tomatoes, bananas, pawpaws and sweat mellon. These provide raw materials for small-scale agro-based industries.

The arid nature of the district makes livestock keeping being the major economic activity The major land use is nomadic pastrolism. The main types of livestock reared include

cattle, sheep and goats, camels and donkeys and the main livestock products are milk, meat hides and skin. Most of the livestock population is concentrated along the Tana River in the southern divisions of Hulugho, Ijara and Masalani. There was a significant increase of 25% on poultry population due to urbanization that probably has changed eating habits.

3.2 METHODOLOGY

3.2.1 Study Design and Study Population

This study was a cross sectional, descriptive and analytical as well as comparative in nature. Comparing the women in urban to that in rural for establishing the data for urban and rural women were compared to establish differences and associations of prevalence of anaemia with the livelihood, food consumption patterns, water, sanitation and hygiene and morbidity. Both risk factors, livelihood characteristics, food consumption patterns, water, sanitation and hygiene and morbidity and the disease (anaemia) were ascertained concurrently with the measurements of other parameters.

The study population consisted of women of childbearing age in Central division and in three other divisions (Dadaab, Liboi and Modogashe). Hereinafter, these women are identified as urban and rural groups respectively.

3.2.2 Sampling Frame

The sample frame of the study consists of all the households in the six target sub-locations with a woman of childbearing age. Registering all the households with women of childbearing age in the six sub-locations developed a list of households. 74 women

from the urban and 144 women from the rural were randomly selected giving a sample of 218.

Table3.3 Distribution of the study households in the sub-locations

Sub-location	Central	Bulo-madino	Bulo-iska deg	Dadaab	Liboi	Modogashe
Sampling frame	160	160	160	320	320	320
Sampled	37	37	37	48	48	48

3.2.3 Sample Size Determination

According to the national micronutrient survey in Kenya (1999-2000), the proportions of women who are anaemic in Garissa are approximately 80%. This assumption and confidence interval (C.I) of 95% were taken into account in the sample size determination. The sample size was estimated using Fischer's formula for cross sectional study. A sample size of 218 was established using the formula: $N = \frac{2 Z^2 p q}{d^2}$ (Fischer et al 1991).

Where by:

N= desired sample size for each group.

Z^2= standard normal deviate, set at 1.96 which corresponds to 95% confidence interval

P= proportion in the total target population expected to be anaemic (80%=0.8).

q=1-p: proportion of non-anaemic women in the study population (20%=0.2).

d^2= the approximate test difference anaemic and non-anaemic between urban

and rural areas of women of child bearing age which is significant at alfa level of 0.05. Therefore:

$N=2 \times (1.96)^2 \times (0.8)(0.2) / (0.075)^2 = 218$ households

An addition of 5% was made to take care of attrition and refusals. The sample size used was 218 households.

3.2.4 Sampling Procedures

As illustrated in **figure 1** this study was carried out in the six randomly selected sub-locations in Garissa District. A preliminary survey for identification and registration of all households with women of childbearing age was carried out. From a population of approximately 1308 women of child bearing age, 218 were randomly selected in this population: 74 women from central division and 144 women from the other three divisions. These women were interviewed to gather information on demographic characteristics, socio-economic status, water, sanitation and hygiene, morbidity, food consumption pattern. A sub-sample for 24- hour recall, haemoglobin, stool and malaria were acquired by simple random sampling from the sampling units in each sub-location. A sub-sample of 64 women was interviewed for dietary intake using 24hr-recall. This number, which is, more than the minimum sample size (50 cases) as recommended by Fisher et al (1983) was asked to describe their dietary intake for the last 24hr-recall. A sub-sample of 109 had their blood drawn for haemoglobin analysis, while a sub-sample of 109 had their blood analysed for malaria parasite. A sub-sample of 109 had their stool samples analysed for helminths and other parasitic infection

Table3.4 Distribution of the sub- samples in the urban and rural groups that were subjected to analysis

Sub-sample	Urban	Rural
Dietary 24-hr recall	22	43
Haemoglobin	37	73
Stool examination	37	73
Malaria test	37	73

3.2.5 Research Assistants

To ensure quick data collection, three research assistants, two nutritionists and one family health field educator were hired, the first two were female while third was male. The qualification criteria for selecting a research assistant were secondary school certificate at the minimum. Eventually the three field assistants who were hired had diploma. The field assistants were trained for two days on questionnaire interpretation, data collection techniques, measurement of dietary intake and interviewing techniques. They were also trained on the basic field ethics. The training continued through the pre-testing period making the period of training into five days. The assistants were closely monitored in the early stages of the actual data collection but general supervision was sustained throughout the data collection exercise.

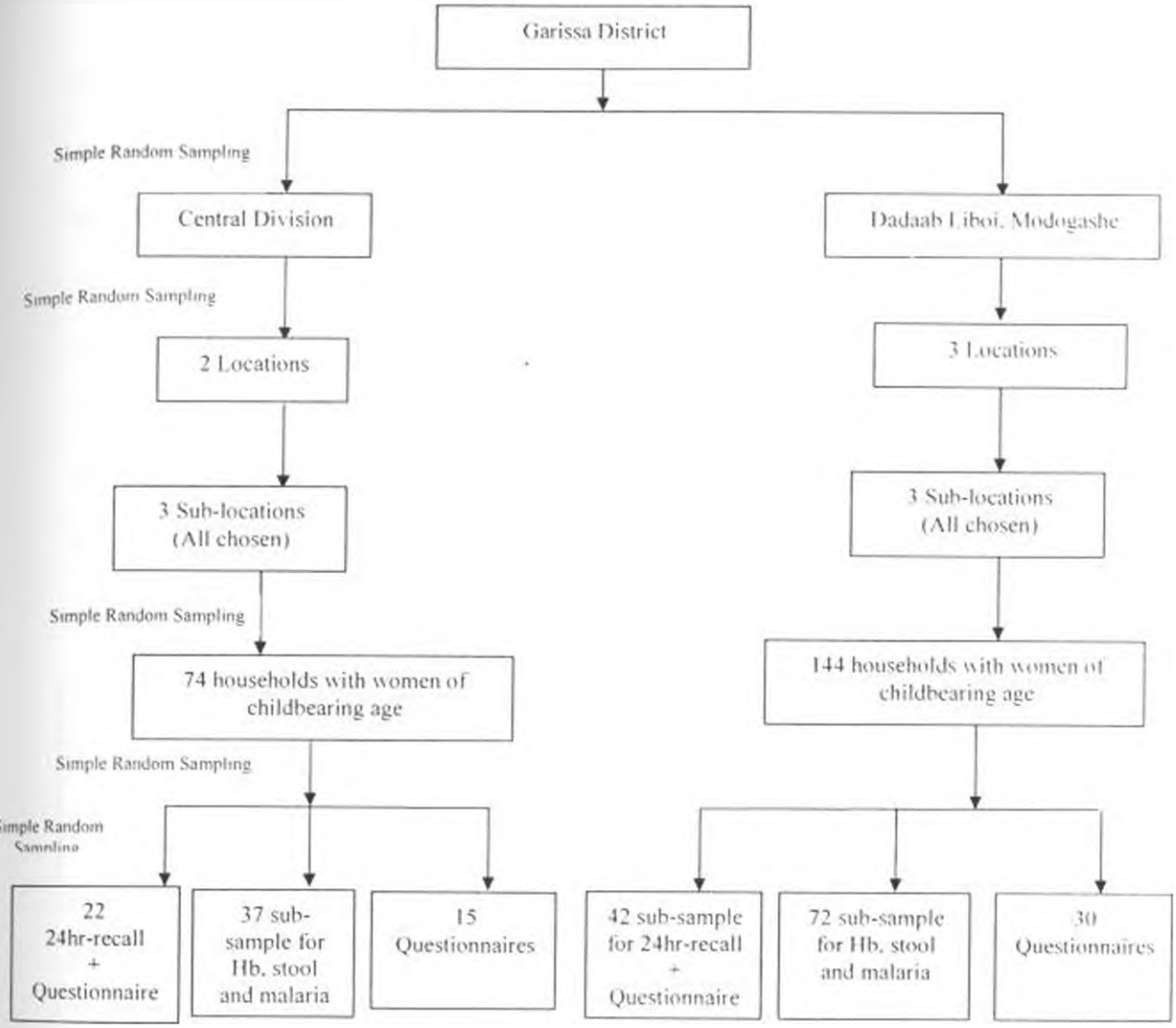
3.2.6. Pre-Testing of the Research Instruments

One of the sub-locations in Garissa district was selected for pre-testing. 20 households were randomly selected and the questionnaire was administrated for pre-testing the appropriateness of the study instruments. The exercise was also aimed at evaluating the skills, efficiency and the performance of the research assistants. Based on the experience, guidance and counseling were given, as necessary and appropriate changes and corrections were made on the study instruments.

