VITAMIN A STATUS OF 6-10 YEAR OLD CHILDREN AND SOME ASSOCIATED FACTORS IN GACHOKA, MBEERE DISTRICT, KENYA

By

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Master of Science Degree in Applied Human Nutrition, in the Department of Food Technology and Nutrition at Nairobi University, Kenya

October, 2001

DECLARATION

Matu Sicily Wangui, hereby declare that this thesis is my original work and, to the best of my nowledge, has not been presented for a degree in any other University to the best of my knowledge.

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DEDICATION

This work is dedicated to my parents Mary Kariuko Matu and Cyprian Matu Mbiriai whose love, atience, sincerity and determination continue to be the guiding principles in my life, more so, for their enuine love for education.

ACKNOWLEDGEMENT

I am greatly indebted to my supervisors; Dr. Wambui Kogi-Makau and Professor Nelson Muroki, of Applied Nutrition Programme (ANP), University of Nairobi for their invaluable input to this work which was funded by UNICEF Kenya Country office, Nairobi and Task Force Sight and Life, Switzerland. This is gratefully acknowledged. Additionally, I am indeed grateful to the Applied Nutrition Programme for the opportunity to pursue the course and partial payment of my tuition fee.

The cooperation of parents, children, head teachers and teachers of the study schools was paramount in the success of this work. To you all, I am very grateful. The administrators in Mbeere District especially the education office, thank you for your support.

I thank my field staff namely, Nancy, Faith, Anne and Juster for their great job and endurance. Mrs Agnes Njagi and Sister Clara from Iriamurai Mission, I am grateful for their support, humour and encouragement throughout the study period.

The contribution of the ANP staff especially Dr. A.M. Omwega for his support and advice, Sophie Ngala, H. Gichia, J. Mugo and Naomi Kariuki cannot go unnoticed. Thank you all for your time, support and making my stay at the ANP worthwhile. Finally, I acknowledge my parents and sisters Anne, Soni, Ruth and Mercy for their support and encouragement during the entire study period. I am indeed grateful to my fiancée Sam Nyamai for his support and encouragement. Friends like Rachel, Peter, King'ori, Feleke, Lucy and Ateka, thank you for your contribution and encouragement.

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OPERATIONAL DEFINITIONS

Adequate Vitamin A Status This is when serum retinol levels are >20µg/dl and is considered to be a level in which all physiological functions of vitamin A are satisfactorily taking place because of adequate levels of vitamin A and reserves which provide protection from deficiency for given period of time.

Deficient Vitamin A Status Refers to that condition where a child has very low serum retinol values of <10 µg/dl.

Githeri A staple dish among the Mbeere community and constitutes a mixture of boiled Maize and beans or cowpeas, when fried, vegetables or potatoes may be added to the dish.

Household All the people who have lived together for at least three months and operate as a unit (by for example contributing to the household income, sharing facilities, eating from the same pot and live in the same homestead) including such members as unrelated workers and relatives who take meals together.

Household head Refers to the person (male/female) who is the major decision-maker on household income and expenditure patterns.

Household income Refers to household's monthly cash earnings equivalent from all sources including sales, salary and remittances.

Index child	A school going child, aged 6-10 years and has been sampled for the study.
Marginal Vitamin A Status	Refers to that state in which a child's serum retinol level is $\geq 10 \leq 20 \mu g/dl$.
Provitamin A carotenoids	Carotenoids such as alpha, gamma and beta-carotene that are capable of being converted to vitamin A in the animal body.
Retinol equivalents	The amount of a substance having biological activity equivalent to that of $1 \mu g$ retinol.
Retinoids	Compounds, either natural or synthetic with a vitamin A-like structure or activity.
Xerophthalmia	the general term applied to all the occular manifestations of impaired vitamin A metabolism, from night blindness through complete corneal destruction.
Vitamin A Deficiency	Includes Xerophthalmia but has much wider implication. It relates to any state in which vitamin A status is subnormal. It can be presumed to occur when the habitual intake of total vitamin A is markedly below the recommended dietary allowances (RDA).
Vitamin A Status	This is defined in terms of the total body reserves of vitamin A, which can vary from excessive (hypervitaminosis), through adequate and marginal, to poor or deficient (hypovitaminosis) states.

