

**NUTRITIONAL STATUS OF PRIMARY
SCHOOL CHILDREN IN USIGU DIVISION, SIAYA DISTRICT,
KENYA** //

M.Sc 1998

By

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Dedication

This work is dedicated to all the unfortunate school children whose ability to achieve maximum benefits from education is hampered by poverty and malnutrition.

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List of Abbreviations

DVBD	-	Division of Vector Borne Disease
EDTA	-	Ethylene Diamine Tetracetic Acid
GOK	-	Government of Kenya
HAZ	-	Height for Age Z Score
Hb	-	Haemoglobin
HPLC	-	High Performance Liquid Chromatography
IMR	-	Infant Mortality Rate
KDHS	-	Kenya Demographic and Health Survey
KEDAHR	-	Kenya-Danish Health Research
UMAC	-	Upper Mid Arm Circumference
NCPD	-	National Council for Population and Development
NGO(s)	-	Non Governmental Organization(s)
NPAN	-	National Plan of Action for Nutrition
TST	-	Triceps Skinfolds Thickness
UN	-	United Nations
UNESCO	-	United Nations Education and Scientific Organisation
UNICEF	-	United Nations Childrens Fund
USAID	-	United States Agency for International Development
WAZ	-	Weight for Age Z Score
WHO	-	World Health Organization

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Abstract

In this study, 720 (360 males and 360 females) primary school pupils in Usigu Division of Siaya District of Kenya were studied in order to establish their nutritional status. The pupils were aged between 10 and 17 years and were all in class five and six.

A total of 19 out of 38 primary schools in Usigu division of Siaya District were systematically sampled for the study. The selected schools formed the study sample and all the pupils from class five and six were eligible for participation.

The study employed three methods of data collection namely: anthropometric measurements, biochemical analysis, and clinical examination.

The findings indicate that 20% of the children were stunted with males having higher levels of stunting (13.5%) than females (6.9%) and 16% were underweight again with levels higher among males (12%) than females (4%). From the biochemical findings, the study showed that 41% of the pupils were anemic with males having a higher percentage (23%) than females (18%) while 24% of them were vitamin A deficient again with males having higher levels (15%) than females (9%). These findings were put through multiple regression analysis and it was proved that they were statistically significant except for anemia.

The study also established that malnutrition increased with the age of the child regardless of sex. Using correlation analysis, it was also evident that there was a positive linear correlation between poor nutrition and age. The study further showed that most of the pupils suffered multiple nutritional problems. For example, 12% of the stunted pupils and 9% of the underweight children were anemic and 5% each of the stunted and underweight pupils were vitamins A deficient.

These results point towards a need to focus more on the school children in order to address their nutritional problems. It is clear from this study that school children in Usigu face serious malnutrition problems. It is also clear that male children are at a higher risk of undernutrition than females at this age, further research to identify the causes underlying these findings are recommended.

More detailed information especially on household food accessibility will help explain some of the underlying factors influencing the nutritional status of these children. There is also need to assess the other environmental factors like morbidity patterns and how they relate to nutritional status of school children. Some of the crucial information is one relating to helminthes infections and their influence on food intake among school children.

Chapter One

INTRODUCTION

1.1 Background Information:

The nutritional status of a population is an indicator of the level of development and future potential in the community. This is in view of the fact that a well-nourished population has the capacity to perform and improve the standard of living through hard work. On the other hand, malnourished people are unable to give their full potential to the activities that foster development because they are often weak and sickly. When considering the school child, malnutrition and ill health is a big hindrance to overall performance. It has a strong effect on success in school, affects psychomotor development and has the capacity to interfere with intellectual development (World Bank, 1991).

A global assessment of child malnutrition covering 76 countries indicates that 36% of preschool children in the developing world excluding China are underweight, 39% are stunted, and 8% are wasted. Of the stunted children, the findings indicate that 23% are moderately stunted. This is a very disturbing picture that requires targeted intervention by the concerned governments (World Bank, 1993).

1.1.1 Sub-Saharan Africa:

Throughout the 1970s, the population in Sub-Saharan Africa expanded more rapidly than food production. With population growth, the estimated number of people who are undernourished increased from 60 million in 1970 to nearly 80 million by the end of the decade (UN, 1987). Africa's nutrition situation became worse in the early 1980's with the onset of drought and resultant further decline in food production. At this time, the undernourished population rose to 100 million people (UNICEF, 1985).

In general, undernutrition is a product of two major conditions classified as inadequate food intake and persistent infections. Therefore, in order to tackle the issue of malnutrition, there must be the possibility of making available adequate food both in quality and quantity to the population affected and accessible health care services. This has not been easy to achieve especially in the African continent despite efforts by various development agencies. Statistics show that between 1985 and 1992, while the world food production increased by 24% outpacing the rate of population growth, Africa's food production decreased by 5% while the population grew by 34% (FAO, 1993). This implies that there is no overall global food shortage to precipitate malnutrition but poverty and purchasing power translates into national and local shortages leading to malnutrition. The United Nations estimates that approximately 780 million people in the developing world are malnourished (UN, 1993). Things are not getting any better with the structural adjustment policies which have greatly diminished many governments' spending on social facilities leading to increased demand on people to pay for services hitherto freely received hence making them inaccessible.

1.1.2 Kenya:

The Kenya Government has always had commitment to eradication of malnutrition and ill health from her population. Through various policy papers, efforts have been made to incorporate nutrition into overall development. In the sessional paper No. 10 of 1965, eradication of hunger, ignorance and disease in the population was emphasized. In the 1979/83 National Development Plan, the government acknowledged that about 30% of the population suffered from one or other form of malnutrition and identified the most vulnerable groups that required targeting. Besides including issues on nutrition and related complications in overall development strategies, five periodic rural child nutrition surveys have been carried out by the government (GOK, 1977; 1978; 1982; 1987; 1993;) in order to assess the status of preschool children. The results of these surveys (Table 1) paint a

gloomy picture with no significant improvement in the nutritional status of children. Other available data also indicate that 38% of all child deaths in the country can be accounted for by malnutrition and associated complications (KDHS, 1993).

The government has also expressed its commitment to address problems of hunger and malnutrition in international fora. For example at the International Conference on Nutrition in Rome in 1992, the government further stated its commitment in this respect. A National Plan of Action for Nutrition was developed to aid in the implementation of appropriate intervention measures to reduce hunger and malnutrition in the communities (NPAN, 1994/5).

These surveys have focused on the preschool children, who are more vulnerable to malnutrition but there is need to give attention to the school children whose consequences are least understood.

Table 1: Percentage of children <5 who are stunted by Province:

Province	1977	1979	1982	1987	1994*
Coast	14	40	39	40	38
Eastern	34	24	27	23	39
Central	28	21	24	15	29
Rift Valley	25	24	22	17	32
Nyanza	21	34	33	32	36
Western	18	24	30	12	37
National	23	27	28	22	34

Source: Fourth Rural Nutrition Survey, 1987

* KDHS, 1993.

Siaya District:

Siaya District has been documented by many studies as one of the top five districts with stunting levels well above 30% for preschool children (GOK, 1982; 1987; 1994; KDHS, 1993). In addition, the district has a track record of very high Infant Mortality Rate estimated at 135/1000 live births as compared to the national figure of 65/1000 live births (GOK, 1996). This may imply that the children who are unable to survive high morbidity from both infections and inadequate food intake die while some proportion of the population survives in a sickly state.

Although information on the nutritional status of school children is scanty, it is believed that the magnitude of the problem among preschool children spills over to affect the school children and for this reason, this study focuses on this group of children. Table 2 gives the trend of under five malnutrition in Siaya district in relation to other districts in Kenya.

Table 2 : Percentage of children <5 who are Stunted by District

District	1992	1997	1993
Kilifi	42	39	50
Kwalia	39	43	53
Siaya	37	26	34
Nakuru	35	24	30
Kisii	31	33	41
South Nyanza	25	30	
Machakos	23	29	40
Narok	20	52	40
Katumu	20	22	32
Kencho	18	31	39
Maru	16	22	38
Taita Taveta	15	24	24
Nyandarua	12	24	31
National	28	22	34

Source: GOK, 1995, Economic Survey.

1.2 A statement of the problem:

The aim of this study is to assess the nutritional status of primary school children of Usigu Division in Siaya District with a view to making recommendations on how to improve the prevailing condition. There have been a series of studies carried out on the nutritional status of preschool children in Kenya. These surveys indicate that malnutrition, as measured by prevalence of stunting among these children, is high

and stable. Unfortunately, not much has been done on the school child with the assumption that these children do not usually have the severe problems found in the early years of life, and there is little mortality in this group from malnutrition. It is further argued that by this age, children will usually be eating from the family pot, and, they will have become, to some extent, immune to many fatal infections and parasites that precipitate malnutrition.

Although there is a low incidence of severe or killing malnutrition in this group, school children are frequently poorly nourished and suffer a variety of parasitic and infectious diseases. They often have long household duties, a long distance to walk to school often on an empty stomach, and an intensive school curriculum to accomplish. The older school children are undergoing the stresses of adolescence, with the girls preparing for the pregnancies and child rearing. Finally, some of the children are at the beginning of puberty growth when nutritional requirements more than double due to accelerated growth. If they are undernourished, they will be unable to meet the nutritional challenges during this period in addition to other energy demands leading to poor health and consequent poor academic performance. It is true that malnutrition among these children does not suddenly disappear just because these children are now above five years of age. Assuming that malnutrition among primary school children in Siaya district is as high as it is among the children under five years, then there is need to get concrete information in order to put in place appropriate interventions

1.3 Justification and significance of the study:

Information on the nutritional status of school children in Kenya is scanty, yet it has been documented that malnutrition has a strong negative effect on success in school (World Bank, 1991). At the same time, there is evidence to show that malnutrition affects arithmetic, reading ability and physical work (Scholz et al, 1997).

There are crucial micronutrients that impact on the performance of school children. Apart from the fact that iron deficiency affects 1.3 billion people today, some of its consequences include delayed psychomotor development, impaired cognitive performance in children and reduced work capacity (Alnwick 1994). On the other hand, vitamin A deficiency is a major public concern in the developing countries. During the 1994 16th International Vitamin A consultative Group meeting in Thailand, Dr. Chirambo in his regional presentation classified Kenya among countries without Vitamin A intervention programs. Yet, a study done in South Nyanza revealed an alarming high prevalence of Vitamin A deficiency (57%) with rates of Bitot's spots standing at 1.3% (Ngare et al 1994). Vitamin A is well known for its impact on the immune system. It depresses the immune response to infection predisposing the school children to frequent infections, which affects school attendance and performance. Knowledge of the nutritional status of the school children especially in an area with high and persistent malnutrition is crucial because it will assist in designing appropriate programs in order to tap full academic potential from these children.

1.4 Study Objectives:

The goal of this study is to provide information that would be used in programmes aimed at improving the nutritional status of school children in Usigu Division, Siaya District.

1.4.1 Specific Objective:

The objective of this study is to determine the prevalence of malnutrition among primary school children in Usigu division

1.4.2 Sub-objectives:

- I. To determine the nutritional status of the school children using anthropometric measures of height, weight, mid-upper-arm circumference and skin-fold thickness.

- II. To determine the prevalence of iron deficiency anemia of the study population.

- III. To establish vitamin A status of the study population.

1.5 Hypothesis

There is no difference in the nutritional status of male and female pupils in the study area.

1.6 Limitations

- i. Selection of the sample schools was purposive hence not random
- ii. The sampled children were only drawn from class five and six

Chapter Two

LITERATURE REVIEW:

2.1 An overview of malnutrition:

Definition - malnutrition is a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate performance in such processes as growth, resisting and recovering from disease and, physical work (Scrimshaw et al 1968; Islam et al 1996). There are two forms of malnutrition: Undernutrition which is associated with dietary inadequacy and often exacerbated by infections and Overnutrition which is linked to excessive food consumption or consumption of imbalanced foods leading to obesity and its related health complications. This study is concerned with undernutrition.

The interactions between malnutrition, food intake and infection are very complex. For example infection induces malnutrition through its effects on food intake, absorption and utilization of nutrients and in some cases the requirement for these nutrients. This occurs when there is loss of appetite (Martorell et al, 1980), decreased efficiency of food and nutrients utilization (Briscoe, 1979), increased energy requirements and eventually leading to growth retardation or stunting in children and wasting in adults (Tomkins, et al, 1983). An inadequate food intake on the other hand brings about malnutrition through the creation of deficiency states that impinge on individual capacity to withstand infections (Tomkins and Watson, 1989). It renders people weak and unable to be fully productive both socially and economically. Therefore, low food intake and infections are bound up synergistically in collaboration with other wider socioeconomic factors to produce malnutrition.

Malnutrition perhaps causes the most widespread human suffering in the world today. The extent and severity of the problem are well documented but changes in the world situation over time are not so obvious, except when brought to public attention by famines and other calamities. According to the FAO (1992), 500 million

people are chronically undernourished, and 13 million children below five years of age died in 1990 of diseases related to hunger and malnutrition.

Information on the nutritional status of children in Kenya is now available to give the general trend and levels of malnutrition in pre-school age children. The periodic national "Rural Child Nutrition Surveys" indicate that the prevalence of stunting among pre-school children has been high (more than 20%) and static over the last 15 years.

The surveys also show that different regions of Kenya have varied trends. In some regions, child nutrition has improved while in others the situation has stagnated. Generally, the level of malnutrition has declined in Central, Rift Valley and Western provinces, and remained stable in Coast, Nyanza and Eastern provinces. The situation has deteriorated in Siaya district over the same period (GOK, 1995).

Malnutrition affects all sectors of the population at different duration, severity and incidence. This has led to the classification of different population groups as vulnerable or not. In these categories, the most vulnerable group is the children below five years. They are the most vulnerable because their immune system is still developing and are therefore less immune to many infections and most exposed to environmental stresses.

The other group that has been identified as very vulnerable to malnutrition is the pregnant and/or lactating women. This group is vulnerable as they struggle for nutrients for personal maintenance and the additional requirements for the growing foetus or breast-feeding baby. For this reason, other population groups have been left out of investigation to a large extent especially in a situation where these groups are competing for very scarce resources.

At the same time, there are non-dietary factors, which have been found to influence the nutritional status of individuals. One of them is helminthes infection (Gyorkos et al 1996; Stephenson LS, 1987; Hall A, 1985). This interferes with protein absorption and utilization accelerating the rate of protein energy malnutrition (Stephenson, 1994). In her study, Stephenson shows that hookworm infection reduces food intake and/or increases nutrient wastage via vomiting, diarrhea, or blood loss that compromises the overall health of individuals.

Stephenson also shows that helminth and schistosome infections occur in the same geographical areas, as does malnutrition, which then supports the fact that these infections have a negative impact on the nutritional status of individuals.

Although stunting and wasting is often attributed to energy and protein deficiency, it is clear that several micronutrients have a direct effect on growth with deficiency resulting in reduced growth velocity. A recent study on protein intakes and needs in Kenyan children concluded that protein deficiency is not a common problem in Kenya (Beaton et al, 1992), yet prevalence of stunting is high and almost constant according to the periodic national nutrition surveys. These findings seem to point to other Micronutrient deficiencies being responsible for the high levels of stunting in the country. This calls for national oriented surveys that focus on the Micronutrient status of the population to explain some of these problems. This study looks at the hemoglobin and Vitamin A status and their relationship with the nutritional status of the study pupils.

2.2 Indicators Of Malnutrition:

There are several indicators in a community, which point to a danger of malnutrition. The following have been identified by various studies as very crucial:

2.2.1 Infant and childhood mortality rates:

Infant and childhood mortality rates are a good indicator of the health status of the population. They reflect the ability of the children to withstand early childhood stresses. When the rate of mortality is high among this sector of the population, it will then indicate high morbidity among these children which is usually accompanied with poor nutrition (Alwar, 1992). There is evidence to show that where infant mortality rates are high, the level of malnutrition is equally high. For example in Kenya, the districts which have the highest infant mortality rates, also have the highest levels of malnutrition (KDHS, 1993).