3.2.7. Research Permission and Consent

Prior to engaging in the study an application for research permit was made and subsequently obtained or given by from the Ministry of Education. The researcher paid a courtesy call to the Garissa District Commissioner and clarified the purpose of the research. He also met with the Garissa Education Officer and Garissa Medical Officer of Health. The researcher briefed and discussed with the community leaders of the selected sub-locations the purpose of this research. After explaining the purpose and requirements of the study to potential respondents, they then made an informed choice and consent form was filled out and signed by every participant

Fig 3.1 Flow Chart of the Sampling Procedure of the Research



3.3 Methods of Data Collection

3.3.1Screening For Anaemia

Internationally, it is accepted that blood haemoglobin level is a key indicator for anaemia (Graitcer et al. 1981). Hence anaemia is detected by measuring haemoglobin concentration that provides information about both the quality and the quantity of erythrocytes that is accurate and relatively easy to obtain. The cut-off points, suggested by WHO **(Table 3.5)** were used to classify the study subjects into anaemia and normal, those whose haemoglobin falls below the level that is shown in the table are considered to be anaemic.

Table3.5 Diagnosis of anaemia using WHO criteria

Subject	Hb below (g/dl)	PVC below
1.Adult male	13	42
2.Adult female (Non-pregnant)	12	36
3.Pregnant female	11	30
4.Child 6 months to 6 years	11	32
5.Child 6-14 years	12	32

Source WHO, 1975

3.3.2 The Principle of the Method

The purpose of screening for anaemia among the study population was to determine haemoglobin concentration of 109 participants. The haemoglobin concentration was analysed by using Sahil method, the haemoglobin was

converted to acid-haematin by the action of the diluted acid, which is determined visually comparing with provided standard.

Estimation of Haemoglobin in blood by Sahli method was used as follows:

- Reagents and apparatus
- Principle
- Procedure
- Advantages
- Disadvantages
- Normal

1.0 Reagents and apparatus.

a) Reagents and apparatus.

b) 20-ul pipette.

c) Sahli compartment.

d) Dry gauze

e) Pasteur pipette.

f) Swaps 70% alcohol or spirit.

2.0 Principle.

Haemoglobin is converted to acid-haematin by the action of the diluted acid, which is determined visually comparing with provided standard.

3.0 Procedure

A. Clean the intercubital vein using 70% of alcohol, about a diameter of 6 cm.

B. Get blood 2 cc using syringe and needle.

C. Empty into a container with anticoagulant (E.D.T.A).

D. Put the 0.1 Hcl N into the Sahli tube to the 20 mark.

E. Using clean dry Sahli pipette, take blood to the 20 ul mark and wipe the outside surface of the tube using the dry gauze.

F. Pipette the blood to the 0.1N Hcl in to the Sahli tube and rinse inside it severally.

G. Mix gently by shaking.

H. Using Pasteur pipette, add the 0.1N Hcl drop wise to the acidified blood and shake after every 2 drops of added 0.1N Hcl.

I. Continue this until the diluted the diluted blood gets the same colour intensity as the standard glasses.

J. Remove the tube and read off the haemoglobin level using the lower meniscus.

K. Record the results.

This method has a percentage error of +-2gm%.

4. Advantages

a) Can be used where there is no electricity.

b) Cheap

c) Easy

d) Do not use large amount of blood.

e) Can be used as a screening method.

f) Instead of Hcl (CHCOOH) rainwater can be used.

5. Disadvantage

a) High percentages of error.

b) The standards fade with time.

c) The procedure has to be repeated once the sample is over-diluted.

d) Discrepancies occur in the colour-blind.

3.3.3 Screening for Malaria Parasite

To diagnosed malaria parasite, blood films were prepared directly from capillary blood. This is one of the best methods of preparation (Monica, 1998). This has the advantage of being convenient.

Examination of blood for Malaria parasites were as follows:

1. **Reagents and apparatus**
    a) Field's stain A and B.
    b) Microscope slides.
    c) Oil immersion.
    d) Microscope.
    e) Water 80% Methanol.
    f) Lancet.
2. **Procedure of the blood collection were as follows:**

1. The forefinger was cleaned using with 70% v/w alcohol and allowed to dry.
2. Using sterile lancet, one finger was pricked and squeezed gently to obtain a large drop of blood.
3. A small drop of blood was put in the centre of the slide and larger drop about 15 mm to its right.
4. Immediately before coagulation the blood was spread on the slide using a smooth edged slide spreader.

5. Without delay the large drop of blood was smeared to cover evenly an area about 15x15 mm.
6. Using a black lead pencil the slide was labelled with participant's name, number and the date on which the sample was obtained.
7. The blood film was allowed to dry in air with the slide placed horizontal position; it was then kept safely.

3.3.4 Thin Film Field's Staining Technique For Malaria Parasite

The method followed in this technique was as follows:

1. The slide was placed on a staining rack and covered with a thin film of methanol approximately 0.5 ml of diluted field stain B.
2. Immediately was added an equal volume of fields stain B and left to stain for one minute.
3. The stain was washed off with clean water; the back of the slide was wiped, cleaned and placed in a draining rack for the film to dry.

3.3.5 Thick Film Field's Staining Technique For Malaria Parasite

The method followed in this technique was as follows:

1. The slide was held with the dried films facing downwards and dipped the slide into the field's Stain A for five seconds. The excess stain was drained off by touching a corner of the slide against the side of the container
2. The slide was washed gently in clean water for about 5 seconds and drained the excess water.

3. The slide was dipped into the field's stain B for three seconds and drained off the excess stain.
4. The slid was washed gently in clean water. the back of the slide wiped. cleaned and placed upright in a draining rack for the film dry in the open air.

3.3.6 Reporting Blood Films For Malaria Parasite

The principle of reporting malaria parasite

The blood film was microscopically examined using 40x and 100x objective. 7x eyepiece was used in preference to 10x eyepiece (with 100x oil immersion objective) because this gives brighter and clearer image.

The method of reporting thick blood film was as follows:

1. When the thick film was completely dry, a drop of an immersion oil was applied to an area of the film which appears mauve coloured (usually around the edges)
2. The oil was spread to an area that covered about 10 mm in diameter. This was to enable the film to be examined at first to a lower magnification
3. The selected area was well stained and not too thick. The100x object (if required was added further small drop of oil) was changed to increase focus.
4. The blood film was then examined for malaria parasites.

The method of examining thin blood film was as follows:

1. When the thin film completely dried. a drop of immersion oil was applied to the lower third of the film and the oil was spread to cover most of this part of the film (serves as a cover glass).

2. The film first was examined with 40x objective to check the staining, morphology and distribution of the cells and to detect malaria schizonts, gametocytes, and trophocytes.
3. The parasites were examined and colour plates 5.43-5.46 were used to help identify the different plasmodium species.

For the thin/thick film following equipments and reagents were utilized:

- A syringe
- Pipette to measure the stain and buffered water
- Two containers of clean water (need not be buffered)
- Microscope

The reagents were as follows:

- Field stain A (reagent NO.25)
- Field stain B (reagent NO.26)
- Buffered water PH 7.1-7.2 (reagent NO.14)

3.3.7 Counting Parasite Numbers (Parasite Density)

Parasite numbers were counted on the blood slides of the participants that tested positive. This was done by estimating parasite numbers µl of blood and counting parasites against white blood cells.

The procedures were as follows:

1. Part of the thick film where the white blood cells are evenly distributed and the parasites are well stained was selected
2. Using the oil immersion objective systematically 100 white blood cells (WBC) counted, the numbers of parasites (asexual) in each field covered were

estimated. Using two hand tally counters did counting; this was repeated two other areas of the film and an average of the three counts were taken.