ABBREVIATIONS

ANP	- Applied Nutrition Programme.
BMI	- Body Mass Index.
CSW	- Community Social Worker.
DPHN	- District Public Health Nurse.
FGD	- Focus Group Discussion.
GoK	- Government of Kenya.
HPLC	- High Performance Liquid Chromatography.
IU	- International Units.
IVACG	- International Vitamin A Consultative Group.
KEMRI	- Kenya Medical Research Institute.
MDIS	- Micronutrient Deficiencies Information Systems.
MOH	- Medical Officer of Health.
PEM	- Protein Energy Malnutrition.
RBP	- Retinol Binding Protein.
RDA	- Recommended Dietary Allowance.
UNICEF	- United Nations Children's Fund.
μg	- Micrograms.
VAD	- Vitamin A Deficiency.
WHO	- World Health Organization.

ABSTRACT

The study was carried out to determine household characteristics and individual child factors associated with vitamin A status of primary school children aged 6-10 years in Gachoka Division, Mbeere District, Kenya. Six schools were randomly sampled for the study namely; Ngenge, Mutus, Gatumbiri, Igumori, Kamurugu and Mutuobare primary schools from which study children were sampled. A total of 330 children, 51.2% females and 48.8% males and their respective households were studied. Blood and stool samples collected from 120 children were examined for serum retinol levels and gastrointestinal parasites respectively. Dietary data, based on a twenty-four hour recall was collected for 140 children while clinical examination for vitamin A deficiency was done on 287 children.

Qualitative and quantitative methods of data collection were employed in the study. The main study tool was a structured questionnaire which was supplemented with focus group discussion, key informant interviews and secondary data. Serum retinol levels and prevalence of gastrointestinal parasites were determined with the aid of well-equipped laboratories and technicians.

Results of the study indicate that 37.5% of the children are vitamin A deficient with serum retinol values <10 μg/dl. Alarming rates of nightblindness (9.8%) and Bitot's spots (26.8%) were also observed. The prevalence of vitamin A deficiency was numerically higher among females (57.8%) than in males (42.2%) and tended to increase with age. Gastrointestinal parasites were prevalent among the children with 61.7% of the children having one or more of these. Children's nutrient intake expressed as a percentage of the recommended dietary allowances was relatively high for all nutrients considered

namely proteins; iron and calories except for vitamin A that stood at 55%.

Factors associated with the vitamin A status of school children in the study area were child's age and gastrointestinal parasites, specifically hookworm and *Endolimax nana*. This was true when vitamin A status was assessed by either clinical signs or serum retinol levels. Other factors namely, child's sex, socio-economic status, household income, maternal knowledge on vitamin A, maternal education, *Giardia lamblia*, *Entamoeba histolytica*, malaria, upper respiratory tract infections, abdominal pains, nutrients intake and consumption frequency of vitamin A rich foods did not have a significant association with children's vitamin A status.

In summary, vitamin A deficiency is a problem of public health significance among school children aged 6-10 years in Gachoka, Mbeere District. Additionally, results indicate hookworm, *Endolimax nana* and child's age as major factors that are associated with the vitamin A status of school children in the study area.

Based on the study findings, it is recommended that vitamin A status of school children in other areas of the country be determined. Vitamin A supplementation and establishment of a routine deworming programme of the school children in the study area, may go a long way in improving the vitamin A status of these children.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND INFORMATION

An interference of the normal balance in the processes that constitute nutrition is likely to cause an imbalance between dietary intake and the body requirement for nutrients and this may result into malnutrition. Malnutrition is an impairment of health resulting from a deficiency, excess or imbalance of nutrients. It includes undernutrition and overnutrition. There are five important forms of malnutrition in the developing world namely; protein-energy-malnutrition, iron deficiency anaemia, vitamin A deficiency, iodine deficiency and zinc deficiency (UNICEF & GoK, 1994).

Vitamin A deficiency was widely prevalent in the densely populated countries of Southern and Eastern Asia and also in parts of Africa, the Middle East, and Latin America (WHO, 1976). Updates from WHO, estimates that VAD, including clinical and subclinical forms of severe and moderate degrees of public health significance exists in 60 countries, and is likely to be a problem in at least an additional 13 countries (WHO, 1995). It affects about 100 million young children in the world (UNICEF, 1998).

Vitamin A deficiency affects 41% of Kenyan children (GoK & UNICEF, 1998). According to WHO, serum retinol level less than 10μg/dl in more than 5% of the population at risk is indicative of a VAD of a public health significance. According to a national micronutrient survey, serum retinol levels of less than 10 μg/dl stood at 7.7% indicating an important VAD problem in the country. Additionally, the prevalence of Bitot's spots and corneal xerosis stood at 1% and 0.1% respectively, which is a further indication of the importance of the problem with reference to the WHO cut offs for VAD prevalence of public health significance (UNICEF & GoK, 1994). Localized VAD studies have been carried out though none has been done in Mbeere District neither was it covered during the national micronutrient survey.