2.2.2 Prevalence of stunting:

There are several lines of evidence that, within a given population, the heights of children at a given age reflect their nutritional status. Some of the good examples include:

- the trend in industrialized countries toward earlier maturity and increased height at all ages over the last century (Tanner, 1976);
- the existence of a relationship between the height of African preschool children, and the socioeconomic conditions affecting their families and their energy and nutrient intakes (Rea, 1971);
- the reduction in the rate of growth during a period of under nutrition (Tanner, 1976), and,
- the rapid growth responses observed in children given dietary therapy or nutritional supplements (Ashworth, 1969; Lampl, Johnstone and Malcolm; 1978).

2.2.3 Diet and food availability:

This is a major indicator of malnutrition in any population. The body requires food for nourishment and if the food is not available, there is the tendency for people to

waste away. The food we eat is important also because it assists in supplying various micronutrients crucial for body growth. There is evidence to show that people tend to waste away during seasons of the year when food is not available. Malnourished children are at risk of stunting and are also faced with higher morbidity and mortality (Serdula, 1988).

2.2.4 Household size and family size:

The effect of family size on the nutritional status of the household has been implied in some studies (Victoria et al, 1986). It is mainly viewed in relation to household food insecurity. Although the size of the family is not an automatic measure for household food insecurity, studies have shown a strong relationship between the two variables especially when family income is also low. A study of urban school children of Bangladesh indicated a strong link between family size/income on the height and weight of these children (Ahmed et al, 1992). The study then implies that family income and family size have a strong influence on nutritional outcome in the household. Another study done among households of a Kenyan semi- arid population indicated that household size was one of the most significant variables that affected nutritional status in the family (Kogi-Makau, 1992). In a study of children 7-9 years of age, Pelto et al(1991) found out that children from larger households remained significantly shorter for their heights and ate poorer quality diets than children from smaller households even when the researchers controlled for household economic status. In a study of the nutritional status of children in the Mwea Irrigation Schema of Kenya, it was established that there was a strong link between malnutrition and income expenditure in the household. All these studies point to the relationship between malnutrition and household size/income (Mwadime et al, 1995).

2.2.5 Micronutrient deficiency:

Micronutrient deficiency is becoming a major problem in the communities although often times it has gone unnoticed. Some of these include Vitamin A deficiency leading to low/reduced resistance to disease (Pinnock, 1991); iodine deficiency leading to goitre and iron deficiency anemia and its effect on motor skills (Sanghvi, 1992). There is a need for more studies and much attention in order to address these resulting complications.

2.2.6 Water and sanitation quality:

Water and sanitation are very crucial in determining the health of individuals in the community. It greatly influences the nutritional status of the population and especially among young children. Access to piped or treated water and type of sewage disposal have been linked with stunting and wasting in the population. The effects are seen mainly through their influence on prevalence of diarrhoea and its outcome. For instance a study of under six years children in Ethiopia indicated that morbidity was high among children who had diarrhoea than those who did not (Victoria et al, 1986).

In another study carried out in Ethiopia, children who live in a home with a latrine and who defecated in the latrine had the lowest morbidity, those with piped water had low morbidity, while those who used river water had the highest morbidity (Yohannes et al, 1992). The study also established that the children with a garbage bin in their compound experienced fewer illnesses as compared to the children without a bin and who hence threw rubbish carelessly in the compound. These studies suggest that there is a link between poor water and sanitation, high morbidity and high levels of malnutrition.

2.3 Nutrition at adolescence:

Adolescence is a period of transition from childhood to adulthood, which is characterized by dramatically accelerated physical, biochemical and emotional development. There is an increase in body weight, body composition and body height lasting up to three years. There is also a rapid enlargement of body organs and tissues. All these changes require additional nutrients' particularly protein, energy, calcium, iron, zinc and vitamins. Failure to provide these nutrients may lead to deficient states. The nutritional status at this time is dictated by food intake, eating habits, types of work done, socioeconomic family background, and, morbidity patterns.

2.3.1 Basis for high requirements:

Adolescence is a period of dynamic change and the growth of individuals is very rapid second only to infancy. It is estimated that in a span of two to four years, linear height increases as much as 25 cm for males and 23 cm for females. On average body weight may increase by as much as 22 Kg during the three years of peak weight gain velocity. In total, during the five to seven years of adolescent growth, 20% of linear height and 50% of ideal body weight are gained (Barnes, 1975).

Aside from these natural growth demands, the adolescent is faced with intense hormonal activity, societal demands and sexual pressure, all of which call for a substantial energy increase. Therefore, this age must be accompanied with sufficient quality food intakes to avoid deficient states. Table 3 shows additional demand for most nutrients at the peak of adolescent growth spurts.

Table 3: Daily increments in body content due to growth among adolescents

Mineral	Sex	Average for period 10-20 yrs (mg)	At Peak's of growth spurts (mg)
Calcium	M	10	400
	F	110	240
Iron	M	0.57	1.1
	F	0.23	0.9
Nitrogen	M	320	610 (3.8 g proteins)
	F	160	360(2.2 g proteins)
Zinc	M	0.27	0.50
	F	0.18	0.31
Magnesium	M	4.4	8.4
	F	2.3	5.0

Source: Forbes, G.B.: Nutritional Requirements in Adolescence. In Suskind, R M, editor: A textbook of Pediatric nutrition, New York, 1981, Raven Press.

2.3.2 Dietary habits of adolescents:

A level of physical and emotional growth that often results in stress and anxiety also marks adolescence. These in turn influence physiological, psychological and social behavior. All of these factors affect nutritional behavior. The incidence of dietary inadequacies is higher in adolescence than in any other time in the life cycle. At this stage deficiencies have a greater effect especially among girls who may possibly be faced with pregnancy challenges soon afterwards. If for any reason the nutritional status of the girl is inadequate before she conceives, she is less able to cope with the added physical stress of pregnancy, and the demands of the growing fetus. As a result they may end up with still births, underweight or premature babies with a higher mortality rate and have inadequate nutritive stores to carry them through the initial period of extra-uterine life.

2.3.3 Potential effects of deficiency:

The adolescents are in a situation where they are fluctuating between supplying the body with the needed nutrients and using up the nutrients and such a state can lead to major deficiencies like stunting, wasting, anemia and xerophthalmia (Tanner, 1962).

2.4 The Role of micronutrients on the Health of school children:

Micronutrients are an important component of the human immune function. Several studies have shown that vitamin and mineral supplementation improve immunity and reduce infection-related illness in healthy populations Van der Vynckt (1986). There is further evidence showing the role of zinc in improvement of growth velocity among children with poor growth (Schlesinger et al, 1992). This therefore indicates the importance of micronutrients to the health of school children. If these children are poorly nourished, they are unlikely to attend school regularly as their peers, a state that disadvantages them and makes it difficult for them to meaningfully compete in any education system. The top Micronutrient deficiencies that are affecting the Kenyan population are iron deficiency causing anemia, Vitamin A deficiency and Iodine deficiency. This study deals only with iron deficiency anemia and Vitamin A deficiency.

2.4.1 Iron Deficiency Anemia:

Iron is an important component of hemoglobin, the oxygen-carrying molecule in blood. A low hemoglobin concentration is associated with hypochromia, a characteristic feature of iron deficiency anemia. Anemia refers to low hemoglobin concentration in the blood commonly caused by iron deficiency and measured by hemoglobin levels, with cutoff points established by the World Health Organization (WHO, 1986). However, anemia can also be caused by a deficiency in one or more of the nutrients required for red blood cells formation, deficiency of Vitamin A or by increased destruction of red blood cells (hemolysis), e.g., during malaria infection. Therefore, there are various types of anemia depending on causes.

Hypochromic anemia is characterized by decreased hemoglobin in red blood cells while hemolytic anemia is characterized by excessive destruction of red blood cells. Measurement of the concentration of hemoglobin in whole blood is the most widely

used screening test for diagnosis of anemia and this is the method applied in the present study.

2.4.1.1 Demand for Iron among school children:

School children are at risk of anaemia because of their high needs for iron. Not only is there a rapid increase in the red blood cells and in muscle mass, which occur in normal development but these children are also predisposed to blood losses due to infection with hookworm, or schistosomiasis and malaria.

Iron deficiency can be found in children of all races, in both sexes, and at all levels of economic status. This deficiency may precipitate anemia which is associated with low dietary intake of iron and/or poor absorption (WHO, 1985). Barnes (1985) shows that the need for iron increases with rapid growth and the increase in muscle mass, blood volume and respiratory enzymes in both male and female. He further shows that there are high needs for the peak of adolescence in males because of gaining lean body mass at a higher rate than the female. Barnes has also shown the dynamic change that takes place during adolescence whereby in a span of 2-4 years, linear height increases in as much as 25 cm for males and 22.5 cm for females. The average teen may gain as much as 22 kg during the three years of peak weight gain velocity. During the total 5-7 years of adolescent growth, 20% of linear height and 50% of body weight are gained. Skeletal mass, internal organs and the uterus also double in size during this time. This condition will require additional iron for optimum performance failure to which will lead to iron deficiency anemia. In the female, there are additional needs for iron through losses during menstruation especially as they mature to be mothers. This is crucial because of the importance of female health, which has inter-generational effects. Merchant and Kurz (1993) have shown that anaemic women give birth to iron deficient children.

2 4.1.2 Effects of anaemia:

The effects of anemia have been studied in several controlled clinical studies among preschool and school children. These studies have shown that anaemic, iron deficient children improved significantly in at least one of the tests applied upon iron supplementation compared to a placebo. Some children not only increased their appetite, but also improved their growth (Lawless et al, 1994). Other studies indicate that anemia compromises physical productivity and capacity of children to learn in school, health and resistance to infection and psychological functioning and cognitive development (ACC/SCN, 1986).

Sanghvi (1992) on the other hand has demonstrated that anaemic children exhibit inferior mental and motor skills when compared to other children who are not anemic. Latham et al (1990) in a study among young Kenyan school children showed that iron deficiency causes growth retardation and supplementation to iron deficient children greatly improved the height of the children as opposed to their counterparts who were given placebo.

In view of these negative effects, it is the intention of this study to establish the prevalence of anemia in this area in order to come up with useful recommendations that can guide any interventions in the area. In doing so, the children will build up their potential through improved health and cognitive performance and overall school achievement. It is assumed that the end result will be a pool of healthy human resource for the district and the country as a whole.

2.4.2 Vitamin A

Vitamins are essential to life. They contribute to good health by regulating the metabolism and assisting the biochemical processes that release energy from the digested foods. They are considered micronutrients because the body needs them in relatively small amounts compared with other nutrients such as carbohydrates and proteins.

Of the major vitamins, some are water-soluble and others are fat-soluble. Water-soluble vitamins must be taken into the body daily because they cannot be stored and are excreted within one to four days. These include vitamin C and the B complex vitamins. Fat-soluble vitamins can be stored over long periods of time in the fat tissue and the liver. These include vitamin A, D, E and K.

This study examines the status of Vitamin A among school children because of its crucial role in visual activities, which are an asset for all school children. Vitamin A plays an important role in the chemical events that are associated with visual excitation and hence prevents night blindness and other eye problems. It also prevents skin disorders such as acne, enhances immunity and may heal gastrointestinal ulcers (Mohanram et al 1974). It is said to protect against pollution and cancer formation and is needed for epithelial tissue maintenance and repair (Rojanapo et al 1980). This is possible through its ability to destroy free radicles and protect tissues from damage by acting as an anti-oxidant. It is also well understood that Protein cannot be processed without this supplement. A national study (GOK/UNICEF; 1995) indicates that Vitamin A deficiency is a public health concern in Kenya and more attention is required in establishing the real extent of the problem.

2.4.2.1 Physiological Functions of Vitamin A:

Vitamin A performs several functions in the body (Yashan et al 1994). The main functions can be identified as follows:

- It combines with proteins to make visual pigments for both night and day vision and hence prevents night blindness and other eye problems.
- It is required for growth and repair of epithelial tissue.
- Essential for protein metabolism in the liver.
- Helps form bones and teeth in infants.
- Essential for glycogen synthesis
- Helps in maintaining the health of the reproductive system.
- Acts as a co-enzyme in the skin, the bone, the retina, the liver and the adrenal glands.
- Regulates formation of cartilage.
- May aid in the synthesis of RNA and the absorption of RNA in the liver.
- Regulates synthesis of some hormones.
- It acts as an antioxidant, which helps protect the cells against cancer and other diseases.
- beta-carotene prevents against vitamin overdose

2.4.2.2 Stages of Vitamin A Deficiency:

Vitamin A deficiency develops in stages and there are different approaches to prevention and treatment depending on the level of deficiency. It can have very undesirable effects if left unchecked. Severe Vitamin A deficiency causes blindness, which has a far-reaching, effect on maintenance of health. This is one of the heavy disease burdens in the developing countries today. It is a major public health concern and affects not only child morbidity and mortality (Beaton et al 1993), but is also associated with impaired iron status. Intervention trials where Vitamin A deficiency is endemic have shown that supplementation elevate blood

hemoglobin levels (Mejia and Arroyave, 1983). In addition to these vital roles, vitamin A is also required for normal growth, development and reproduction, and is essential in protein synthesis, development of skin tissue and mucous membrane. The major cause of this deficiency is an inadequate dietary intake to meet requirements, which are sometimes made worse by low absorption.

- The first level is Night Blindness. At this stage, the individual cannot see in dim light and treatment with Vitamin A for only 1 - 2 days will be sufficient to solve the problem.
- Bitot Spots - These are foamy, soapy whitish patches on the white part of the eye. If this is not treated, then we have the next condition.
- Conjunctival Xerosis - The eye becomes drier and less shiny. This can be treated with 1 - 2 weeks' administration of Vitamin A. If that is not done, then you have active corneal lesions.
- Active Corneal Lesions - This is the darkening of the area covering the corneal making it cloudy.
- Corneal Xerosis - The corneal becomes dry.
- Corneal Ulcers - The corneal bursts and creates a scar.
- Keratomalacia - The ulcers will then lead to keratomalacia, which is partial blindness due to the scars. Immediate treatment with Vitamin A will stop keratomalacia.
- Corneal Scars - If keratomalacia is not treated, then there are corneal scars which is a condition of total blindness.

2.4.2.3 High Risk Groups:

Due to scarcity of green vegetables in the and areas and during droughts, there is a high possibility of deficiency among such communities. It will also affect early-weaned children, undernourished children, children with measles, diarrhoea, and acute respiratory disease, the elderly, pregnant adolescents, prisoners and displaced persons (De Pee, et al. 1994).

2.4.2.4 Symptoms of Vitamin A deficiency:

Knowledge of symptoms of vitamin A deficiency is crucial in order to put in early intervention and avoid the undesirable effects that may affect the population. The main symptoms of Vitamin A deficiency are:

- Xerophthalmia
- Night blindness or difficulties seeing in dim light
- Rough, dry skin.
- Growth retardation in children due to impaired metabolism of the hormones, skeletal tissue and membranes.
- Increased susceptibility to infections due to damage to the linings of the lungs, gastrointestinal tract, salivary glands and tear ducts.

2.4.2.5 Effects of Vitamin A deficiency:

Vitamin A deficiency causes impaired nonspecific and specific, especially cellular immunity (Van der Vynckt, 1986) and predisposes one to infection (Pinnock, 1991). Pinnock shows that Vitamin A deficiency reduces T-cells ability to fight infection and reduces mucous production resulting in more bacteria being able to attach themselves to respiratory mucosa. The same leads to prevalence of diarrhoea in children with measles.