3. The number of parasite per µl of blood was calculated as follows:

$$\frac{\text{WBC count x parasite counted against 100WBC}}{100}$$

3.3.8 Stool examination for parasite infestation

For concentration method of the stool examination the equipments used were:

- Small glass rods.
- Pestle and mortar
- Strainer
- Electric centrifuge
- Plain glass centrifuge tubes
- Graduated glass centrifuge tubes
- Screw capped universal bottle with rubber liner
- Clean slides
- Clean cover slip
- Pasteur pipette with rubber teat
- Stool containers

The reagents utilized in this method were as follows:

- 10 % formal saline.
- Ether (Lugol's iodine)

Stool examination was performed to ultimately establish relationship between hookworm and other intestinal parasites to the anaemia status of the community.

Using the Concentration method described by (Fleck and Moody, 1993). As described below:

1. Ten ml of 10% formal saline in a graduated glass or centrifuge tube was poured into the clean mortar.
2. One to two (1-2 g) of stool (approximately tea spoonful) was placed in the mortar, using a wooden applicator stick and the mixture emulsifies using a pestle.
3. The suspension was sieved through a strainer into the universal bottle and labelled with the bottle the participant's laboratory number using a grease pencil.
4. About 3 ml of ether in a graduated glass of centrifuge tube was measured, and poured into the universal bottle. The cap was tightly screwed and shaken vigorously.
5. The mixture was transferred into plain glass centrifuge tube and labelled with the participant's laboratory number. The centrifuge at medium speed of 2 minutes was used at an electric centrifuge.
6. The mixture was separated into 4 layers:
    - An upper layer of ether
    - A plug of debris and fatty materials
    - A layer of formal saline
    - Sediment.
7. The plug of debris with an applicator stick was loosened and the supernatant was poured (ether, formal saline, plug of debris, and fatty material) into a sink with running water.

8. The bottom of the tube was tapped with finger to re-suspend the sediment and transferred to a drop of sediment on to clean slide using a Pasteur pipette with rubber teat.
9. A cover slip was put and then the slide was labelled with the participant's laboratory number and the slide placed on the microscope stage.
10. The x10 objective into position and focus was swung; the preparation examined systematically for cysts larvae and ova and then was examined the structures in more detail using the x40 objective.
11. If the cysts were seen, few drops of lugol's iodine was added to the remaining sediment in the centrifuge tube, mixed well and a drop of sediment placed into a clean slide and a cover slip.
12. The cysts were examined systematically using x10 objective and in more detail using the x40 objective and the findings were recorded.

3.3.9 24 Hour Dietary Recall

The purpose of 24-hour dietary intake was to determine the mean per capita calorie, protein and iron intake (both haem and non haem) of the study group.

Food intake data were collected from a randomly selected sub sample comprising 65 women. The procedures that were followed in data collection on food intake are as described by (Gibson, 1994). Respondents were asked to recall the time the food was eaten, the name of the dish and the ingredients that were used by the household during the 24 hours preceding the interview. They were asked to show the amount of each ingredient used to prepare the meal, using household measures and food models, then they were asked to estimate the total volume of the dish and the amount of the food the women took including the leftover. Detailed

description of all meals and ingredients were recorded on a form designed for this purpose (**appendix 1**: Section C). Values of household measures of each ingredient were converted into grams and/or millimetres. The amount of calorie, protein, fat, carbohydrates, vitamin A, vitamin C, and iron content of each meal was calculated using Kenyan food composition table.

For estimation dietary intake these instruments were used

1. Measuring graduated cylinders of 1000ml.
2. Kitchen scale
3. Jugs of 250ml and 500ml.
4. Plates of different sizes
5. Tape measures

3.4 STUDY INSTRUMENTS

3.4.1 Questionnaire

A questionnaire comprising five sections was applied in this study. The first section sought information on demographic and socio-economic characteristics. These include number household members <15years and >64years, education, income, occupation of women. The second section consisted of food production and utilization. The third part focussed on food consumption i.e. 24 hour dietary recall. A form, which clearly indicated the different types of foods that were consumed, amount of ingredients, amount eaten, was utilized in the estimation dietary iron intake. The fourth section dealt water, sanitation and hygiene, seeking information on source of water, water treatment, as well as possession of latrines, and how to handle the food before cooking. The fifth section constitutes accessibility and availability of health facilities, common disease of study areas, whether they use or not vitamins or iron

supplements. Three forms were assigned to record the results of different laboratory analysis.

The first form was used to record haemoglobin concentration results of the participants. The second was for the results of blood slide for malaria parasite and parasitic counting (counting the number of parasite per µl of blood). The last one was used in recording stool examination results.

3.4.2 Data Entry, Cleaning and Analysis

Data were entered, cleaned and analysed using SPSS version 10 at Applied Nutrition Programme (ANP) Means and proportions were calculated for quantitative and qualitative data respectively. Chi square tests were used to compare different amounts in proportion and means with reference to haemoglobin status (anaemic and normal) and also between rural and urban areas in Garissa district. The chi-squared test was also used to test association between dichotomous variables. To control the determining factors for anaemia, ANCOVA (analyses of covariance) was used. A p-value of less than 5% was considered statistically significant. Regression to relate haemoglobin level with social, demographic, and economic factors was also applied in this study. Graphs were plotted using Microsoft excel version 10 and SPSS (statistical package for social science) for both qualitative and quantitative data. For the dietary intake assessment Kenyan food composition table was utilized for the calculation of the mean nutrient intake in terms of calorie, protein, carbohydrate, vitamin A, vitamin C and Iron.

3.4.3 Data Validity, Reliability and Quality Control

The questionnaire was validated through pre-testing. The assistants were closely supervised during pre-testing and early stages of actual survey by the researcher. Probing questions were asked to reduce errors arising from respondent memory lapses. Each completed questionnaire was checked immediately after return from interview to ascertain that all questions had been answered correctly and consistently. After entering the data, frequencies of all the variables were done to ensure that all information had been correctly entered, specifically through detection of outliers and subsequently counter checking against data as recorded in the questionnaire.

3.4.4 Limitations

The survey was conducted just before the start of the raining season; this was before most of the rural roads were muddy and inaccessible. Another limitation was that, early morning some of the women who would have been interviewed were busy, being for small-scale traders to earn their daily income, however they were available for interview later in the evening. It is clear that data obtained through survey having a retrospective component are not without limitations. Most questions in this study required recall of the past events and therefore prone to memory lapse. Furthermore some doubtful responses occurred, as some respondents did not report the truth.

3.4.5 Informed Consent

To obtain informed consent from the women in the study, the principal investigator held meetings with them and explained the purpose of the study and the procedures that would be undertaken. In addition, during the actual data collection, the enumerators further explained the importance of the current study. At this point an

oral and written consent letter was obtained. The relatives were also invited to witness the actual blood and stool sample collection exercise in their homestead. Majority of the relatives did turn up to witness the blood and stool sample collection process. The witnessing was merely to enhance trust, encouragement and encouragement.

4.0 RESULTS

4.1 SOCIO-DEMOGRAPHIC CHARACTERISTIC OF THE STUDY POPULATION.

A total of 218 households with a population of 1308 participated in the study. Slightly over a third (37%) and about two-thirds (66%) constituted the urban and rural sample of households respectively. Central division constituted the urban population and three sub-locations were sampled, which were Central, Bulo-iskadeg and Bulo-madina.

The overall mean number of household members was six. Bulo-iskadeg had the highest mean number of household members while Liboi had the lowest. The overall mean of the household members under the age of fifteen years was four. The overall mean of the household members who were over 65 years old was zero point four; the highest number of household members was in Bulo-iskadeg while the lowest was in Modogashe.

4.1.1 Literacy, Occupation and Income of the Women in the Study Population

Over two-thirds (82%, n=218) of the women studied were illiterate. Less than one-tenth (9.2%, n=218) had attained or completed primary school. Only five (2.3%) of the women had attained and/or completed secondary school. A small proportion of the study women (14%) had attended adult education adult literacy classes

About three quarters of the women (75.2%, n=218) were housewives who did not earn any form of income. Those women were mainly taking care of the children. Less than a quarter (23.8%) of the women was in small-scale businesses (hawking, selling

miraa and tea shops) to sustain their families. Only one percent of the study women were informally employed. The t-test shows that there is no relationship between anaemia and number of people per household (P>0.05).

Table 4.1: Socio-demographic and economic characteristics of women of childbearing age in Garissa district.

Attribute	Groups combined	Urban	Rural	Statistical test	P-value
House hold size	6 2-10	6 2-10	6 3-10	t=0.48	P=0.386
< 15 years	4 1-6	3 1-6	3 1-5	t=0.92	P=0.338
>64 years	0.4 1-3	0.5 1-2	0.3 1-3	t=1.62	P=0.204
Illiterate	66(78%)	17(20%)	49(58%)	X^2=5.203	P=0.074
Literate	19(22)	6(7%)	13(15)	X^2=1.3	P=0.239
Small scale trader	96	11%	15%	X^2=0.72	P=0.397
Formally employed	96	3%	0%	X^2=5.6	P=0.361
Non employed	96	26%	31%	X^2=2.66	P=0.103

4.2 Socio-Economic Characteristics of the Studied Population.

The study women were mainly housewives (73.4%, n=218). The small-scale traders (23.9%) contributed money towards their family upkeep. About 5% of the study women provided labour to other homesteads to earn income.

Majority of the studied women live below poverty line (87%, n=218). This was based on daily expenditure. Most of the studied women lived in their own houses (84.4%)

while the rest rented houses. Household members in under fifteen and above 65 years, literacy, occupation and their income have no impact on prevalence of anaemia ($p=0.05$). Therefore the hypothesis, which postulates that, there is no difference between the urban and the rural population as far as socio-economic aspect is concerned was accepted. **(Table 4.1).**

4.3 SOURCES OF IRON FOR THE STUDY WOMEN

4.3.1 Dietary Sources

Varying percentages of studied women used various sources of iron. Almost all 95% of the women consumed beans as the source of iron. The proportion of women who reported its consumption either in urban (93%) or rural (97%) was similar. Other iron rich foods that were commonly used were maize, rice, camel meat and goat meat. Wheat flour, cow meat, simsim and liver were rarely consumed **(Table 4.2).**

Table 4.2:Dietary source of iron consumed by women within the last seven days

Food types	Percent households		Combined percent		
				X^2	P-value
	Urban (N=74)	Rural (N=144)			
Plant source					
Beans	93	97	95		
Rice	93	86	88		
Maize	74	83	80		
Sunflower	86	76	79		
Wheat flour	94	63	73		
Simsim	12	21	18		
Irish potatoes	22	2	9		
Avocado	4	0	1.3		
Animal source					
Goat meat	43	49	47	3.11	0.154
Camel meat	67	30	43	2.3	0.316
Cow meat	20	0	7	5.11	0.07
Liver	4	0	1.3	0.02	0.59

4.3.2 Non-Dietary Iron Source

Slightly over a fifth of the women (22%, N=218) reported that they used multivitamins as a complementary source of iron mostly from rural, while slightly over a quarter used iron tablets as a complementary source to dietary iron. Both urban and rural proportions are same. Overwhelming majority (61.5%) of the women did not use any non-dietary iron source (**Table 4.3**). There is no association between the level of education and the probability of qualitative consumption of dietary iron sources, odds ratio 0.42, C.I=(0.19-0.87), p-value (P>0.05), while the small scale traders are more likely to consume non-dietary sources of iron than the unemployed women, odds ratio 2.82, C.I=(1.43-5.57), (p<0.05). There is no association between the place of residence (urban and rural) and the quantitative consumption of non-

dietary sources of iron, odds ratio=0.96, C.I=(0.52-1.77), (p>0.05). There is no association between the quantitative consumption of iron rich foods and non-dietary sources of iron, odds ratio=0.84 C.I=(0.71-0.98), (p>0.05). While there is an association between the quantitative consumption of poor iron food and the use of non-dietary sources of iron odds ratio=1.56 C.I=(1.34-1.82), (p<0.05), this means that those taking foods poor in iron are more likely to consume non- dietary source of iron as a complementary than those taking iron rich foods.

Table 4.3: Distribution and proportions of the women by non-dietary sources of iron.

Non-dietary iron source	Frequency consumed in urban(N=74)	Frequency consumed in rural(N=144)	Total
Multivitamin	46(65)	88(61)	134(61)
Iron tablets	12(16)	20(14)	36(16)

Figure in parentheses are percentages

4.4 FOOD PREPARATION AND CONSUMPTION METHODS

4.4.1 hygiene practices in Food preparation and consumption

More than half (52%) of the studied women wash their hands before preparing and eating the food. While the rest wash sometimes (30%) or they do not wash their hands at all (18%) while they are the same proportion the urban and rural group.

Only 2%, N=218 of the women did not add fat or fry their food, while majority the rural and urban group 97 and 100 percent respectively they add fat or fry their food.

Majority of the urban and rural group they took tea or coffee with breakfast 74.3 and 75.7 respectively while the rest took with snacks and immediately after meals. The hypothesis, which postulates that there is no association between food preparations with the prevalence of anaemia among urban and rural group is rejected ($p<0.05$) **(Table 4.4)**

Table 4.4 Percentage distributions of the women by frequency of food preparation

	Urban	Rural	x^2	p-value
Do you wash hands?			31.2	0.04
Yes	55.4	50.7		
No	44.6	49.3		
When tea/coffee usually taken				
Breakfast	74.3	75.7	39.2	0.03
With snacks	4.1	4.9		
With or after meals	21.6	19.4		
Was the food fried?				
Yes	100	97.2	20.2	0.032
No	0	2.8		

Merely a majority (51.8%, N=218) of the women consume tea for breakfast, majority of the consumers are women from the rural. Tea is taken either with Anjera (28%) or Chapati (12.4%). A bout half of the women consume rice (50.5%) or maize (46.3%) for lunch and supper. But the consumption of rice in either urban or the rural are same. The consumption of maize was higher (77%) among the rural group **(Table 4.5)**

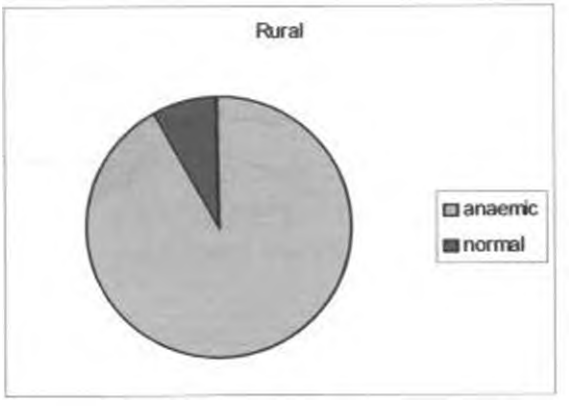
Table 4.5 Percentage distributions of the women by frequency of consumption

Meal	Food	Frequency in urban (N=74)	Frequency in rural (N=144)	Total
Break fast	Tea	4.0	91	51.8
	Anjera	65	39	28.0
	Chapati	1.0	4.0	12.4
	Porridge	4.0	10	7.8
Lunch	Rice	50	60	50.5
	Maize	23	78	46.3
	Beans	0	4.0	1.8
	Spaghetti	1.0	2.0	1.4
Super	Tea	0	1.0	0.5
	Chapati	0	2.0	0.9
	Porridge	4.0	0	1.8
	Rice	36	54	41.3
	Maize	19	60	36.7
	Beans	3.0	14	7.8
	Spaghetti	1.0	1.0	0.9

4.5 PREVALENCE OF ANAEMIA

Among the urban women, the mean HbC was 8.9 ± 2g/dl, while the rural women was 7.6 ± 1.6 g/dl. Among the urban women had HbC ranging between 5 g/dl to 14 g/dl, while among the rural group this range was 5 g/dl to 12 g/dl.

The prevalence of anaemia was high; nearly all the women (88.1%, n=109) who were screened were anaemic. Haemoglobin status showed higher level of anaemia in the rural group (61.5%) than in the urban group (26.6%), (**Fig 4.1**).