There is further evidence to demonstrate that there are disturbances in circulating vitamin A levels during acute and chronic infections (Jagadeesa & Reddy, 1979). These disturbances are likely to be very significant in the developing world where Protein Energy Malnutrition and infectious diseases often coexist. For example, increased risk of respiratory infections and diarrhoea was found in preschool children with mild xerophthalmia, compared to children with normal eyes (Sommer et al, 1984; Pinnock, 1991). Furthermore, it has been noted that there was increased mortality rates among preschool children with mild xerophthalmia as

opposed to children with sufficient vitamin A (Sommer et al, 1993). Rahmathulah et al (1990) has also demonstrated that vitamin A supplementation contributes to child survival by showing a mortality reduction of 54% in his study. Further still, randomized, controlled trials of vitamin A supplementation can reduce overall mortality in preschool children (West et al, 1991).

All these studies have shown the undesirable effects of vitamin A deficiency as well as the fact that supplementation reverse these effects. It is the intention of this study to find out the prevalence of vitamin A deficiency among the study population in order to bring it to the attention of the relevant authorities for appropriate action.

2.4.2.6 Consequences of Vitamin A Deficiency:

As far back as 1981, estimates showed that 60% of children with xerophthalmia die, 25% of the survivors remain totally blind, and 50-60% remain partially blind (IVACG, 1981). There is further evidence to show the large contribution of Vitamin A deficiency to the number of blind people in the world today. Pinnock (1991) in his study found out that 20-40 million children in the world had vitamin A deficiency, 3 million had severe vitamin A deficiency leading to high rates of xerophthalmia and blindness. In view of this, school children are likely victims of mild xerophthalmia and hence unlikely to concentrate and enjoy school. No specific data on vitamin A status is available on Siaya and it is hoped that this study will give useful insight into the extent of the problem.

2.4.2.7 Dietary Sources of Vitamin A:

It is important to note that only animal sources contain preformed Vitamin A. These include: whole milk, eggs, fish liver oils, and animal livers. However, plant sources can also be useful when foods containing beta-carotene (substances found in the plants that the body needs to make vitamin A), which are converted to vitamin A by intestinal cells. Dark green and yellow fruits and vegetables such as carrots,

pumpkins, yams, apricots, broccoli, parsley, cantaloupe papaya, alfalfa, spinach, spirulina and garlic, yellow corn, soybeans, tomatoes and palm oil. This then implies that there is no shortage of dietary vitamin A sources to justify existence of a deficiency status as is the possibility of lack of appropriate education to the communities on dietary sources. Most of these vegetables are readily available in most communities even if not throughout the year since vitamin A is fat soluble and can be stored in the liver during the months of the year when the foods rich in the vitamin are available and consumed (Wasantwisut et al 1994).

2.4.2.8 The demand for Vitamin A among school children:

Vitamin A studies have concentrated on infants and preschool children mainly because of its association with increased morbidity and mortality in this age group. However, there is mounting evidence that vitamin A deficiency is a major nutritional problem among school children. The greatest evidence is seen in India where considerable work has been done in recent years to determine the extent of vitamin A deficiency and its consequences on children five to fifteen years of age (Gopaldas et al, 1983; Bakshi and Gopaldas, 1989). Studies in some areas of Gujarat have reported nearly 80% of school age children exhibiting biochemical vitamin A deficiency with up to 12% of those children having xerophthalmia clinically responsive to vitamin A therapy, suggesting a state of true vitamin A deficiency.

Although mortality is rare beyond preschool years, frequent morbidity such as upper respiratory tract infections, parasitism, febrile illnesses and diarrhoea associated with vitamin A deficiency is a major obstacle to these children. It affects school attendance and ability to enjoy school and related activities.

Besides, considering the demands on a primary school child, visual competence is an asset taking into account the reading they are required to undertake in order to achieve academic excellence. In this regard then, there is need to provide adequate vitamin A among these children. While a clear priority exists to prevent vitamin A deficiency in preschool age, increased attention needs to be given to the extent,

severity and consequences of vitamin A deficiency in the school child especially prior to and during adolescence which has been focused on in this study. This will be valuable knowledge to the community of Siaya who then can be assisted to come up with simple and inexpensive but appropriate methods of alleviating the risks of xerophthalmia among school children. There are plenty of vitamin A rich foods in the community both animal as well as vegetable sources that can be exploited.

2.5 Nutrition Assessment:

Malnutrition can be measured by well-established methods including anthropometry, biochemical analysis, clinical examination and dietary intakes.

2.5.1 Anthropometric Assessments:

Anthropometry is defined as measurements of variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition (Jelliffe, 1966). This method can be used to detect degrees of malnutrition in an individual or population. It also provides information on past nutritional history, which cannot be obtained with equal confidence using the other assessment techniques. The main measurements used are: height, weight, age, arm fat area and arm muscle area.

These measures make up the major anthropometric indicators of nutritional status, i.e., height for age, weight for height and weight for age.

2.5.1.1 Advantages:

This method of data collection is preferred in most studies for its advantages. For example the procedure is simple and safe and applicable to a large sample size. The equipment used is inexpensive, portable and can be locally available. The exercise is straightforward and it does not require highly skilled personnel to

perform the measurements and it is possible to devise screening tests to identify individuals at high risk to malnutrition.

2.5.1.2 Limitations:

Although this method has advantages, it also faces certain limitations. The main weaknesses include the fact that the procedure is relatively insensitive and cannot detect disturbances in nutritional status over short periods of time and it cannot detect nutrient deficiencies. It is unable to distinguish between disturbances in growth or body compositions caused by nutrient deficiency. The other problem has to do with the fact that weight taken at one point in time does not explain much about the past or future and may be misleading.

2.5.1.3 Sources of error:

Some of the errors associated with anthropometric measurements are examiner/enumerator errors during examination and recording, which can be avoided by having two examiners recording the readings independently. The second source of error is instrument error if not calibrated appropriately and this was observed during this survey. The instruments were calibrated appropriately at the beginning of each session.

2.5.2 Laboratory Methods:

Several stages in the development of a nutritional deficiency state can be identified by laboratory methods. In primary or secondary deficiencies, the tissues become depleted of the nutrients. As a result of this depletion, reductions may occur in the levels of nutrients or in the levels of their metabolic products in certain body fluids and tissues, and/or in the activity of some nutrient-dependent enzymes. This depletion may be detected by biochemical tests, or by tests that measure physical or behavioral functions dependent on specific nutrient levels (Solomons, 1985). Some of the notable examples are iron deficiency anemia and vitamin A deficiency.

2.5.2.1 Advantages:

This method is most ideal for use in cases where the individuals are marginally malnourished before a clinical syndrome develops. It identifies what otherwise cannot be detected at clinical level and helps to make it possible to give early treatment which is also usually cheaper. It can also be used to identify community risk factors.

2.5.2.2 Limitations:

One major limitation is the cost of laboratory methods which makes it unaffordable for large community studies.

2.5.3 Clinical Methods:

A medical history and a physical examination are the main clinical methods used to detect signs (observations made by a qualified examiner) and symptoms (manifestations reported by the patient) associated with malnutrition. These signs are often nonspecific, and only develop during the advanced stages of nutritional depletion; for this reason diagnosis of nutritional deficiency should not rely exclusively on clinical methods (McGanity, 1974). However, some manifestations are quite clear to the clinical personnel upon observation such as kwashiorkor, marasmus, Bitot spots and goitre.

2.5.3.1 Limitations:

Limitations of clinical method include: non-specificity of the physical signs where some signs may be produced by more than one nutrient deficiency or even non-nutritional deficiencies, examiner inconsistencies or multiple physical signs.

2.5.4 Dietary Methods:

The first stage of nutritional deficiency is identified by dietary assessment methods. During this stage, the dietary intake of one or more nutrients is inadequate, either because of a primary deficiency (low levels in the diet), or because of a secondary deficiency (interference with the ingestion, absorption, transport, utilization, or excretion of the nutrients). Through this assessment it is possible to estimate whether or not individuals are consuming adequate amounts and compositions of nutrients necessary for good nutrition.

Dietary assessment can be done in two ways. One, by quantitative daily consumption methods that consists of recalls or records designed to measure the quantity of the individual foods consumed over a one-day period. By increasing the number of measurement days for these methods, quantitative estimates of the actual recent intakes, or for longer time periods, usual intakes of individuals can be obtained. Some of the quantitative methods used for this purpose include, twenty four-hour recall and estimated food records.

The second one includes the dietary history and the food frequency questionnaire or in other words recall methods. Both these methods obtain retrospective information on the patterns of food use during a longer and less precisely defined time period. By computing the estimated food intake, it is possible to give a rough estimate of the food consumption of the individuals.

2.5.4.1 Limitations:

- i Analysis does not show absorption
- ii It is tedious

- iii It requires a well-trained person to do the enumeration
- iv Estimates may not be accurate
- v Not representative of the real situation
- vi Expensive

Conclusion:

From this review, it is clear that malnutrition has a negative effect on human health. Some of the consequences are very undesirable. There is evidence that malnutrition can be eliminated or at the least minimised.

Although a lot of research has been undertaken to determine nutritional status of pre-school children, minimum effort has been made to establish the nutritional status of school children despite enormous evidence showing that poor nutrition affects mental ability of children. There is need to do an evaluation of the impact of poor nutrition on school performance among school children in Kenya especially in areas with endemic malnutrition.

This study will provide valuable information on the nutritional status of school children beyond pre-school age in Usigu Division of Siaya District.

Chapter Three

METHODOLOGY

3.1 Study Site

This study was carried out in Usigu Division, which is one of the nine divisions making up Siaya District in Nyanza Province. The division was selected because of its proximity to the lake and possible increased probability of helminth infections. There is no information on the division perse and a description of the district gives the general characteristics of the division.

Siaya District is bordered by Busia District to the north, Kakamega and Vihiga Districts to the north east; Kisumu District to the south east, and Homa Bay District across the Winam Gulf to the south(Figure 1). It has an area of 2,524 square kilometres and a population density of 253 persons per square kilometre. The district has a total of 143,369 households as per the 1989 population census.

Siaya District is traversed by two main rivers, Yala and Nzoia, both of which flow southwestward into Lake Victoria. In addition, there are streams, some of which are tributaries of the two main rivers. The average altitude of the district rises from about 1,140 metres on the lakeshore in the south to about 1,300 metres in the north and east. However, there are scattered hills that rise to about 1,280 metres in some parts of the lakeshore. These include Got Ramogi, Usenge Hills, Got Abiero and Nango Highlands.

The highlands in the north receive higher rainfall than the lower areas in the west and south. The long rainy season is normally from March to May while the short and more erratic one comes around October/November.

Figure 1: THE MAP OF SIAYA DISTRICT



3.1.1 Demography

The population of Siaya is homogenous in terms of relevant social, economic, and cultural variables. The 1979 Census showed that Siaya District had a total population of 474,516. This was a 24% increase in comparison to the 1969 population. According to the 1989 census, the total population had further increased to 639,439 with the Luo community accounting for 96% of the population. At the same time, the population of Usigu has increased from 20,073 in 1979 to 32,461 in 1989 with an inter-censal growth rate of 4.9% which is the highest in the whole district according to the Siaya District Development Plans for 1989-1993. Table 4 shows the population distribution of Siaya district by age as per the 1989 national population census data.

3.1.2 Socioeconomic situation:

Land is a major natural resource in Siaya District. Most people practice a non-cash agricultural economy by growing maize, sorghum and cassava for subsistence. However, in the northern parts, where rainfall is more plentiful, maize, beans and sugar cane are also grown for sale. Besides land, people of Siaya also make use of Lake Victoria through fishing. A lot of people, especially in Usigu division engage in fishing and related activities making fishing the major source of livelihood

A major disadvantage associated with involvement in fishing for the community has been noted as most children are dropping out of school to engage in these activities because there is easy access to substantial amounts of money. This affects the male children who often spend much of their time fishing for money rather than going to school and the female children who are lured into marriage at an early age by the "rich" fishermen.

Table 4 Population Distribution by age and sex in Siaya District

Age	Male	Female	Total
0 - 4	54,208	54,718	108,924
5 - 9	51,173	50,442	101,615
10 - 14	47,158	45,667	92,825
15 - 19	34,772	34,867	69,639
20 - 24	18,033	26,772	44,805
25 - 29	13,891	22,185	36,076
30 - 34	11,289	17,972	29,271
35 - 39	9,721	16,345	26,066
40 - 44	8,410	14,387	22,797
45 - 49	6,984	12,845	19,829
50 - 54	7,709	12,249	19,958
55 - 59	7,953	11,499	19,452
60 - 64	6,909	8,155	15,064
65 - 69	5,339	6,113	11,452
70 - 74	4,058	4,683	8,741
75 - 79	3,396	2,813	6,209
80+	2,896	2,994	5,890
Total	294,313	345,128	639,439

Source: National population census, Vol.1 (2-30)(CBS, 1989)

3.1.3 Health Situation:

Siaya District has a poor record of health as portrayed by the level of infant mortality as well as maternal mortality. The Infant Mortality Rate (IMR) in Siaya

District is among the highest in Kenya, standing at 130/1000 live births compared to the national average of 65/1000 live births. In addition, maternal deaths constitute 4-5% of the total mortality in the district. Prevalence of chronic malnutrition in Siaya according to 1987 Rural Child Nutrition Survey was 25.9%. The same was recorded at 36% during the 1993 Demographic and Health Survey. The coverage of safe water supply is 4% while the latrine coverage for the whole of Siaya District is 47% with Bondo and Usigu Divisions with coverage of only 8%. The combined effects of inadequate safe water and latrine coverage tend to create the problem of periodic outbreaks of cholera and dysentery.

Siaya District has the following health related problems in order of decreasing importance: malaria, diarrhoeal disease, upper respiratory tract infections, anemia, intestinal worms, urinary tract infections, measles, bilharziasis, eye infections, and pneumonia.

3.1.3.1 Nutrition Situation:

Siaya District has a very high prevalence of malnutrition. As indicated in the findings of several surveys, stunting among under five children is still very high. According to the Kenya demographic and Health survey of 1993, stunting among children below five years was recorded at 34%. There is hardly any data on micronutrient status in the district but available information on the status in neighbouring South Nyanza District indicate that problems do exist (Tomkins and Watson, 1989).

3.1.3.2 Health Care Facilities in Siaya:

There are a total of 49 health facilities in the District. These include 1 District Hospital, 1 private hospital, 2 mission hospitals, 1 Sub-District Hospital, and 44 Health Centres and Dispensaries. In addition to these, there are 2 Divisions of Vector Borne Disease (DVBD) stations in the District - one in Siaya town and another in Bondo town. According to the Siaya District Development Plan for 1994-1996, there are three (GOK) health facilities in Usigu division. These include one health centre and two dispensaries.

Several NGOs and other development agencies have various activities in Siaya District. These include CARE International, UNICEF, Lake Basin Development Authority, DANIDA with the Family Life Training Programme, Swedish International Development Agency, Church of the Province of Kenya and Africa Medical Research Foundation. On average, Siaya district is fairly well served with health facilities although the community is still faced with many health problems.

3.1.4 Conditions of the schools in Siaya District:

There are 601 primary schools in Siaya district and 38 of these are in Usigu division. Figure 2 below shows the distribution of schools in Usigu division. Most of the schools for this study were poorly developed. They lacked many of the attributes of primary schools taken for granted in more prosperous settings. There was no guarantee for a building for all classes. Some of the classes take place under a tree; no chairs and desks for the pupils and some of them were sitting on the floor and writing on their laps, no water or if available it was unsafe, and, poor or non-existent sanitary facilities. All these conditions combined with poor nutrition and poor health can hamper returns from the primary school investments in this country. In fact, some of these conditions may be the causes of malnutrition because of exposure to poor health.

3.2.1 Study Design:

This was a cross-sectional study designed to assess the nutritional status of primary school children of Usigu Division in Siaya District. The selection of Usigu was purposive as was that of Siaya. It may be important to note that despite Siaya being fairly well served with health facilities, on the national average, many health problems persist, making it a likely choice for any health research. The nutritional status of the population was assessed using clinical examination and anthropometric indices while prevalence of micronutrient deficiency was measured by biochemical tests.

3.2.2 Sampling procedure and the Sample Size:

This study is based on a cross-sectional sample of nineteen out of thirty eight primary schools in Usigu division. The research instrument was pretested in two schools and the necessary adjustments made before the actual research exercise. The two schools where pretesting was done were eliminated from participation in the research. In order to determine the starting point, a coin was tossed. The schools were drawn systematically from one end of the division (West to East) until the desired sample size of about 1000 children was attained. All pupils in classes five and six in the sampled schools were eligible for the study but the participation was optional. Twenty two percent of the pupils did not take part in the study either because the parent or guardian did not consent to the child's participation, or, the child was absent from school during the study period, or because of the child's fear of blood removal. In the end, a total of 720 children or 78 percent of the total eligible population, participated.

The study selected the two classes for participation for two reasons. One, this study was part of a larger longitudinal study, thereby implying that the class seven and eight pupils were not suitable because they were expected to complete their primary education before the larger study was completed. The second reason that cut off the pupils below class five was inability for these children to communicate well in English or Kiswahili which were the main study languages.

3.2.3: Data Collection

The data collection exercise took place between January and February 1995. The data collected included:

- Anthropometric measurements - Age, weight, height, Mid Upper Arm Circumference, and Triceps Skin Fold.
- Laboratory methods- hemoglobin and vitamin A.
- clinical examination - signs of malnutrition

3.2.3.1 Anthropometric Measurements:

Anthropometric data is the data from simple body measurements such as height, weight, arm circumference, and skinfold thickness.

Procedure:

The anthropometric exercise started with the registration of the pupils. At this point, the age of the child was obtained and information on family background and water and sanitation was recorded. Then the pupils changed their dressing and wore a standard light cloth (leso) at a specially prepared section of the class before proceeding for clinical examination. A qualified clinical officer who also sought information on current morbidity carried out clinical examination by nature of the problem from the children. Thereafter the children proceeded to have their anthropometric measurements taken.

Age:

The age of the child was obtained from the pupil's parents who indicated the child's birth date on the consent form and this was counter-checked with the pupils during the interview.

Height:

A portable SECA stadiometer for measuring stature was used. The subjects were measured standing straight with the head stationed such that the Frankfurt Plane is horizontal, the feet together, knees straight, heels, buttocks and shoulder blades in contact with the vertical surface of the stadiometer with the arms hanging loosely at the sides and shoulders relaxed. The movable headboard was then gently lowered until it touched the crown of the head and measurements were taken at maximum inspiration to the nearest millimetre. Two field workers took independent measurements and the average reading was recorded. This was useful in monitoring errors because if the difference between the two independent readings was more than 1 centimetre then the field workers repeated the measurements on the spot to correct the error.

Weight:

A portable platform beam balance SECA machine was used to measure weight. The machine was placed on a flat surface in class and checked for accuracy at the beginning of each session using a 5-kg weight. The subjects stood unassisted in the centre of the platform looking straight ahead. Body weight was recorded to the nearest 0.5 kg.

Triceps skinfolds Thickness:

Using a Harpenden Calipers with a standard contact surface area of 20-40 mm² and reading to 0.1 mm accuracy, the skinfolds thickness was measured between the tip of the acromion process of the scapula and the olecranon process of the ulna. The measurement was made with the arm hanging relaxed at the side. The skinfolds parallel to the long axis was picked up between the thumb and forefinger of the left hand, clean away from the underlying muscle, and measured at this point.

Duplicate readings were made for each case to improve the accuracy and reproducibility of the measurements.

Mid Upper Arm Circumference:

Using fibre glass tape measure, which does not stretch, the measurement of the circumference of the left arm midway between the acromion process of the shoulder and the olecranon process of the elbow was made to the nearest 0.1 cm.

3.2.3.2 Laboratory Methods:

The laboratory methods or biochemical evaluation of nutritional status involves an analysis of nutrients or related metabolites in such tissues as the blood and urine. Low blood levels of a nutrient may reflect low dietary intake, defective absorption or utilization, or excessive need or excretion. Occasionally, analysis will be made with a biopsy sample of liver or bone, but this technique is not justified in routine nutritional evaluations because it is rather hazardous and involving.

Blood Collection and Storage:

After a clean venipuncture, 10ml venous blood was drawn from the cubital vein using micro lance sterile G21 disposable syringe (Beckton Dickinson). After collection, 1 ml of blood was aliquoted in EDTA bottle, labelled with study number and subject name using permanent ink to be used later for hemoglobin (Hb) analysis. This was then mixed gently. The remaining 9ml of blood was put in a corresponding plain bottle wrapped in aluminum foil and stored in an upright position in a cooler at a temperature of 8 - 10° C and transported to the field laboratory awaiting Vitamin A analysis. At the field laboratory, the blood samples for vitamin A were left to clot before they were centrifuged at 3000 rpm for 15 minutes. Clear serum was separated using Pasteur pipette and transferred into a 1.8 Nunc

Cryotubes covered with aluminum foil. Serum samples were flushed with pure nitrogen gas and stored under liquid nitrogen at a temperature of -70° C. Sample handling and analysis for Vitamin A were done in dim light based on the method described by De Ruyter and De Leenheer(1976).

Hemoglobin Measurement:

The analysis of hemoglobin was done on the same day using a Coulter Counter machine Model M530 and the results printed automatically using Coulter Printer Model M530.

Principle:

The sample dilution ratio is 1:500 and includes a lysing agent. The lysing agent, which is added to the diluted sample during manual dilution, not only lyses the erythrocytes, but causes a substantial conversion of Hb to a pigment with an accuracy equivalent to hemoglobin cyanide which is measured at 525 nm.

Materials and methods

- Semi-automatic double diluter III (Coulter Electronics LTD)
- EDTA Blood samples
- Diluent - Isotone II (Coulter Electronics LTD)
- Lysing agent - Zap-oglobin (Coulter Electronics LTD)
- Coulter Mixer (Coulter Electronics LTD)
- Coulter Counter Model M 530 (Coulter Electronics Ltd. England).
- Coulter Printer (Coulter Electronics LTD)

Procedure:

Using a double diluter III, a 1 in 500 dilution was made in Isotone II and six drops of Zap-oglobin (a strong lysing agent) were added and mixed gently by inversion. The hemoglobin of this solution was then read using the Coulter Counter model M 530.

The coulter counter was calibrated weekly using 4c Normal Control (Coulter Counter, Coulter Electronics Ltd. England) and checked daily using both 4c Normal and 4c Abnormal to ascertain that it has reproduced the assigned values before being used to measure the test samples (sample under investigation). The coefficient of variation (C.V.%) was found to be 4.9% (n=13) S.D. 0.3796084 for 4c Normal. For 4c Abnormal, the values gave a C.V of 5.8% (n=12) S.D.=0.1669694.

These Hb standards were obtained from the agent of the coulter Electronics in Kenya (Technomed LTD, Kenya). The WHO cut-off points for age and sex for low Hb levels were used (Annex 1).

Vitamin A analysis:

Vitamin A is stored in the liver, and since the survey work could not take liver biopsy, actual estimation of serum vitamin A was done. A low serum level in this case reflects low levels of circulating inadequate recent intake of vitamin A. Since vitamin A is photosensitive, the serum samples intended for analysis were kept in Cryotubes covered with aluminum foil and kept in liquid nitrogen for a period not exceeding three months after collection before it was analyzed. Analysis was done using High Performance Liquid Chromatography (HPLC).

Principle:

A given volume of serum is diluted with ethanol or methanol, which denatures the proteins and releases Vitamin A. Vitamin A, is extracted with a suitable organic solvent. After centrifugation, an aliquot of the organic phase is injected into a normal phase or reversed phase HPLC column. A UV detects retinol and Internal Standard (retinyl acetate) peaks - detector set at 325 - 328 nm. Retinol is quantitated by use of peak area ratios relative to an internal standard (retinyl acetate).

Materials and Methods:

- 100 μ l Serum
- Internal Standard - Retinyl acetate, all Trans (highest purity)
- Stock standard - Retinol, all Trans (highest purity)
- Mobile phase - Methanol, HPLC grade
- Analytical balance
- Vortex
- Water bath kept at 50⁰ C
- Nitrogen gas and glass test tubes with screw caps
- Pasteur pipettes with rubber teats
- Hamilton gastight # 1705 syringe (50 μ l)
- Extracting solvents - Diethyl ether: Dichloromethane: 2-propanol (80:19:1 v/v) HPLC grade
- HPLC System, Hitachi Model 885 - 4592, Hitachi L-6000 Pump, Hitachi L-4000H UV-detector, Hitachi D2520 GPC Integrator (Hitachi LTD, Tokyo Japan)
- 1210 ultra cleaner (Branson)
- Column - 10 mm particle μ Bonda pak C18 3.9 x 300mm steel (Waters Millipore Corporation)
- Guard Column - C 18 Material (Waters Millipore Corporation)
- Injector - Cotati California Rheodyne (Manual)
- MSE centrifuge

Retention Times

- Retinol - 4.32 min.
- Retinyl acetate - 5.79 min.

Procedure:

The serum samples were transported to the reference laboratory in Nairobi where the analysis was to be done. They were kept in the deep freezer at -40°C until the time of analysis. During analysis, serum samples were removed from the deep freezer and left at room temperature until they were completely thawed. Then, they were mixed by vortex to make them homogeneous. Out of each sample, an aliquot of $100\ \mu\text{l}$ of serum was taken and put in a corresponding test tube and $5\ \mu\text{l}$ of internal standard (retinyl acetate) added.

In order to precipitate the proteins, $100\ \mu\text{l}$ of methanol was added followed by 20 seconds vortex. Then $200\ \mu\text{l}$ of extracting solvent was added and again followed by a 60 seconds vortex making sure that the bottom of the tube was completely agitated. The contents were centrifuged at 3000 rpm for 2 minutes using an MSE centrifuge. The protein precipitate was deposited at the bottom of the tube leaving the organic phase at the top. Then $100\ \mu\text{l}$ of upper layer of organic phase was transferred to a corresponding tube using a clean Pasteur pipette.

Clear supernatant was separated and dried in a water bath at 50°C under a stream of nitrogen gas. The resultant vitamin A residue was dissolved in $50\ \mu\text{l}$ of mobile phase (95 parts methanol and 5 parts distilled water). This is a transport media for vitamin A. Vitamin A standards (Retinol) were prepared using Vitamin A deficient plasma and were treated similarly. Varying concentrations of Retinol standards ranged from 0, 10, 20, 40, 80, 120 mg/dL.

$20\ \mu\text{l}$ each of the standards and the processed samples were injected onto a normal phase $\mu\text{Bondapak}$ column through a manual injector (Rheodyne) using Hamilton Syringe. Retention time was used to identify the peaks. Known retinol and retinyl acetate standards were injected separately for identification. Peak area ratio used as a measure of each analyte relative to the internal standard. Vitamin A levels in unknown samples were determined from a standard curve prepared from

the ratio of retinol and internal standard (retinol/internal standard) plotted versus the concentration of the retinol standards. Regression analysis of the data was performed for each analyte. Regression coefficient ranging from 0.98 upwards was acceptable. A cut-off point of 20 $\mu\text{g/dL}$ was used to determine the individuals who were vitamin A deficient (Kaplan et al, 1990).

3.2.3.3 Clinical method:

Clinical method involves an assessment of those parts of the body that can be readily observed in a routine physical examination. The most commonly observed tissues are the eyes, mucous membranes, skin, hair, mouth and thyroid glands. An examination of these tissues are normally used to detect signs and symptoms associated with malnutrition. These signs and symptoms are non-specific and only develop during advanced stages of nutritional depletion. Therefore, diagnosis of nutritional status can not rely exclusively on clinical methods but included laboratory tests.

A qualified and experienced clinician carried out the clinical examination on the children. Body changes related to inadequate nutrition that can be seen or felt in superficial epithelial tissues were recorded. These included especially the eyes, skin, hair and buccal mucosa and organs near the surface of the body such as parotid and thyroid glands and internal systems such as the liver and spleen. The clinical method was seeking to establish children suffering from vitamin A deficiency (signs of xerophthalmia), iron deficiency (signs of anemia), and, iodine deficiency (signs of goitre).

3.2.4 Data Analysis:

The data was processed using dBase IV and SPSS programs. First frequencies were run on all variables. This was followed by cross tabulations and finally correlation and regression analysis on different study variables controlling for sex.

The weight for age, height for age, arm muscle area for age, arm fat area for age, hemoglobin levels, and vitamin A status were derived. A cut-off point of -2 sd and -1 sd was used to determine the population that was moderately and mildly malnourished respectively for anthropometric indices. The WHO accepted Hb levels for age was applied to determine the children who were anemic, while a cut-off point of 20 $\mu\text{g/dL}$ of blood was used to determine the subjects with Vitamin A deficiency.

Chapter Four

RESULTS

4.0 Introduction

There is no single reliable measure of an individual's nutriture. A combination of anthropometric, biochemical, and clinical data is usually collected to give a picture of nutritional status of a population. This study employed all three methods out of which frequency distributions, cross tabulations, correlation and regression analysis were done and the findings reported below.

In order to identify those children who are malnourished, a cut-off point of -2 sd and -1 sd for moderately and mildly malnourished, respectively was applied. The Z score has been preferred in this study because it classifies accurately the number and proportion of subjects within a specified range for each age and sex category and not only the tail end of the distribution.

4.1 Demographic profile of the study population:

This study covered a total of 720 children out of which 50% (360) were girls. The children were aged between ten and seventeen years. The largest proportion were 12 years of age (28%) and the least were 17 years old (0.7%). Most of the children were from class five 56% (402) while the remaining 44% (318) were from class six

This study also showed that fifty eight percent (58%) of the children were from families of five to eight children, followed by the children from a family of one to four children (30%) while the remaining 12% were from families of 9 - 13 children. These are children born to one woman.