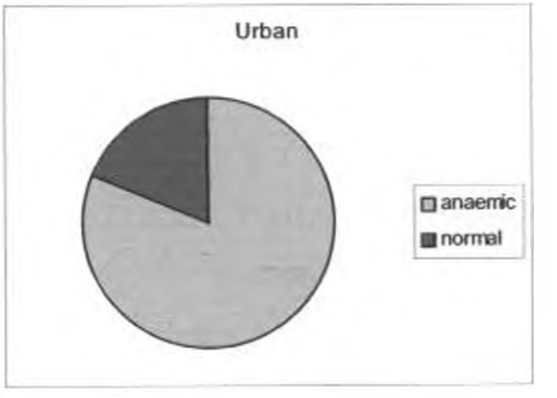


Fig 4.1: Prevalence of anaemia among women of childbearing age in urban and rural groups.

More than half (61.5%, n=109) of the studied population who were anaemic were from the rural areas. There is a high significant association between anaemia and the place of residence (urban and rural groups), p<0.05 (**Table 4.6**). The probability of getting anaemia is higher in rural than urban, P<0.05,OR= 4.41, C.I= (3.63-5.35).

Table 4.6 Prevalence of anaemia among women in urban and rural group.

Place of residence	Anaemia	Non anaemia	X^2	P-value
Urban	61.5	38.5	24.08	0.00009
Rural	26.6	73.4		

The highest prevalence of anaemia in Garissa district among women was in central division (81%, N=36) while the other three divisions, Liboi, Dadaab and Modogashe had prevalence of anaemia (17%, 15%, 15%, N=144) respectively (**Table 4.7**).

Table 4.7 Prevalence of anaemia by division in Garissa district

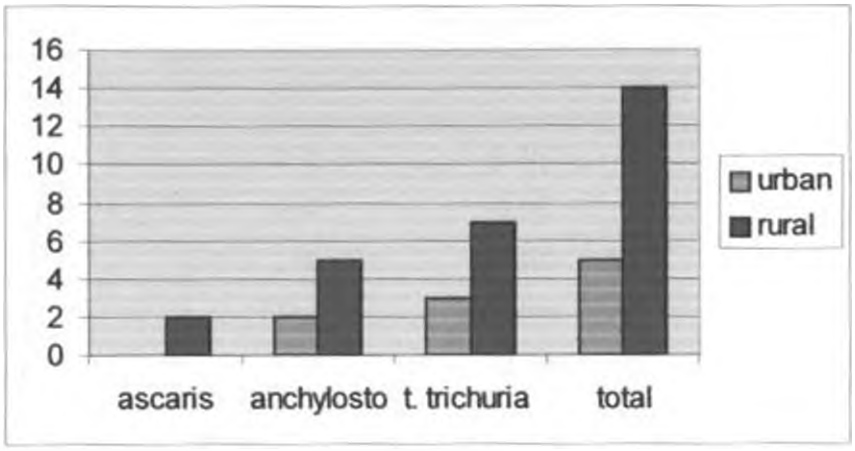
Division	Anaemic	Normal	Total
Central	28(81)*	7(9)	36(100)
Dadaab	21(15)	3(2)	24(17)
Liboi	24(17)	0(0)	24(17)
Modogashe	22(15)	3(2)	25(17)

*Figures in parentheses are percentages

4.5 PRESENCE OF MALARIA AND STOOL PARASITE AMONG WOMEN OF CHILDBEARING AGE

Among the women screened for stool parasitic infection less than a fifth (17.4%, n=109) were positive. The most common stool parasite was Trichuris Trichuria, while others were Anchylostoma duodenal and Ascaris infestation. Ascaris are the most

prevalent in rural group other than urban group. The other parasites, Ascaris, Trichuris Trichuria are also common among rural population hence a higher number



of parasites in rural compared to urban (**Fig 2**)

Fig 4.2: Prevalence of stool parasites among women of childbearing age

4.7 FREQUENCY CONSUMPTION OF IRON RICH FOODS AND HAEMOGLOBIN LEVEL

There is a weak relationship ($p \geq 0.05$), but not significant between the food types consumed both in urban and rural and the occurrence of anaemia (**Table 4.8**). This means that the hypothesis, which speculated that there is no relationship in food types, consumed between urban and rural areas and anaemia can therefore be accepted.

Table 4.8: Frequency of consumption of iron rich foods and its relation to anaemia.

Food types	Haemoglobin level		
	N	r	p
Avocado	218	-0.762	0.448
Beans	218	-0.58	0.402
Liver	218	0.408	0.314
Goat meat	218	-0.089	0.369
Camel meat	218	-0.161	0.122
Cow meat	218	-0.020	0.767
Maize	218	-0.820	0.279
Rice	218	-0.077	0.288
Wheat flour	218	0.081	0.307
Irish potato	218	0.361	0.128
Simsim	218	0.238	0.144
Sunflower	218	0.104	0.173

The correlation of food types and anaemia status is similar for urban and rural groups (**Table 49**) except for liver that is a high positive correlation but not significant for urban (r=0.673, p=0.143), unlike rural (r= -0.015,p=0.854)

Table 4.9 Comparison frequencies of consumption iron rich foods in urban and rural groups in relation to anaemia

Food types	Haemoglobin			
	Urban (N=74)		Rural (N=144)	
	r	p	r	p
Avocado	-0.762	0.448	-	-
Beans	-0.127	0.300	-0.021	0.809
Liver	0.673	0.143	-0.015	0.854
Goat	-0.106	0.564	-0.066	0.585
Camel	0.031	0.831	-0.248	0.105
Cow	-0.057	0.632	-	-
Maize	-0.117	0.395	-0.071	0.440
Rice	-0.093	0.447	-0.095	0.292
Wheat	0.97	0.424	0.107	0.315
Irish potatoes	-0.089	0.451	0.098	0.242
Simsim	0.316	0.407	0.198	0.293
Sunflower	0.171	0.178	0.044	0.601

4.8 RELATIONSHIP BETWEEN PREVALENCE OF MALARIA PARASITE AND ANAEMIA

More than a quarter (26%, n=109) of the studied women were positive for malaria parasite. There is high significant association ($p < 0.05$) between the malaria parasite infestation and the prevalence of anaemia in both rural and urban women population sample (**Table 4.10**). The data indicated that presence of malaria parasites was

associated with the high prevalence of anaemia among women of childbearing age in urban and rural groups, while there is significant positive correlation between haemoglobin and malaria parasite density among women in urban and rural groups (r= 0.399,P=0.000).

Table 4.10 Prevalence of malaria infections among urban and rural groups in Garissa district

Malaria	Anaemia	Normal	Total	Statistical test	
Urban	28 (26)**	0 (0)**	28 (26)**	X^2=5.10	P=0.028*
Rural	68 (62)**	13 (12)**	81 (74)**		
Total	96 (88)**	13 (12)**	109 (100)**		

*Fischer exact test

** Figures in parentheses are percentages

4.9 THE PREVALENCE OF ANAEMIA AMONG WOMEN BY STOOL PARASITE TYPE AND REGION.

There was high significant ($p < 0.05$) association between the occurrence of intestinal parasites and the prevalence of anaemia among the study women.

Therefore there is a direct relationship between the occurrence of stool parasite infection and prevalence of anaemia (**Table 4.11**).

Table 4.11 Percentage distribution of women by parasite type and region.