Table 5 Demographic Characteristics of the Study Population as Percentage

Class	Age	10	11	12	13	14	15	16+	Total
5	Male n=213	7	10	16	8.6	8.4	5.8	3.1	59.3
	Female n=186	8.3	9.4	15.5	7.2	6.6	3.3	1.4	41.7
6	Male n=147	1.7	2.2	9.5	7.2	9.5	6.1	4.5	40.7
	Female n=174	0.8	4.7	14.6	9.1	10.5	7.2	1.4	48.3
Total	720	8.9	13.3	27.9	16.1	17.5	11.2	5.1	100%

4.2 Health status:

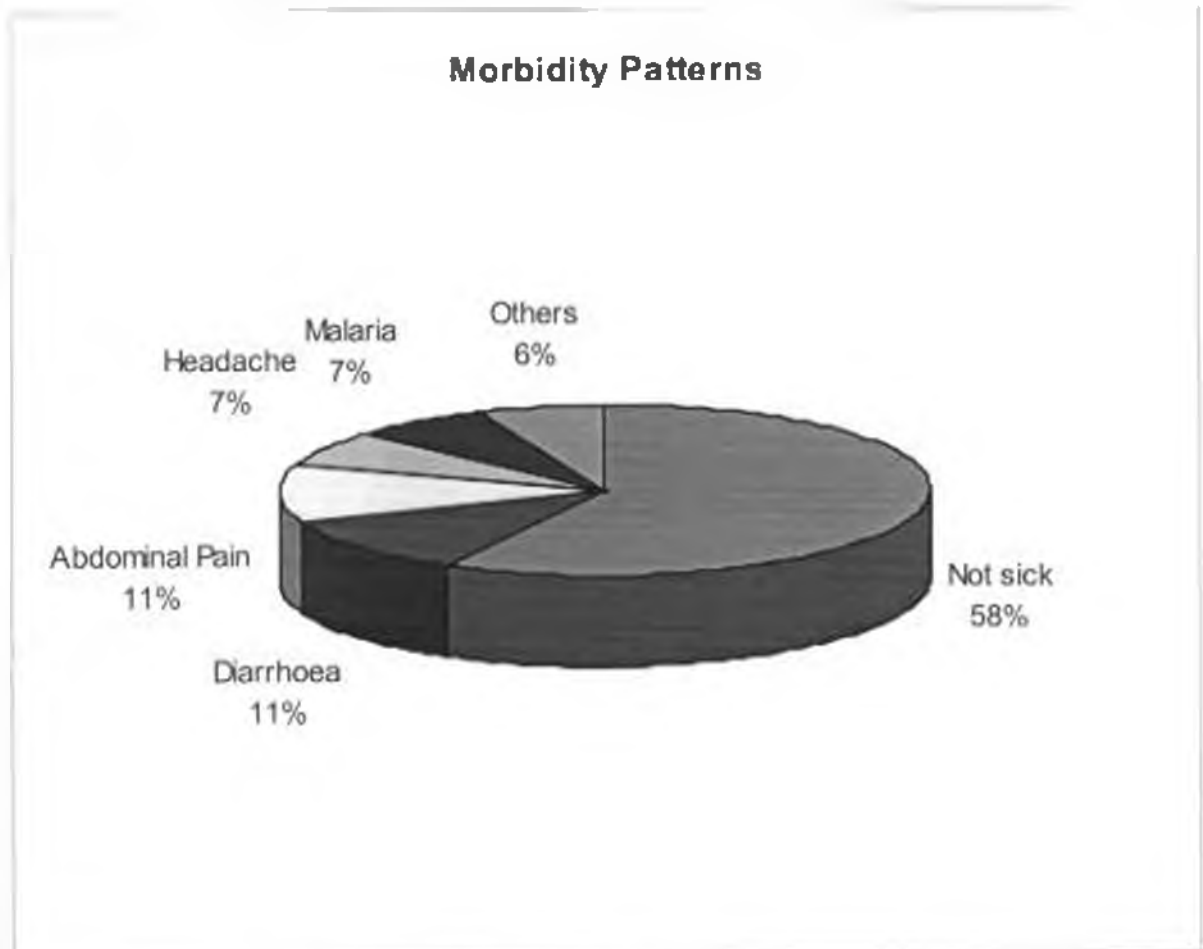
This study sought to establish current morbidity in the population by asking the pupils if they had been suffering from any kind of illness two weeks to the date of interview. The results indicate that 41% of the respondents had been sick during the two weeks prior to the day of interview with the majority suffering from abdominal pains (11%) or diarrhoea (11%). The other health problems reported although to a lesser extent were malaria and headache 6.7% and 6.8% respectively. Malaria in this case is as reported by the respondents and not laboratory tested and confirmed. Figure 3 gives the morbidity patterns of the study population.

4.2.1 Treatment Options Sought during illness:

The study also sought to know the kinds of treatment sought during times of illness. According to the findings, it is clear that the community uses a combination of options. They sought treatment from government facilities, private practitioners, and traditional herbalists and even purchased self-prescribed drugs from the local shops. There was a high dependence on across the counter purchase of self-prescribed drugs from the shops as reported by 74% of the respondents besides

utilizing other options. It was also noted with concern that at times families resorted to prayer if they were unable to meet medical expenses (2%).

Figure 3: Morbidity patterns in the Study Population:

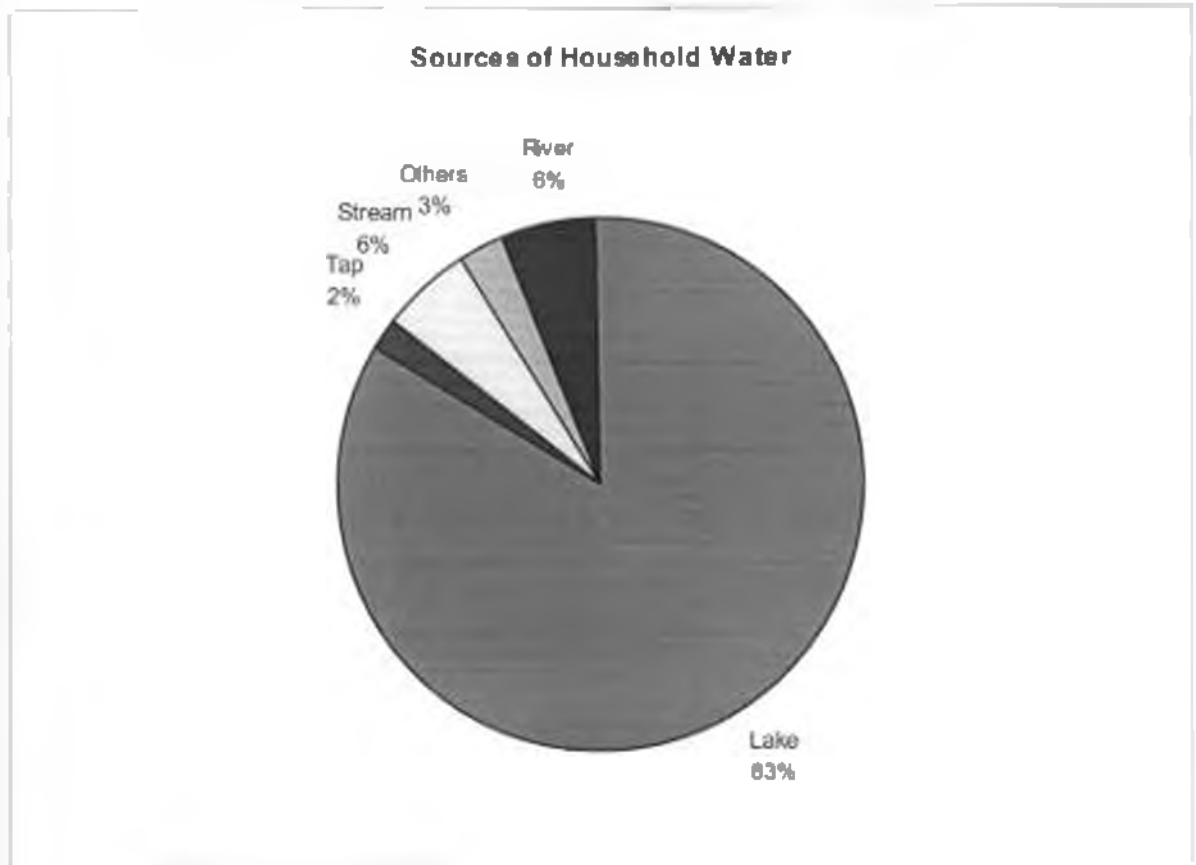


The study further indicated that majority of the children do not seek medical treatment when unwell. Two hundred and ninety six (296) children reported that they had been ill and 52% of them did not seek any medical attention. However, 28% got treated at home (purchased drugs from the shops or used traditional herbs), 11% went to the dispensary or health centre, and 5% went either to a private medical practitioner, or the district hospital.

4.2.2 Sources of Household Water

The source of household water can sometimes have a bearing on the nutritional status of a population. If the population draws drinking water from unprotected areas, they are susceptible to waterborne diseases.

Figure 4: Sources of Household Water:



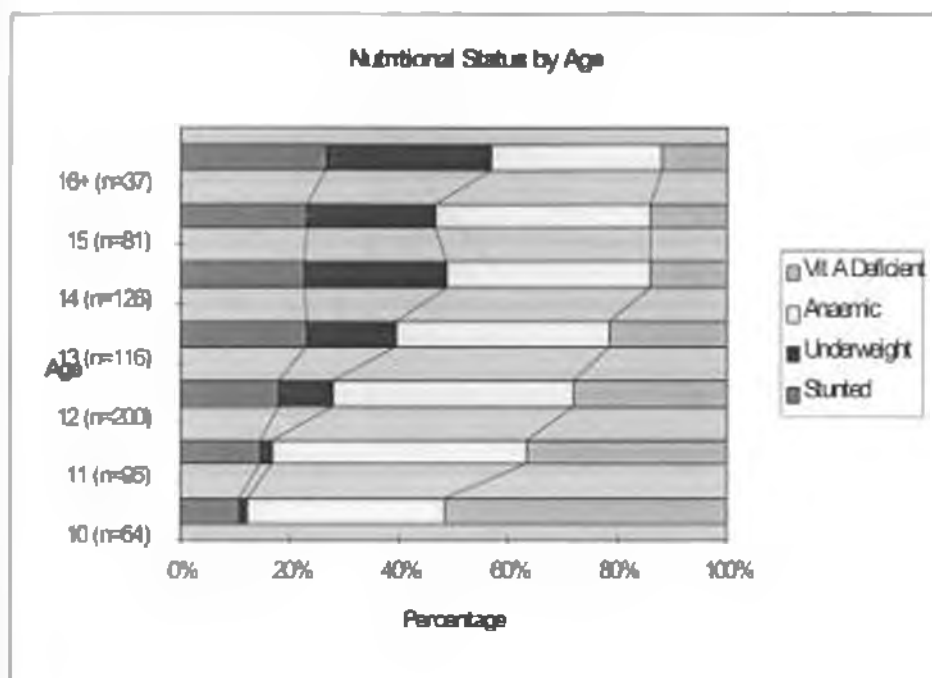
For this reason the study sought to establish the major sources of household water and whether they have any influence on the nutritional status of these pupils. The results in Figure 4 above show that the main sources of household water for the study population was the Lake (84%) with only 2% of the population using tap water

4.3 Nutritional status:

The children underwent anthropometric measurements of growth (weight and height) from which two basic indices; height for age and weight for age have been derived. Simultaneously, body fat was assessed using triceps skinfolds thickness and fat free mass using mid-upper-arm circumference from which arm muscle area for age, and arm fat area for age were computed. Following these computations, a Z score of -2 sd or less was used to classify the children with moderate malnutrition and a Z score of between -2 and -1 sd to represent those with mild malnutrition. The rest of the children were classified as normal according to these indicators. The results of these measurements are presented in figure 5 below.

The figure indicates that 20% of the children were moderately stunted, 16% were moderately underweight, 41% were anaemic and 24% were Vitamin A deficient. It also indicates that stunting and underweight was highest among children fourteen years of age and lowest among those below twelve years. The pattern is such that the levels of stunting and underweight increases with age and peaks at age fourteen and then starts dropping again. The figure also shows that vitamin A deficiency decreased with the age of the child.

Figure 5: Overall Nutritional status by Age

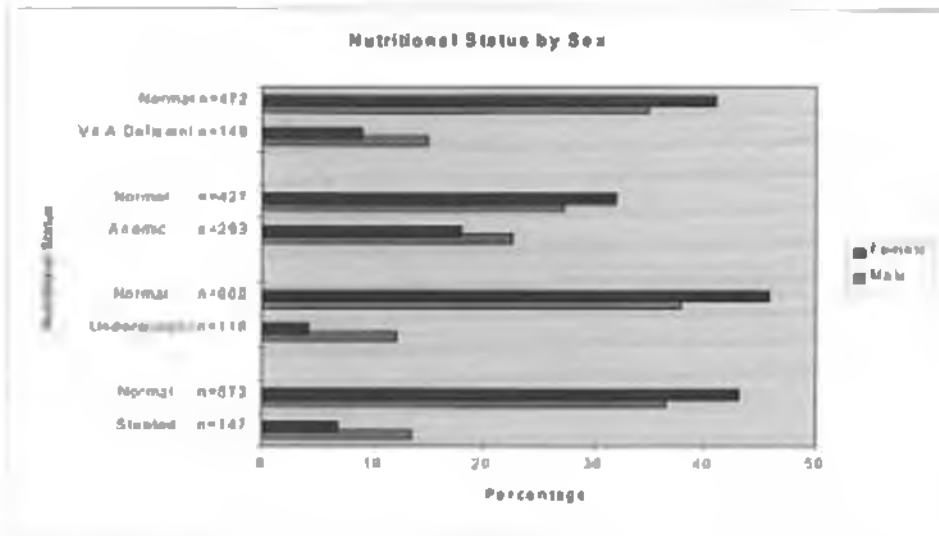


On the other hand, the pupils twelve years old contributed the highest proportion of anaemic children (11%) followed by the children age fourteen (8%). This was true of Vitamin A deficiency whereby the highest percentage was among the children twelve years old (7%)

4.3.1 Nutritional Status by Sex:

The study shows that the females were by far better placed than males using all indices. It shows that twice as many boys were stunted compared to the girls because of the 20% children stunted, 13% were boys and 7% were girls (Figure 6). At the same time, of the 16% underweight children, 12% were boys and only 4% were girls which gives a 3:1 ratio.

Figure 6: Nutritional Status by Sex



The study also shows that the levels of anaemia were lower among girls compared with the levels among boys. Out of 41% anaemic pupils, 23% were males and 18% were females. This was not different when looking at Vitamin A deficiency because 15% males were deficient compared to 9% females.

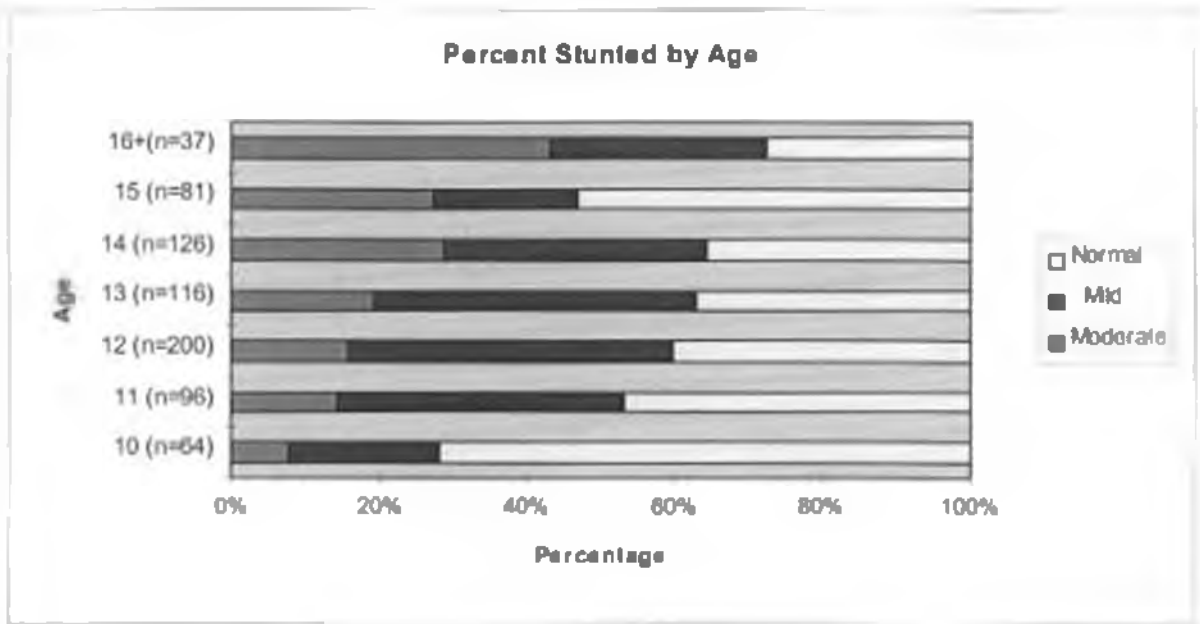
4.3.2. Stunting

The analysis of height for age index categorized the children by Z score in order to classify them by degree of stunting. The results indicate that 20% of the children were moderately stunted falling at -2 sd from the mean (table 10). Stunting was higher among boys than girls. Even when assessing children who were mildly stunted, the prevalence was still higher among the boys (20%) than girls (17%). When considering the two classes, 22% of the children in class six were moderately stunted compared to 19% of the class five children.

4.3.2.1 Stunting by Age

Figure 7 below shows that the level of stunting among the study subjects increases with the age of the child, slightly reducing at the age of fifteen years and then increasing again.

Figure 7: Percent stunted by Age:



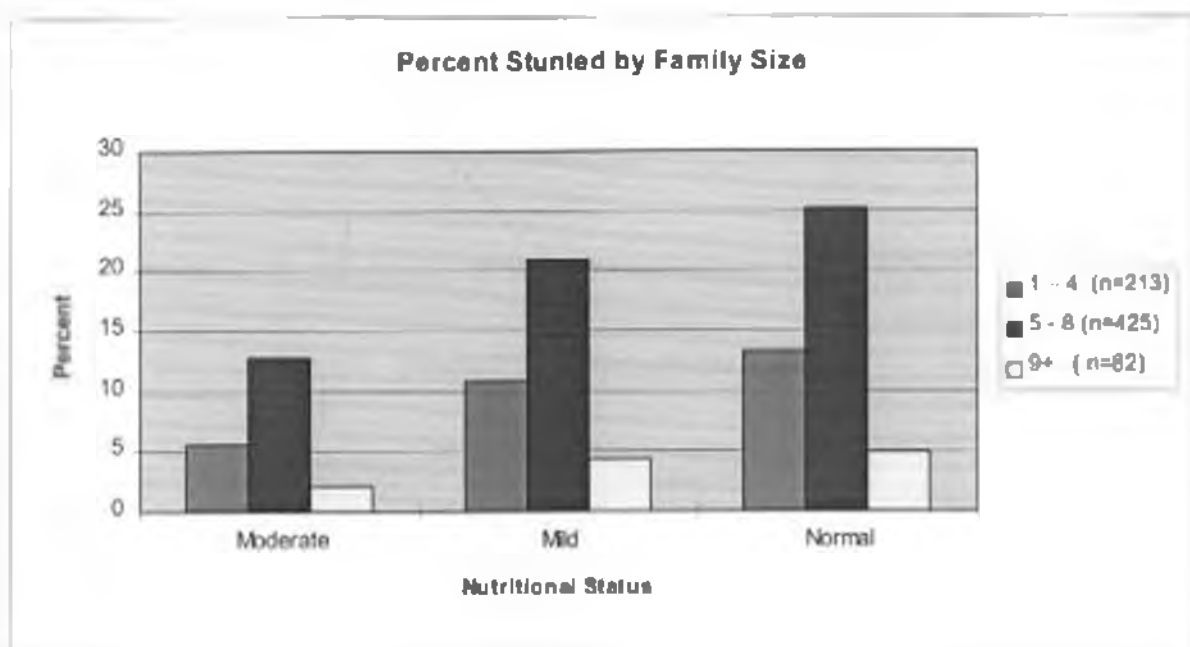
4.3.2.2 Stunting and Morbidity:

The level of stunting was looked at against whether the child had suffered from any illness two weeks prior to the survey. The results indicate that fewer stunted children had been ill (22%) compared to those who were not ill (34%). When the kind of illness was considered, it was noted that 28% of the children who had suffered headache were moderately stunted compared to the children who had diarrhoea or abdominal pain with 25% each.

4.3.2.3 Stunting by Family Size:

This study showed that of the 20% moderately stunted children, 13% came from families of five to eight children, 6% came from families with one to four children, while the remaining 2% were from families with more than eight children (Figure 8). The same trend was seen among mildly stunted children whereby out of the 36% affected, more than half (21%) came from families of five to eight children, 11% were from families with four or less children and only 4% were from the families with more than eight children

Figure 8: Percentage children stunted by family size



4.3.3 Underweight:

The findings indicate that, 16% of the children were underweight for their age with prevalence of moderate underweight increasing with the age of the child and accounting for the higher levels among class six pupils(19%) than class five pupils (14%).

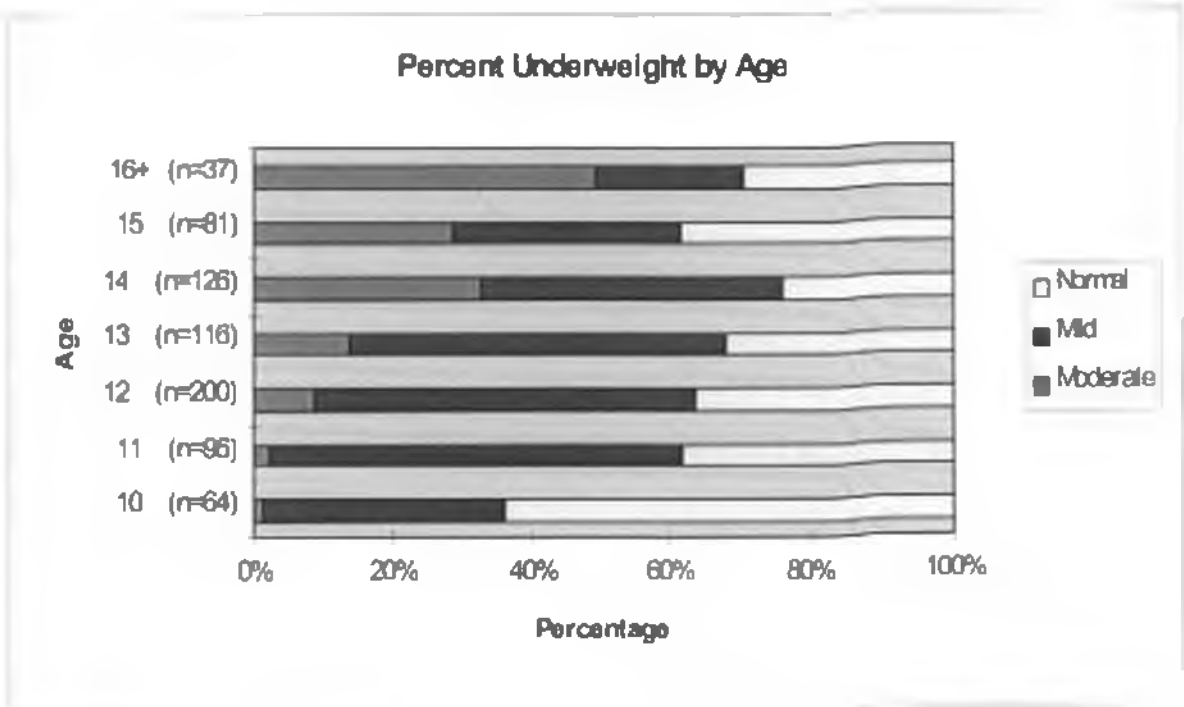
4.3.3.1. Underweight by sex:

As seen in figure, prevalence of underweight was higher among boys than girls whereby 12% of those children who were moderately underweight were boys constituting 24% of the total boy population as opposed to 4% girls constituting only 8% of the girl population. At the same time, out of the total 48% mildly underweight children, 25% were males and 23% were females.

4.3.3.2: Underweight by age

As can be seen in Figure 9, the degree of underweight increases with age. Moderate underweight peaks at age fourteen years and then starts to drop at age fifteen although still higher than the levels seen for pupils below age fourteen.

Figure 9: Percentage children underweight by age



4.3.3.3: Underweight by source of water:

There was no specific relationship between the source of water and underweight among the study pupils (Table 6). Those who indicated that they drew their water from the lake had a prevalence underweight of 16%, while those who took their water from the river, stream or tap had a prevalence of, 20%, 26% and 13% respectively. There was no moderate underweight among the rest of the children who took their water from the bore hole, pond or used rain water.

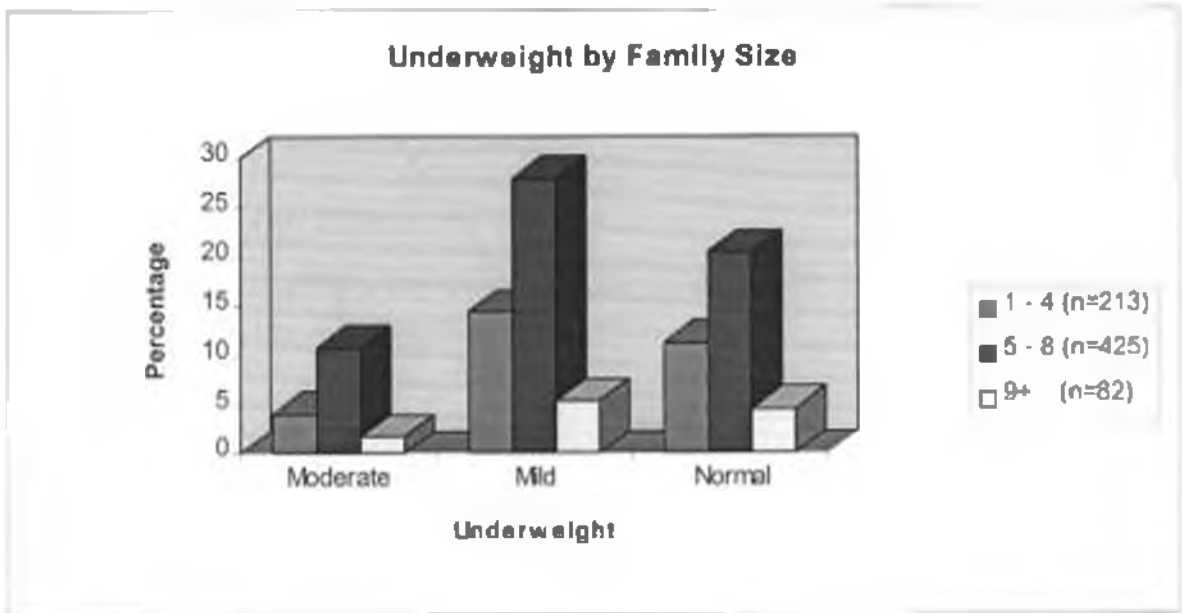
Table 6: Percentage children underweight by source of water:

Water source	Moderate	Mild	Normal	Total
Lake (n=603)	13.3	38.3	32.0	83.6
River/Stream (n=83)	2.6	8.2	3.9	12.7
Other (n=34)	0.5	3.1	0.2	3.7
Total N=720	16.4	47.6	36.1	100.0

4.3.3.4 Underweight by Family Size:

Moderate underweight was recorded as highest among children from families with five to eight children (11%), followed by families with one to four children(4%). The lowest levels of moderate underweight were recorded among families with nine or more children (Fig. 10).

Figure 10: Percentage children underweight by family size:



4.3.4 Upper Muscle Area for Age:

The results indicate that there was higher prevalence of moderate muscle wasting among males (15%) than females (1%). The study also shows that muscle wasting increases with age. There was no moderate muscle wasting among children age ten years and it was only 1% and 2% for ages eleven and twelve respectively, 4% for thirteen years old but 15% for those fourteen years old, 23% for fifteen years old and 34% for sixteen plus. The results further indicate that 68% of the children with moderate muscle wasting were moderately stunted, 83% were moderately underweight, and 69% were anaemic.

4.3.5 Upper Fat Area for Age:

The study shows that there was no moderate fat wasting among children of all ages and therefore, the results were looked at from the point of view of mild fat wasting. Fat wasting affected more females than males with 52% females having mild fat wasting as opposed to 15% among the males. The results also indicate that the pupils suffered multiple problems as 17% of the children with mild fat wasting were moderately stunted, 14% were moderately underweight, and 35% were anaemic.

4.4 Biochemical Analysis:

In this study, The WHO, 1972 standards for age were applied to determine the children who were anemic, and a cut-off point of 20 g/dL was used for vitamin A deficiency.

4.4.1 Hemoglobin Status:

From the findings, 41% of the children were anaemic with prevalence higher among males (46%) than females (35%).

4.4.1.1 Anaemia by Nutritional Status:

This study showed evidence that malnourished children are faced with multiple problems. Of the 20% stunted children, 12% were anaemic while of the 16% underweight, 9% were anaemic meaning that most of the children with poor nutrition are also anaemic. It was also clear that prevalence of anaemia increased with the age of the pupil with a significant rise at age eleven, a drop at age twelve and thirteen, and a gradual rise from age fourteen. In general, prevalence of anemia was higher among males (23%) than females (18%).

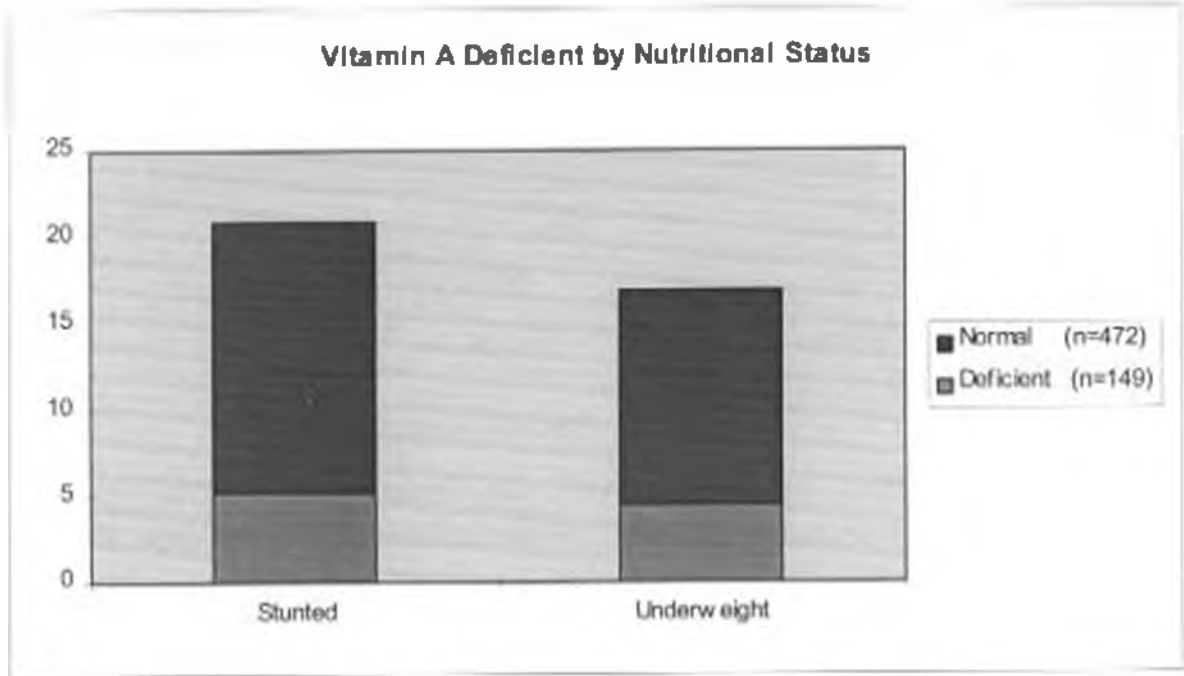
4.4.2 Vitamin A:

Vitamin A analysis was done on a total of 621 children. Twenty four percent of the children were deficient with $<20 \mu\text{g/dL}$ of blood of vitamin A. The prevalence was higher among males (15%) than females(9%) and it was noted that prevalence decreased with age after age twelve. When looked at against other deficiency states, the results indicate that, prevalence was marginally higher among anaemic children (25%) than the children with normal haemoglobin levels (23%). It was the same among moderately and mildly stunted children (26% each) but lower for the children with normal height for age (21%). The prevalence was even higher among the moderately and mildly underweight children (29%) and (25%) respectively.

4.4.2.1 Vitamin A Status by Nutritional Status:

The study shows that of the 21% stunted children, 5% were Vitamin A deficient while of the 17% underweight children, 5% were deficient (Figure 11).