Parasite type	Urban N=36	Rural N=73	Total N=109	Statistical test	
				X^2	p-value
Ascaris	0 (0)*	2 (3)*	2 (2)*	74.00	0.000
Anchyclostoma	2 (6)*	5 (7)*	7 (6)*	144.36	0.000
T. Trichuria	3 (8)*	7 (10)*	10 (9)*	146.00	0.000

* Figures in parentheses are percentages

The occurrence of Ascaris in urban group is almost absent unlike the Trichuris Trichuria and Ancylostoma that have almost similar prevalence in urban and rural groups. Out of 109 women, 19 (17.4%) were anaemic and their distribution according to their haemoglobin status and their residential status is shown in **(Fig 4.3).**

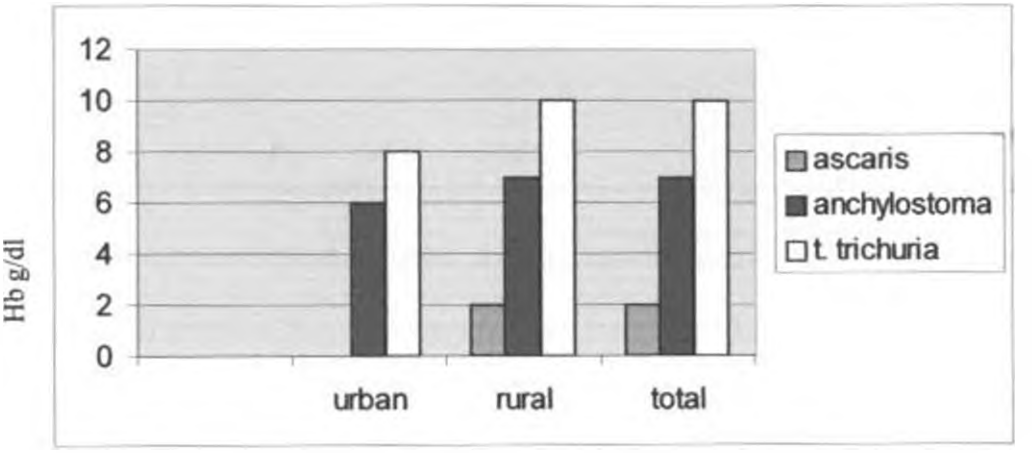


Fig 4.3 Percentage distribution of helmenthes infestation among women in urban and rural groups

Those women in rural who are parasite positive are more likely to get anaemic than those women in urban group OR=1.48, C.I=(0.72- 4.69), p=<0.05. There is no association between helminthes infestation and prevalence of anaemia in urban group OR=0.80,C.I=(0.22-2.91), p>0.05. While there is an association between helminthes infestation and prevalence of anaemia in rural group, OR=1.04,C.I= 0.39-2.76), p<0.05. This means that those women in rural who are parasite positive are more likely to be anaemic than those women who are negative parasite.

4.10 THE RELATIONSHIP BETWEEN FOOD PREPARATION AND CONSUMPTION PATTERNS OF ANAEMIA

There is a weak relationship between food consumption patterns and anaemia prevalence of women childbearing age in urban and rural Garissa district **(Table 4.12)**

Table 4.12 Food consumption pattern in relation to anaemia between urban and rural groups in Garissa district

Food consumption	Haemoglobin	
	r	p-value
Fruit	-0.29	0.335
Vegetable	-0.09	0.195
Cereal	-0.004	0.476
Meat	0.30	0.331
Legumes	-0.65	0.170
Oil	-0.005	0.455

The correlation between anaemia status and food consumption patterns for the foods in (**Table 4.12**) seems to be weak except for meat (r=0.30, p=0.331) and legumes (r = -0.65, p=0.170). Meat having source of haemo-iron, provides ready source than legumes that have non-haemo iron.

4.11 RELATIONSHIP BETWEEN DIETARY INTAKE AND PREVALENCE OF ANAEMIA

The dietary intake was measured by means of 24-hour dietary recall of the examined households. **(Table 4.13)** shows that vitamin A, Fibre and zinc intakes are significant negatively correlated ($p<0.05$) with haemoglobin level. A weak (not significant, $p>0.05$) relationship was found between other nutrient intake and haemoglobin level In any case fruit consumption looked at separately and the overall dietary intake of vitamin A nutrient was inadequate for the community. The overall intake of both zinc and fibre also proved to be insufficient.

Table 4.13: Nutrient content from overall dietary intakes (24-hour recall) and haemoglobin level

Nutrient	Haemoglobin		
Nutrient	N=65	r	p-value
Energy		-0.113	0.156
Protein		-0.199	0.156
Fat		0.28	0.416
Carbohydrates		-0.13	0.150
Fibre		-0.210	0.36
Vitamin A		-0.232	0.26
Vitamin C		-0.051	0.423
Iron		-0.179	0.067
Zinc		-0.232	0.037.

Table 4.14 Summary of the key findings on women childbearing age in urban and rural areas in Garissa district

Summary of status of the hypothesis	
Hypothesis	**Hypothesis status**
1. There is no relationship between food types consumed and prevalence of anaemia among rural and rural women aged 15-45 years.	
Groups combined	Accepted
Rural group	Accepted
Urban group	Accepted
2. There is no association between food preparation and consumption patterns with the prevalence of Anaemia among rural and urban women	
Groups combined	Rejected
Rural group	Rejected
Urban group	Rejected
3. There is no association between malaria and helminthes infestation on the one hand and prevalence of anaemia in rural and urban among women	
Groups combined	Rejected
Rural group	Accepted
Urban group	Rejected
4. There is no difference between characteristics of livelihoods on the prevalence of anaemia in rural and urban Women	
Groups combined	Accepted
Rural group	Accepted
Urban group	Accepted
5. The total macronutrient intake does not correlate the prevalence of anaemia both urban and rural women	
Groups combined	Accepted
Rural group	Accepted
Urban group	Accepted
6. the total micronutrient intake (vitamin A, C, Iron and Zinc) does not correlate the prevalence both urban and rural women	Accepted
Groups combined	Accepted
Rural group	Accepted
Urban group	

5. DISCUSSION

5.1 ANAEMIA PREVALENCE

The study shows a high prevalence of anaemia among women of childbearing age living in Garissa district. About 88.1% of the total population of the studied community was anaemic (in urban 26.6% and in rural 61.5%, n=109). This is in agreement to the results of Kenya national Micronutrient survey of 1999 where by the prevalence of moderate and severe anaemia was estimated between sixty-three and eighty-six percents respectively (National micronutrient Survey, 1999). This is due to the fact that women of childbearing age who constituted the study population are vulnerable to iron deficiency anaemia (Brooker et al., 1988, Yip and Dalman, 1995).

5.2 DEMOGRAPHIC AND SOCIO-ECONOMIC FACTORS AND ANAEMIA INCIDENCE

5.2.1 Women Education Level And Occupation

Chaudury (1986) reported that greater education is positively associated with greater awareness of the importance of nutrition, the nutrient content of food and nutrition options offered by market purchase or home production. Better-educated parents should be able to provide more nutritious diets due to their ability to identify nutritious food. On the other hand, education is also a measure of taste. However, higher education increases the desire to consume nutritious food and food items to the detriment level of nutrition. If education represents taste, the elasticity of nutrition with respect to education may be positive or negative. However, the prevalence of anaemia was not significantly higher (p-value < 0.05) among illiterate women in urban (89.4%, n=36) and in rural women (79%, n=73) than the literate women urban (23%, n=36) and rural (21%, n=73). This reflects either the fact that there are more

factors affecting/influencing than the education level of the mothers toward the anaemia situation of the community in the studied population or in agreement with Chaudury (1986) that it is elasticity of nutrition caused by change of the taste with respect to education might be having negative effect to the anaemia situation of the study population.

5.2.2 Household Income

Education and increased income controlled by mothers have been reported to improve nutrition security of the households (Chaudhary, 1986). However, this study did not relate any particular source of income with the prevalence of anaemia, as this association was not significant.

The majority of the women in the studied population (87%) were living below poverty line as per the cut off point set by UNICEF which is 30$ per household per month (UNICEF, 1990). The prevalence of anaemia was significantly higher in women living below the poverty line (87%) than in women living above the poverty line (10.7%). This is in agreement with other study by Chaudry (1986) who observed that low household income affects directly the food intake, frequency, and childcare and health service of the poor. This means that poverty should be one of the prime considerations in this community when planning nutritional security strategies in general and nutritional anaemia prevention strategies in particular.

5.3 PARASITIC INFESTATION INCIDENCE AND ANAEMIA PREVALENCE

WHO (1990) confirmed that Intestinal parasites exacerbated iron deficiency by increasing the loss of blood from intestine. This loss in association with a low intake

of iron and/or its poor absorption can lead to profound anaemia which impairs the intellectual development of children and limits both children's and adults' capacity for physical activity. **Eric, (2001)** found that the most significant risk of hookworm infection is anaemia secondary to loss of iron (and protein) into the gut.