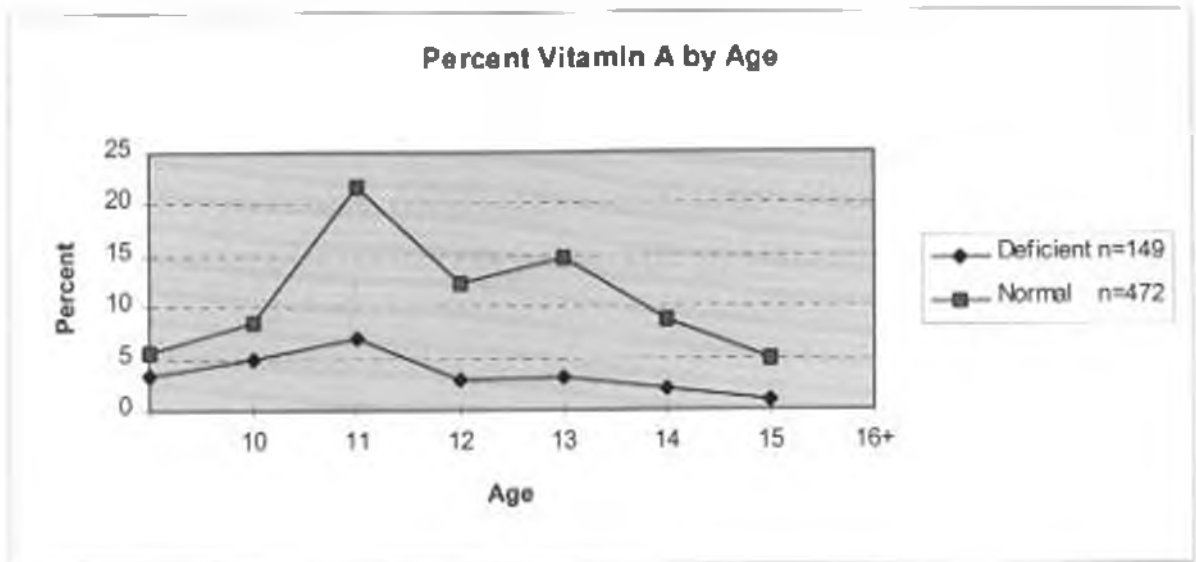
Figure 11: Percent Vitamin A Deficient by Nutritional Status



4.4.2.2 Vitamin A status by Age

The highest percentage of Vitamin A deficient children were 12 years old(6.9) and the lowest were 16 years(1%). This seems to imply that the older the children got, the less likely it was for them to suffer from Vitamin A deficiency. In fact, children age 11-14 were most at risk from Vitamin A deficiency (Fig. 12).

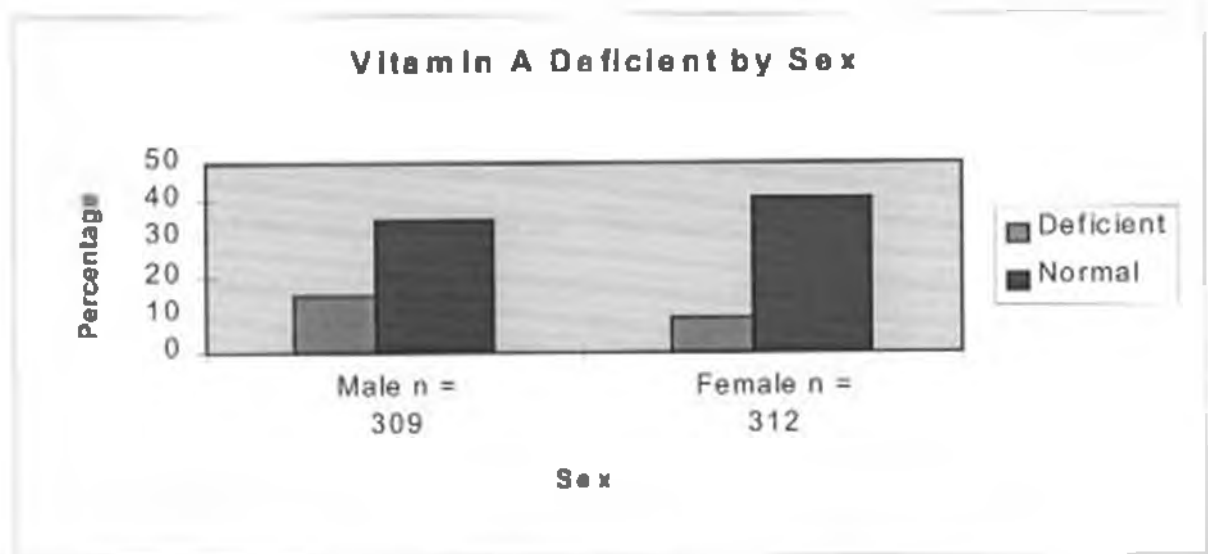
Figure 12: Percentage Vitamin A Deficient by Age:



4.4.2.3: Vitamin A status by sex

Figure 13 shows that out of the 24% Vitamin A deficient children, 15% were males and 9% were females reinforcing the finding that the male children were at a higher risk from malnutrition than the female children.

Figure 13: Percentage children Vitamin A Deficient by Sex



4.5 Physical Examination:

A physical examination was carried out on the children in order to identify known signs of malnutrition. The analysis indicates that the children showed no signs of Vitamin A deficiency or goiter. However, 12% (87) of the children showed signs of anaemia. Simultaneously, 8% (60) of the children had enlarged liver, and 10% (72) had enlarged spleen, which may be a sign of endemic malaria and helminth infections.

4.6 Correlation and Regression Analysis

This section gives the significance of the findings of the study as presented in the tables of prevalence. The significance has been looked at by gender.

Table 7: Correlation and Regression Analysis:

Independent Variable		HAZ	Nutritional WAZ	Status HB	VIT A
Age	Male	.6604	.6645	.1766	.0993
	Female	.6809	.6878	.1083	.2185
Family Size	Male	.0561	.0169	.0932	.0556
	Female	.1375	.1338	.0680	.1523

From the correlation analysis table above, it is evident that there exists a strong positive linear correlation between age and all nutritional indices under discussion for both males and females. The same applies to the correlation analysis between family size and the nutritional indices. This means that as the age or family size increases stunting, underweight, anaemia and Vitamin A deficiency increases. The only exception seen is the correlation between anaemia and family size for the females with a negative correlation implying that the incidence of anaemia decreases as the family size increases.

4.7 Intervariable Correlation.

This section deals with Intervariable correlation in order to assess the factors responsible for the nutritional outcome in this study.

Table 8: Intervariable Correlation

Correlation	HAZ	WAZ	HB	VIT A
HAZ	1.000	.8979	.1546	.2112
WAZ	.8979	1.000	.1418	.2191
HB	.1546	.13418	1.000	.1084
VIT A	.2112	.2191	.1084	1.000

The intervariable correlation analysis table shows that there exists a fairly strong and positive linear relationship between stunting and underweight (.898). Linear correlation between stunting and anemia is almost equivalent to the one between underweight and anemia i.e. .15 and .14 respectively. The linear relationship between stunting and vitamin A deficiency is also almost the same as that between underweight and vitamin A i.e. .21 and .22 respectively.

This finding may imply that nutritional problems among study children were closely linked and the most malnourished children suffered multiple problems. This can be explained from the fact that some nutritional problems precipitate other complications.

4.7.2 Sex Differentials in Nutritional Status.

The tables of prevalence indicate that the females were performing better than the males in all nutritional indices in this study. This prompted the need to carry out a Student T- test in order to determine whether this difference was significant or not. The results of the test are presented below.

4.7.2.1 Stunting.

Independent samples Sex

Group 1: SEX EQ 1 Group 2: SEX EQ 2

t-test for: HAZ ZSCORE: Average Height in cm

	Cases	Standard Mean	Standard Deviation	Standard Error
Group 1	360	-.1150	1.033	.055
Group 2	360	.1141	.954	.050

| Pooled Variance Estimate | Separate Variance Estimate |

F	2-Tail	t	Degrees of 2-Tail	t	Degrees of 2-Tail
Value	Prob.	Value	Freedom	Value	Freedom
1.17	.127	-3.09	719	-3.09	713.40
			.002		.002

The results of the T-test above give a low significant value (.002). This observation suggests that there is a difference in stunting rates between males and females.

4.7.2.2 Underweight

Independent samples Sex

Group 1: SEX EQ 1 Group 2: SEX EQ 2

t-test for: WAZ ZSCORE: Average Weight in KG

	Cases	Mean	Standard Deviation	Standard Error
Group 1	360	-.1326	.950	.050
Group 2	360	.1315	1.031	.054

| Pooled Variance Estimate | Separate Variance Estimate

F	2-Tail	t	Degrees of 2-Tail	t	Degrees of 2-Tail
---	--------	---	-------------------	---	-------------------

Value Prob. | Value Freedom Prob. | Value Freedom Prob.

1.18 .122 | -3.57 719 .000 | -3.58 715.16 .000

The T-test analysis above shows that there exists a difference between males and females regarding incidence of underweight judging from an insignificant value of less than .05.

4.7.2.3 Anaemia

Group 1: SEX EQ 1 Group 2: SEX EQ 2

t-test for: Hb

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	309	12.3644	1.470	.084
Group 2	312	12.4266	2.364	.134

| Pooled Variance Estimate | Separate Variance Estimate

F 2-Tail | t Degrees of 2-Tail | 1 Degrees of 2-Tail

Value Prob. | Value Freedom Prob. | Value Freedom Prob.

2.59 .000 | -.39 619 .694 | -.39 520.96 .694

The two tailed probability of the T-test above is equal to .694. This value is fairly high hence the hypothesis that there is no difference between males and females is accepted as regards the incidence of anemia.

4.7.2.4 Vitamin a Deficiency

Independent samples Sex

Group 1: SE EQ 1 Group 2: SE EQ 2

t-test for: Vitamin A

Chapter Five

DISCUSSION

5.1 Discussion

This study shows a picture of the nutritional status of primary school pupils in Usigu division of Siaya District. Some of the findings are very interesting and need further information. For example, It is noted that up to 30%(213) of the children came from a family of one to four children (Fig. 8). This does not reflect the normal community in Kenya and more especially in the rural areas where marriage is generally universal. We expect that majority of the population have more than four children. However, the study showed that one third of the population falls in this category. This may be seen among single mothers and since these were families within marital union, it is suspected that they had lost some of the children born rather than that they had planned their families. This assumption can be supported by the very high infant mortality rate recorded in Siaya district over the years as indicated by the National Rural Child Nutrition Surveys (GOK, 1983,1987; KDHS, 19893).

This study indicated that 41%(296) of the respondents had been sick during the two weeks prior to the day of interview and most of them were suffering from abdominal pains (11%) or diarrhea (11%). The results of the study also showed that 84%(603) of the children recorded the lake as the main source of household water (Fig. 4). The Lake as a source of water for household use is under the category of unprotected water sources, which contribute to high risks from water borne diseases and subsequent incidents of diarrhoea. This confirms other studies conducted in Siaya earlier on. For example, K'Oyugi (1983)in a study of mortality and morbidity situation in the district indicated that, diarrhoea is very prevalent due to poor environmental conditions. Other studies have also indicated that only 18%

of the households in Siaya District have a latrine within their compound implying that most of the people dispose of their human excreta in the open which is then washed into the unprotected water sources resulting in exposure to waterborne diseases. Although this was not the focus of this study, continued water contamination and the resulting waterborne diseases could well induce malnutrition.

Pointing towards the economic situation in the community and the possible impact of cost-sharing in health is the 2%(14) population of pupils who reported that at times during times of illness, the family resorts to prayer. This is an indication of a state of helplessness when the families are under financial stress and unable to meet their medical expenses rather than belief in spiritual healing. The responses on treatment options indicate that the people of Siaya rely on several options, but again prevalence of self-administered drugs is seen as a major health concern. This is detrimental mainly because there is a likelihood of people taking an under dose of drugs due to costs and further perpetuating the problems by creating resistance to various drugs. It may also mean that the community is treating symptoms of the disease and not the causes. This may lead to endemic health problems in the population or worse still lack of proper diagnosis for the problem leading to morbidity and mortality in the community especially among infants and children.

The study shows that the level of malnutrition among females was lower than that for males using all indices. Apart from the tables of prevalence, a student T - Test was done to find out whether the difference was significant. The results show that the difference was highly significant except for anemia and hence we can say that males children are at a higher risk of malnutrition at this age than the females.

In this respect, it may be possible that the boys spend much of their time at the lake fishing where they are exposed to intestinal helminthes which then interfere with their nutritional status. They may also spend less time at home where proper meals

are available. Further investigation is necessary in order to establish the contributing factors.

As seen in figure 7, the level of stunting increases with the age of the child. The regression analysis further showed that there was a positive linear regression between nutritional indices and age for the pupils. This may imply that as these children grow older, their nutritional demands increase to cover up for the accelerated growth. Therefore if they do not get sufficient food, then they are malnourished. If this turns out to be the case, then ways of improving their nutritional status will ensure optimum performance in school since poor nutrition affects levels of concentration as well as cognitive performance in individuals.

The issue of age on the other hand may be explained by the assumption that some of the pupils were too old for primary five or six. These may be the children from low socio-economic backgrounds who miss many school days perhaps due to non payment of school dues, poor health and lack of motivation resulting in overall poor performance and repeating of classes.

Family size has an effect on the quantity and quality of food available in the household. It affects the availability of other economic resources that play a major role in the health and well being of household members. Although the study showed family size as the least factor influencing nutritional status, there was a positive linear relationship between family size and the nutritional indices considered in this study. This can also imply that the big families have pressure from household food security.

The study shows that there was no moderate fat wasting among children of all ages. Since fat wasting mainly affects women, then this finding reinforces the fact that females in this study were doing relatively well.

Although it is assumed that the girls would have a higher prevalence due to loss of blood through menses, this was not the case in this study. This may be interpreted as a consequence of high requirements by the boys to compensate for increased volume of the red blood cells required for the muscle building as they approach adolescence. On the other hand, the small proportion of girls who had reached menarche in this study may be another plausible explanation for the difference.

From this study, it is evident that malnourished children are faced with multiple problems. Of the 20% (147) stunted children, 12% are anaemic while of the 16% (118) underweight children, 9% are anaemic. Furthermore, the study indicated that stunting was one of the main factors, which influence anemia outcome. It is possible that these children had other underlying problems like malaria or intestinal worm infestation that make them more vulnerable to undernutrition

The regression analysis showed a positive linear regression between nutritional indices and age in this study. At the same time when considering the proportion of the children anemic by age, it is clear that it is lowest among the children age ten years and highest among those age sixteen. This therefore implies that the pupils' demand for iron is not met as they get to puberty and subsequent sexual maturation. Table 3 shows the daily increments in body content due to growth among adolescents especially at the peak of growth spurts.

Although section 4.4.1.1 indicates that prevalence of anaemia was higher among males compared to the females, a student T-test showed that there was no significant difference between the two groups. Maybe there is no difference in iron needs between the males and females because while the males are covering for demands for muscle buildup, the girls are compensating for losses during menses.

The prevalence of Vitamin A deficiency was higher among males than females both from the table of prevalence and the student T-test (Fig. 13). The prevalence was

looked at against other deficiency states and the results indicate that, prevalence was higher among anemic pupils. Since vitamin A is linked to the body immunity, it may be that the deficient children suffer from frequent illnesses, which then affect food intake and utilization, leading to malnutrition.

Siaya district is a malaria endemic area bordering Lake Victoria. The presence of enlarged liver during physical examination could be an indicator of prevalence of parasite infestation. This can be supported by findings of the parasitology component of the larger KEDAHR project, whereby majority of the children were suffering from parasitic infections including schistosoma mansoni (72%), hookworm (54%), trichurias, and, ascariasis. It is therefore possible that some of the nutritional problems identified among these children can be traced back to parasite infestation in the community.

Chapter Six

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion:

This study shows that the school children in Usigu Division of Siaya District face problems of malnutrition. Seven hundred and twenty (720) primary school children were sampled from 19 out of 38 schools and the results were as follows:

- 20% (137) of them were stunted;
- 16% (118) were underweight;
- 41% (293) were anaemic,
- 24% (149) had a deficiency of vitamin A.

These results were compared with the nutritional status of under five children in the district and it was noted that the level of stunting is higher among under five children (34%). However, the level of underweight is the same for the two groups which is recorded at 16% (GOK, 1995).

The study further points to the fact that malnutrition among these children increases with the age of the child which is an indicator of the higher demands for good nutrition among adolescent children. The adolescent children are in most cases neglected and not considered as a group at risk from malnutrition. This is unfortunate because there is evidence from this study to show that adolescent children are at risk from malnutrition. In addition, the review of literature, demonstrated that there are high demands for essential nutrients in the body for the expected rapid growth at this stage of development (Table 3). It should be noted that during adolescence, even poorly nourished individuals will experience some

growth but this should not blind us from the fact that undernourished adolescents will not experience full potential growth. It is true also that they will suffer from frequent illness and lack energy to meaningfully compete with their peers in all aspects of personal development including education.

Although it is commonly argued that the girl child is disadvantaged at the family level, the findings of this study have shown that the nutritional status of the girls was superior to that of the boys. It is assumed that this is a bonus the girls earn for spending more time in the kitchen preparing the family meals.

Apart from looking at nutritional performance per se, it is clear that some variables played a key role in determining the nutritional status of individuals. These included source of drinking water, age of the child, sex of the child and possibility of another nutrient deficiency. In view of these findings, it is clear that there is need for more studies on the nutritional status of school children to complement the few available studies. This will assist in designing appropriate programmes involving the school children aimed at alleviation of malnutrition among them. It is not possible for children to significantly improve their nutritional status simply because they have passed the pre-school age. Investing in a national survey on the nutritional status of school children will definitely be worthwhile. It is anticipated that this exercise will take a shorter time and less funds because of the convenient location of the study subjects as compared to under five children.

6.2 Recommendations:

- I The Ministry of Education should invest in a national survey on the nutritional status of school children to ensure a strong and healthy human resource base for the country.
- II Water and sanitation are a major factor in determining the nutritional status of

a population. It is clear that safe drinking water is inadequate in the area and efforts must be made by The Ministry of Health to provide to provide safe drinking water in the community.

III The is need for The Ministry of Health to give health education to the community members on the importance of the following aspects:

- boiling drinking water from unprotected sources.
- use proper methods of excreta disposal.
- Seek proper medical attention in times of illness.

6.3 Areas for further research:

- I Cultural attitudes and therefore constraints towards the use of proper sanitary facilities, clean water, and medical facilities.
- II Factors contributing to higher levels of malnutrition among boys than girls at the age of 10 to 17 years.

REFERENCES

ACC/SCN (1986). Report on the Twelfth Session of the ACC Sub -Committee on Nutrition and its Advisory Group on Nutrition. ACC/1986/P/10. Tokyo, 7-11 April, 1986. ACC/SCCN, C/o FAO, Rome.

Ahmed F; Mohiduzzaman M, Barua S; Shaheen N, Margetts BM; Jackson AA; Effect of family size and income on the biochemical indices of urban school children of Bangladesh European Journal of Clinical Nutrition. 1992. Jul; 46(7): 465

Alwar AJ, The effect of protein energy malnutrition on morbidity and mortality due to measles at Kenyatta National Hospital, Nairobi (Kenya). East African Medical Journal - 1992 Aug; 69(8):415-8

Ashworth A; (1969). Growth Rates in Children Recovering from Protein - Calorie Malnutrition. British Journal of Nutrition 23: 835-845.

Beaton GH, Calloway DH, Murphy SP, Estimated Protein Intakes of Toddlers: Predicted Prevalence of inadequate intakes in village populations in Egypt, Kenya and Mexico. Am. J Clin Nutr 1992; 55:902 - 911.

Briscoe J. The Quantitative effect of Infection on the use of food in poor countries. Am.J Clin Nutr 1979; 32:648 - 73.

De Ruyter, M.G.M. and De Leenheer, A.P. (1976) Determination of Serum Retinol (Vitamin A) by High Speed Liquid Chromatography. Clin. Chem. 22:1993.

EU, Wasantwisut , P, Sungpuag, V, Chavasit, U, Chittchang, S Jittinandana, T Viriyapanich, Identification of Seasonal Vitamin A Rich Foods and Recommended Methods of Preparation and Preservation in Northeast Thailand. Institute of Nutrition, Mahidol University, Thailand. IVACG, 1994.

FAO (1992), *The Fifth World Food Survey*. Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO/WHO (1987) requirements of vitamin A, iron, folate and vitamin B12. Food and Agriculture Organization of the United Nations Rome, Italy

Gyorkos TW; Camara B; Kokoskin E; Carabin H; Prouty RSO; Survey of parasitic prevalence in school aged children in Guinea. *Sante* 1998 Nov-Dec: 6(6) 377-81

Government of Kenya; Economic Survey, 1995.

Government of Kenya: Third Rural Child Nutrition Survey, 1983. Nairobi, Kenya.

Government of Kenya: Fourth Rural Child Nutrition Survey of 1987, 1991.

KDHS: Kenya Demographic and Health Survey 1993. Calverton, Maryland: NCPD, CBS and MI.

Hall A; Nutritional aspects of parasitic infection. *Prog. Food Nutr Sci* 1985;9:227-56. (REVIEW)

Islam MA, Rahman MM; Mahalanabis D; Rahman AK; Death in a diarrhoeal cohort of infants and young children soon after discharge from hospital: risk factors and causes by verbal autopsy. *SO. J-Trop-Pediatr.* 1996 Dec; 42(6): 342-7.

IVACG (1981). The symptoms and signs of vitamin A deficiency and their relationship to Applied Nutrition. Report of the International Vitamin A consultative Group, July 1981.

Jagadeesa, V and Reddy, V; serum complement levels in malnourished children. *Ind. Res* 1979 70 745, 749, WHO Monograph No. 53 World Health Organization - Geneva.

Kaplan A. Lawrence, Judith A. Miller, Evan A. Stein, and Meir J. Stampfer. Simultaneous, High Performance Liquid Chromatographic Analysis (HPLC) of retinol, tocopherol, lycopene, and alpha and Beta - carotene in serum and plasma. *Methods in Enzymology*, Vol.189. Copyright 1990 by Academic Press Inc.

Kogi-Makau W. Indicators of nutritional Status of households of a Kenyan Semi-arid population. *East African Medical Journal*. 1992 oct; 69(10):560-2.

Lampf M; Johnstone FE; Malcom LA (1978). The Effect of Protein Supplementation on the Growth and Skeletal Maturation of New Guinean School Children *Annals of Human Biology* 5:219-227.

Latham MC; Stephenson LS; Kinoti SN; Zaman MS; Kurz KM Improvements in growth following iron supplementation in young Kenyan school children. *Nutrition* 1990 Mar-Apr; 6(2):159-65.

Martorell R, Yarbrough C, Klein RE. The Impact of Ordinary Illness on the Dietary Intake of Malnourished Children. *Am J Clin Nutr* 1980; 33:345 - 50.

McGanity WJ. 1974; *The Clinical Assessment of Nutritional Status*. Miles Symposium 11. Miles Laboratories Ltd. Rexdale, Ontario. Pp.47-64.

Mejia LA and Arroyave G. Determination of Vitamin A in blood. Some practical considerations on the time of collection of the specimens and the stability of the vitamin. *Am J Clin Nutr* 1983; 37:147 - 151.

Merchant KM; Kurz KM Women's nutrition through the life cycle: social and biological vulnerabilities. In *the health of women: a global perspective* , edited by Marge Koblinsky, Judith Timyan and Jill Gay Boulder Colorado Westview Press, 1993. :63-90.

Mohanran M, Reddy V, Mishra S. Lysozyme activity in plasma and leucocytes in malnourished children. *Br J Nutr* 1974;32:313-16

Mwadime R.K.N; Omwega A.M; Kielmann N; Korte R. Predictors of Nutritional Status among Participants in a Rice Irrigation Scheme in Kenya. *Ecology of Food and Nutrition*. Vol 35 pp-263-274(1995).

Pelto GH; Urgello J; Allen LH; Chavez A; Martinez H; Meneses L; Capacchione C; Backstrand J; Household size, food intake and anthropometric status of school-age children in a highland Mexican area. *Social Science and Medicine*. 1991;33(10):1135.

Pinnock C. Vitamin A. *Nursing Journal of India*. 1991 Nov; 82(11):307-8.

Rahmathullah L; Underwood BA; Thulasiraj RD; Milton RC ; Ramaswamy K; Rahmathullah R; Babu G; Reduced mortality among children in southern India receiving a small weekly dose of Vitamin A. *New England Journal of Medicine*. 1990 Oct 4;323(14):929-35.

Rea JN(1971). Social and Economic Influences on the Growth of the Pre-School Children in Lagos. *Human Biology* 43:46 -63.

Rojanapo W, Lamb AJ, Olson JA. The prevalence, metabolism and migration of goblet cells in rat intestine following the induction of rapid, synchronous Vitamin A deficiency.

S. de Pee, C.E. West, Muhilal, D. Karyadi, J.G.A.J Hautvast. Effectiveness of vegetables in improving Vitamin A Status of Lactating Women in west Java, Indonesia, Department of Human Nutrition, Wageningen Agricultural University,

The Netherlands and Nutrition Research and Development Centre, Bogor, Indonesia. IVACG meeting in Thailand, October 1994.

Sanghvi TG. Vital nutrients: supporting life, health, and productivity through iron, iodine, and vitamin A nutrition. Arlington, Virginia, International Science and Technology Institute, Vitamin A Field Support Project [VITAL], [1992] 36 P USAID Contract No. DAN-5116-C-00-9114-00.

Schlesinger L, Arevalo M, Arredondo S, Diaz M, Lonnerdai B, Stekel A. Effect of a Zinc fortified formula on immunocompetence and growth of Malnourished Infants. *Am J Clin Nutr* 1992; 56:491 - 498

Scrimshaw NS; Taylor CI; Gordon JE. Interactions of Nutrition and Infection. World Health Organization: Geneva 1968.

Solomons N. Assessment of the Nutritional Status. Functional Indicators of Pediatric Nutriture. *Pediatrics Clinics of North America*(1985) 32:319-334.

Sommer, A. (1982). Nutritional Blindness Xerophthalmia and Keratomalacia. Oxford University Press, New York.

Sommer, A. E. Djunaedi, A.A. Loeden, I. Farwotjo, K.P. Wedy, R. Tilden and L. Mele (1986) Impact of vitamin A supplementation on childhood mortality. *Lancet*], 1169 - 1173 May 1986.

Sommer A, Katz J, and Tarwotjo, F. Increased risk of respiratory disease and diarrhoea in children with pre existing mild vitamin A deficiency. *Am J. Clin Nutr* 1984 40, 1090 -1095.

Stephenson LS; Helminth parasites, a major factor in Malnutrition. *World Health Forum*. 1994 15(2):169-72.

Stephenson LS; Impact of Helminth Infections on Human Nutrition. Taylor and Francis: London, New York and Philadelphia 1987

Tanner JM; (1976) Growth as a Monitor of Nutritional Status. *Proceedings of the Nutrition Society*. 35:315-322

Tanner J M, Growth at Adolescence, 2nd edition, 1962. Oxford: Blackwell Scientific Publications.

Tomkins AM, Garlick PF, Schofield WN, Waterlow JC (1983). The combined Effect of Infection and Malnutrition on Protein Metabolism in Children. Clin Sci 1983; 65:313 - 24.

Tomkins AM and Watson F. "Malnutrition and Infection" United Nations October 1989.

UN 1987. Demographic Yearbook. 37th issue. Department of International Economic and Social Affairs, Statistical Office, United Children's Fund. New York.

UNICEF (1985). Within Human Reach. A future for Africa's Children. United nations Children's Fund. New York.

Van der Vynckts, Malnutrition: major handicap to children in School. Paris, France, UNESCO, 1986. 4 p. UNESCO Special.

World Bank, World Development Report 1991. New York: Oxford University Press.

World Bank World Development Report "Investing in health, World Development Indicators" 1993. Oxford University Press.

Ya-shan H, Lin X and Tong Y. Effect of Vitamin A status on immune function in the Youth of China, 1994 Report of the XVI International Vitamin A Consultative Group Meeting.

Yohanness AG, streatfield K; Bost L; Child morbidity patterns in Ethiopia. Journal of Biosocial Science: 1992 Apr; 24(2): 143-55.

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Annex 1

WHO Hb AGE AND SEX CUT-OFF POINTS

Age (yr.)	Hemoglobin (g/dL)	
	male	female
0.5 - 6 11		11
6 - 14	12	12
>14	13	12

Source: Nutritional Anaemia. WHO Technical Report Series No. 3. 1972 World Health Organization, Geneva.

Annex 2

QUESTIONNAIRE

Anthropometric Measurements

Name of School _____ Serial No. _____

School Code No. _____

Child's Name _____ Class _____ Sex _____

Date of Birth _____

Date of Examination _____

Weight in Kg _____ Height in Cm _____

1. _____ 1. _____

2. _____ 2. _____

U.M.A.C. IN CM

TST IN CM

1. _____ 1. _____

2. _____ 2. _____

Socio-Demographic information

- 1 Give me the names of all your brothers and sisters including yourself starting from the eldest (clarify that you are looking for own mothers children only)

i _____

ii _____

iii _____

iv _____

v _____

vi _____

vii _____

viii _____

ix _____

x _____

xi _____

xii _____

- 2 What is the source of drinking water in your home?

1 Lake 2 River 3 Pond 4 Borehole
5 Tap 6 Other (specify)

- 3 When a member of your family is sick, where do you seek treatment from? (multiple answers possible)

1 Dispensary/Health centre 2 Buy drugs from the shops
3 Herbalist 4 Other (Specify)

Current Morbidity

4 Have you been sick for the last 2 weeks?

Yes --- No---

5 If YES, what was the problem?.....

6 Were you treated? Yes--- No---

7 If YES, where were you treated?

Home--- Dispensary--- H/Centre--- D/H---
Private Clinic--- Traditional Healer---

8 Is there any member of your family who is currently sick? If yes Please specify

None--- Mother--- Father--- Sister/brother---
Other ---

Physical Examination

Mark Y/N as appropriate

9 General Outlook - Anemia--- Jaundice---
Dry Conjunctiva--- Bitots spots--- Oedema---
C N G Signs of Goitre---
P A Enlarged Liver--- R.M.C.L ---Cm M.S.L ---Cm
P A Enlarged Spleen--- L.M.A.L ---CM L.M.C.L---Cm
Skin - Dermatitis (Specify)-----
Other abnormalities (specify)-----

Annex 3

Informed Consent Form for Participation in Research:

I, Mr /Mrs./Miss----- being a person aged 18 years and over and being a parent/guardian have been made to understand that, growing children sometimes have different types of worms in their intestines which cause blood loss thereby causing iron deficiency anemia. The worms also compete for food the child eats and consequently retards the child's growth and school performance. The aim of the study as explained to me is to determine the best treatment regimen for children with worms in their intestines in order to demonstrate whether, and to what extent the treatment affects the following :

- Growth velocity, school participation and performance, physical fitness
- immunity as seen from frequency of infections

I have been made aware that my child -----(name and class of child) will undergo a complete physical examination to determine his/her eligibility into the study. If my child is included in the study, I have been informed that the following procedures will be undertaken:

- The child's blood will be checked once every beginning of term for three terms, but only a small amount. 10ml of blood will be needed, which will not harm the child at all and that a medical person will draw the blood.
- The child will provide stool and urine specimens once every term for three terms.

I have also been informed that the micronutrient tablet that will be given has properties that may stimulate multiplication of the parasites in children with chronic malana infection. In this respect, all participating children will be monitored closely for one week before they are given the tablets and malaria drugs will be made available to treat those who will have malaria episodes. The drugs that will be given will not harm my child if he/she does not have the worms and falls in the treatment group.

At the end of the study, all children, both in the test and control groups who will have participated will be treated and be free of worms. I have been informed that total confidentiality will be observed and that I will not make any monetary contributions towards these treatments.

I understand that I have the right to volunteer my child for this research and I may for this reason withdraw my child from the study at any time, without penalty or loss of benefits to my child.

All the above conditions have been explained to me in the Luo Language in which I am fluent.

Parent/guardians full name.....Signature

Date and Place

Independent Witness

Principal Investigator.....