The present study showed that the prevalence of anaemia is higher among the rural group compared to their urban counterpart. The intestinal parasites that are implicated in this study are Ascaris lumbricoides, Anchylostoma and Trichurius Trichuria. Different parasites namely hookworm (Brooker et al. 1999), *Ascaris lumbricoides* (Stoltzfus et al., 1997), *plasmodium falciparum* (Steketee et al., 2001) are the most involved in this causation. The high prevalence of those parasites in the sample of the current study showed highly significant difference ($P < 0.05$) with anaemia among women in urban and rural group.

Studies conducted in Tanzania have indicated that malaria in pregnancy is often associated with increased risk of severe anaemia, abortion, intrauterine foetal death and low birth weight (Minyiki et al. 2000). Malaria causes haemolyses, which in turn causes anaemia (SCN News, No.5, 1990). Malaria mostly affects pregnant mothers, whose immunity drops when they become pregnant. Malaria in pregnant women has two main results first, death during childbirth, which occurs at the rate of about 1500/day in Africa, in part because of anaemia due to malaria. Second, incidence of low birth weight babies is 20-40% of all babies born in areas where malaria is prevalent.

In patients with high parasitemia, anaemia may develop rapidly due to haemolysis of the parasitised red cells and this may worsen even after completion of anti-malarial therapy. the present study found no association between parasitic loading (parasitemia) and haemoglobin level.

In areas with no malaria, the mean haemoglobin levels were markedly higher than those found in areas with stable malaria transmission, though changes with increasing intensity of transmission were unclear. Eighteen studies from areas with stable malaria transmission in sub-Saharan Africa suggested that the median prevalence of severe anaemia in all-parity pregnant women is approximately 8.2%. Assuming that 26% of these cases are due to malaria, it is suggested that as many as 400,000 pregnant women may have developed severe anaemia as a result of infection with malaria in sub-Saharan Africa in 1995 (Guyat and Snow, 2001). Severe malarial anaemia occurs 1.42–5.66 million times annually and kills 190,000–974,000 (> 13% CFR) children < 5 years of age annually (Murphy and Bremen, 2001).

Findings by Monsen et al (1978) indicated that the prevalence of anaemia (haemoglobin [is less than] 110 g/l), particularly those with high intensities of hookworm and Schistosomiasis, he suggested that hookworm and Schistosomiasis were responsible for 6% and 15% of anaemia cases, respectively. Fifteen months after deworming with albendazole and praziquantel the prevalence of anaemia was reduced by a quarter and that of moderate-to-severe anaemia (haemoglobin [is less than] 90 g/l) was reduced by nearly a half.

5.4 FOOD INTAKE AND ANAEMIA

As assessed by the 24-hour recall, food intake did not show association with anaemia. This study showed that only vitamin A, zinc, and fibre significantly correlated with the haemoglobin level of study subjects. This is consistent what Sommer and West (1996) have found. They concluded that vitamin A deficiency might be a common cause of impaired Hb synthesis and contributor to anaemia. While the exact mechanism remains to be determined, they include impaired mobilization of iron stores, possibly due to an effect of vitamin A deficiency on transferin receptors.

Suharno and Muhilal (1996) found that large body of evidence indicates that vitamin A deficiency is an important factor in the aetiology of nutritional anaemia. In their findings they suggested that measures to combat anaemia in pregnant women at the population level should involve improving nutrition status with respect not only to iron but also to vitamin A. Their study showed also that Vitamin A and iron supplementation significantly increased haemoglobin by 12.78 g/L compared with the double-placebo group. One-third (3.68 g/L) of the increase could be attributed to vitamin A supplementation and two-thirds (7.71 g/L) to supplementation with iron. The pattern of changes in packed cell volume was similar to that in haemoglobin.

In another study in Ethiopian women, a significant correlation was found between serum retinol levels and haemoglobin (Welde-Gabriel et al. 1993). A combined iron and vitamin A supplement has been found to be 40% more effective in reducing anaemia than iron supplement alone (Suharno and Muhilal, 1996). Such findings are not specific to supplementation. Vitamin A sugar fortification program in Guatemala resulted in improved iron status of the population (Mejia and Arrovave, 1982). A trial

with vitamin-A fortified Mono-Sodium Glutamate (MSG) in Indonesia increased haemoglobin levels among women (Muhilal et al, 1988).

Zinc is another important micronutrient and its deficiency is going to be the next priority micronutrient after iodine, iron, and vitamin A to receive global effort toward its elimination (Kenya national micronutrient survey, 1999). Zinc deficiency is now known to be fairly widespread throughout the world. Causes of zinc deficiency include dietary inadequacy, mal absorption, and health complaint (Agate et al, 2000). From FAO national food balance data it is estimated that 48% of the global population is at risk of Zinc deficiency. The base of dietary pattern among the studied population was cereals which are high in phytic acid, a potent inhibitor of zinc absorption a fact which explains that the association between zinc dietary intake and anaemia among the subjects. In agreement with present study, another one conducted in Kwazulu natal, South Africa concluded that marginal zinc deficiency mainly coexists with marginal deficiency in vitamin A and iron (Spinnler et al, 2000). Different trials in different countries have shown that zinc supplemented malnourished children gain weight more rapidly, with significant reduction in anaemia, morbidity, and fatality rates (Caydar et al, 2000).

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

1. A majority of the people in Garissa (87%) live in abject poverty and are below poverty line.
2. The prevalence of anaemia in Garissa is high, the prevalence was higher in rural group (61.6%, n=144) than urban group (26.6%, n=74) there is a highly significant difference association between anaemia and the place of residence. x^2 =24.08, p<0.05,
3. There is higher malaria and helminthes infestation among women in urban and rural group, there is significant association (p<0.05) between malaria and helminthes infestation on the one hand and prevalence of anaemia among women in urban and rural group.
4. The livelihood characteristic of the women in urban and rural has no impact on prevalence of anaemia in Garissa. The hypothesis, that there is no difference between livelihood characteristics and the prevalence of anaemia in urban and rural women is accepted.
5. The correlation of food types and anaemia status is similar for urban and rural groups except for liver that is high positive correlation but not significant for urban (r=0.673, p=0.143), unlike rural (r= -0.015, p=0.854).
6. Total daily macronutrient intake (protein, fat, and carbohydrate) does not show any significant correlation with the prevalence of anaemia therefore, the hypothesis that the Total macronutrient intake does not correlate with the prevalence of anaemia are accepted.

7. The micronutrient intake specifically Vitamin A. and zinc show significant negatively correlated with the prevalence of anaemia. The hypothesis that the total micronutrient intake does not correlate with the prevalence of anaemia is partly rejected.
8. The consumption food patterns in urban and rural Garissa district shows that. there was no significant difference between urban and rural group in Garissa district. therefore the hypothesis that. there is no difference between consumption patterns on the prevalence of anaemia in urban and rural group is accepted.

6.2 RECOMMENDATIONS

1. For effective primary prevention. there is need to increase the intake and bioavailabilty of micronutrients particularly Vitamin C. vitamin A. and zinc is required. Bioavailabilty could be increased by fermentation particularly in the case of minerals iron and zinc and probably vitamin A. a process of breaking down the matrix in which nutrients in particular vitamin A and probably zinc is required this process. which involve size reduction and probably in combination with ($p < 0.05$) sieving will also reduce fibre contents thereby increasing mineral intake.
2. Health and nutrition education should be given priority and should be set up health and nutrition committee by the government authorities at sub-location level. for mobilization and participation health and nutrition. In addition sanitation should be encouraged within this forums. To prevent malaria and parasitic infestation improving community awareness should also be emphasized also within existing MCH programs in the district.

3. A deworming program should be emphasized. At the individual and community level, people should be taught personal and environmental hygiene through health education, washing hands before handling food, after using the toilet and cooking meat thoroughly in order to kill the cysts. Health personnel should provide routine health education in the MCH and community meetings on the subjects of personal and environmental hygiene. They should emphasise the importance of hygiene by use of IEC tools such as role-plays and posters.

4. NGOs and MOH (Ministry of Health) should implement a mosquito (malaria) control program around Tana River with community participation. Distribution of mosquito treated nets should cover areas other than provisions only to those attending MCH

5. Given the high level of poverty an income generation program aiming at empowering women to improve their economic status should be introduced to improve the anaemia such as overall nutritional status considering strong Somali social network.

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APPENDIX 1

QUESTIONNARIE

Factors Associated with Dietary Iron Intake and their Impact on Prevalence of Anaemia Among Childbearing age Women 15-45 Years Old in Garissa District

[Fill the tables and spaces appropriately, where answers are provided circle the corresponding circle].

SECTION A

Demographic characteristics

Village.....code.....HHNO.....Urban =1 Rural=2

Date of Interview ..... Name of Interviewer.....

Name of respondent..... Relation to the household----------

District ---------- Division ---------- Location---------- Sub-location----------

Household characteristics:

1. How many household members are there in this family----------
2. How many people in this household are <15 years-------- and >64 years----
3. Which is the main religion in this household? [Circle] Muslim=1 Christian=2 Other=3
4. What is the occupation of the women? [Circle] Farmer=1 Small-scale trader=2 Formally employed=3 Not applicable=4
5. What is the education of the women in this household? [Circle] Illiterate=1 Preschooler=2 Primary=3 Secondary=4 Adult education=5
6. What is the contribution of the women to the household? [Circle] Money=1 Labour/herding=2 Casual labour=3 Not applicable=99

Social Economic Status.

7. [Observe or ask] Do you own the following assets?

	Assets	Owned yes=1 no=2	If it is yes how many
2.1	Car		
2.2	Motor cycle/ scooter		
2.3	Sewing machine		
2.4	Television		
2.5	Gas cooler		
2.6	Wardrobe/cupboard		
2.7	Sofa set /easy chair		
2.8	Bicycle		
2.9	Land		
2.10	Cows		
2.11	Goats		
2.12	Sheep		
2.13	Donkey		
2.14	Camel		
2.15	Chicken		
2.16	Others (specify)		

8. Do you own land? 1=Yes 2= No

9. [If yes] how many acres do own? ----------

10. Is the house you live in your own or rented? 1= Own 2. Rented

11. [If rented] How much do you pay per month? Ks ----------

12. [Observe] what material has been used to construct the main house?

a) Roof

1) Makuti 2) Iron sheet 3) Tiles 4) Grass/ thatch 5) Others (Specify)

b) Wall

1) Mud 2) Plaster 3) Wood 4) Brick/ Stones/Block 5) Iron sheets 6) Others (specify)----------

c) Floor

1) Mud 2) Cemented 3) Wood 4) Bricks/ Stones/ Tiles 5) Others (Specify) ----------

13. What are the two main sources of energy you use for lighting?

1st ----------

2nd ----------

1) Wood 2) Tin lamps 3) Hurricane lamps 4) Pressure lamps 5) Gas 6) Electricity.

14. What are the two main sources of energy for cooking?

1st ----------

2nd ----------

1) Wood 2) Charcoal 3) Paraffin 4) Gas 5) Electricity 6) Others (Specify)----------

SECTION B

Food Production and Utilization

15. What is your main source of staple food?

1. Farm / Garden 2.Shop /Kiosk 3. Market 4. Others (Specify)

16. [If garden] are your food usually sufficient for the household needs in six months?

1 =Yes 2 =No

17. Which is the main source of vegetables for your household?

1.Farm 2. Shop/ Kiosk 3.Market 4.Others (Specify) 5. Gift

18. Which is the main source of fruits?

1. Farm 2. Market 3. Shop 4.Gathered from bush 5. Others (Specify)------

SECTION C

Food Consumption Patterns

19. What food do you most commonly eat for?

1. Breakfast----------
2. Lunch----------
3. Supper----------

20. When is tea/coffee usually taken? 1=Breakfast 2= With snacks 3=With or immediately after meals 4=Others (specify)----------

21. Of the listed foods which ones did the family consume in the last 7 days?

Food	Yes=1 No=2	Amount units	Source	Usual Freq.	Price per unit	Method of cooking
Avocado						
Banana						
Orange						
Lemon						
Onion						
Citrus						
Papaya						
Passion fruit						
Tomatoes						
Cabbage						
Green Pepper						
Mangoes						
Beans						
Cow peas						
Liver						
Goat's Meat						
Camel's Meat						
Cow's Meat						
Eggs						
Maize grain (white)						
Maize grain						

(yellow)						
Rice						
White floor						
Sorghum						
Irish Potatoes						
Water melon						
Cashew nuts						
Sim Sim						
Sunflower						
Ghee						

Frequency of consump. Source Method of cooking

1=Once daily. 1/day 1=Purchased 1=Cooked for along time

2=Twice per day. 2/day 2=Home grown 2=Cooked slightly/steamed

3=Once or Twice per week 1-2/wk 3=Gift 3=Served raw

4=Once per month. 1/month 4=Field gathering 4=others (specify)

5=Never

6=Rarely

22. Was the food fried/oil or fat added? Yes=1 No=2

23. Which type of pot do you use for cooking?

1.Alluminium 2. Iron 3.Earthen ware 4. Copper

HOUSEHOLD FOOD INTAKE: 24 HOUR RECALL

24. What did the women the whole of yesterday?

Meal time	Dish	Ingredients	Amount in standard units	Amount of ingredient in HH household measure	Volume of cooked dish	Amount eaten	Leftovers
Breakfast							

Snacks							
A Lunch							
Supper							

SECTION D

Water Sanitation and Hygiene:

25. What is the main source of water for the household?

1. River 2. Borehole 3. Roof catchments 4.Other (Specify)----------

26. How much did the household use in the last 24 hours? 1= 20-50lts 2=50-80lts

3 =80-100lts 4=100 and above

27. How long does it take you to get water from the source you use?

1. Water within the household
2. Less than 30 Min
3. 30 Min---1 Hr
4. 1 Hr-----2 Hr
5 2 Hr and more

28. Do you purify your drinking water? 1= Yes 2= No

29. [If yes how do you treat your drinking water?

1=Boiling 2.Filtering 3=Sedimentation 4=Chlorination 5=others (Specify)

30. Where do you store your drinking water?

1= Plastic 2=Clay pot 3= Metallic 4= others (Specify)

31. [Observe] whether it has a lid. 1=Yes 2= No

32. Do you have a latrine in your homestead? 1=Yes 2= No

33. [If yes] indicate the type of latrine.

1= Enclosure 2= pit 3=others (specify)----------

34. Do you wash hands before handling food? 1= Yes 2= NO 3= Sometimes

SECTION E.

Morbidity:

35. The last time you were ill where did you get treated? Circle all the methods mentioned.

1=Hospital 2= Health centre 3= Dispensary 4= Traditional medicine healer
5= Community health worker 6=Other specify----------

36. How far is nearest health facility?

	Government facility	Private facility
1= Less than 30 min		
2= 30-1 hour		
3= 1 hour and more		

39. Do you know about intestinal worms? 1=Yes 2= No

40. What causes worm infestation?

1= Eating soil 2= Drinking untreated water 3= Eating uncooked food

4=others---------- **41.** Do you use vitamin or iron supplements? Yes=1 No=2

42. [If yes, which ones]

1= Multivitamins 2= and Iron tablets 3= Cod liver oil 4= None

4= Others----------

43. Have you ever been advised to take tablets to improve your blood? 1=Yes 2= No

44. [If yes, by who] 1=Health facility staff doctor

2=Health worker

3=Relative or friend

5=Others----------

45. Which are the five commonest diseases in this area that affects women 15-45 years? (List in order of priority)

1.
2.
3.
4.
5.

APPENDIX 2

HAEMOGLOBIN RESULT FORM

	Hb level
Haemoglobin	

MALARIA PARASITE RESULT FORM

Parasitic infection		Parasite Density
Positive	Negative	

Parasite infection

1= Positive

2= Negative

STOOL EXAMINATION RESULT

Parasitic infection	If positive type of infection
Ascaris	
Ancylostoma duodenale	
Trichuris Trichuria	
Taenia	

APPENDIX 3

Iron Content Per 100 G

Food type	Iron mg	Inhibitors (Phyt in phosphorus)
1. Beans	9.38	5.5
2. Rice	1.50	8.3
3. Maize	4.52	1.90
4. Sunflower	0	0
5. White flower	2	0
6. Goat meat	2.16	0
7. Camel meat	5	0
8. Simsim	6.75	0
9. Irish potatoes	1.36	0
10. Cow meat	3.56	0
11. Liver	10	0
12. Avocado	1.86	0