Depending on the degree of the deficiency, a range of abnormalities appear in the eyes of vitamin A deficient children. In its mildest form, night blindness occurs. In more severe forms, lesions occur on the conjunctiva and the cornea, which if untreated can cause irreversible damage, including partial or total blindness. Vitamin A deficiency also impairs the immune system, makes children vulnerable to diarrhoea and measles which kill 2.2 million and nearly 1 million children every year respectively (UNICEF, 1998).

1.2 STATEMENT OF THE PROBLEM

Several interventions and programmes have been designed to solve the problem of vitamin A deficiency. These include supplementation with high dose vitamin A capsules; fortification of foods; educational programmes; primary health care; nutrition rehabilitation programmes and horticulture related production activities (WHO, 1982). The Kenya government is committed to the eradication of VAD in her population as reflected in the country's' National Plan of Action for Nutrition (GoK, 1994). Various policy issues have been raised to help prevent VAD in the country. Most of these solutions have been adopted in Kenya. However, there is evidence that VAD prevalence still remains a problem in the country as indicated by results of a study carried out in 14 districts in 1994 among pre-school children aged 6-72 months (UNICEF/GOK, 1994).

The results indicate that severe VAD (20% and above) is prevalent in Mombasa, Kwale, Kitui, Kisii, Kisumu, Bungoma, Baringo, Garissa, Mandera and South Nyanza Districts; moderate VAD (10-19%) was prevalent in Nyeri, Nakuru, Meru and Kiambu Districts while mild VAD ($\geq 2 \leq 10\%$) was not reported in any district.

Previously, studies have been carried out to determine vitamin A status of children (of the rural communities) in Kenya. Unfortunately not much has been done on school children with the assumption that these children do not usually have the severe problems found in the early years of life. It is further argued that by this age, children will usually be eating from the family pot and that they will have passed the age at which they are susceptible to many fatal infections and parasites that precipitate VAD. Although information on the vitamin A 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. In addition, school children are at risk of micronutrient deficiencies because of the nutritional needs imposed by their rapid growth and maturation (Frederick, 1994). This study, therefore, focuses on this group of children and also attempts to document socio-demographic and personal characteristics that are significantly associated with vitamin A status of rural school children in Mbeere District.

1.3 JUSTIFICATION

Given the important role that vitamin A plays in the body it is pertinent that factors predisposing to VAD in children be alleviated. It is therefore, important that social characteristics that are closely associated with vitamin A status are determined. If high risk households can be identified through use of risk indicators that can be easily collected, community based programmes may be more easily targeted to their children.

1.4 EXPECTED BENEFITS

The information obtained is expected to be of use to the government and non-governmental organizations. The results will help provide guidelines in planning and targeting interventions aimed at solving and preventing VAD. Once this is achieved, it will save the country a good proportion of its gross national product lost through deaths, disabilities and reduced productivity. 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.

1.5 STUDY QUESTIONS

This study aimed at addressing the following questions:/

1. What is the vitamin A status of school children aged 6-10 years in Gachoka, Mbeere District?
2. What socio-demographic and socio-economic factors are associated with vitamin A status of children aged 6-10 years in the study area?
3. What individual child factors are associated with vitamin A status of 6-10 years old children in Gachoka, Mbeere District?

1.6 RESEARCH OBJECTIVES

1.6.1 Main objective

To determine household characteristics and individual child factors associated with vitamin A status of children aged 6-10 years in Gachoka, Mbeere District.

1.6.2 Sub-objectives

1. To determine the vitamin A status of school children in selected schools in Gachoka, Mbeere District.

2. To determine household socio-demographic and socio-economic factors namely, income, education, religion, social economic status, marital status, household size, dependency ratio, ages of household members.

3. To determine children's morbidity experience.

4. To determine the prevalence of gastrointestinal parasites in children.

5. To determine children's dietary intake of proteins, calories, iron and vitamin A.

CHAPTER TWO

LITERATURE REVIEW

2.1 MAGNITUDE OF VITAMIN A DEFICIENCY

According to WHO vitamin A deficiency, including clinical and subclinical forms of moderate and severe degrees of public health significance, exists in 60 countries in the world and it is likely to be a problem in at least an additional 13 countries (WHO, 1995). It is estimated that 251 million preschool children are severely or moderately subclinically deficient while 2.8 to 3 million are clinically affected. Thus, at least 254 million children of preschool age are "at risk" in terms of their health and survival. In 1998 data reported by UNICEF show that VAD affects about 100 million young preschool children in the world (UNICEF, 1998). This indicates a reduction in the prevalence of VAD. Over the last five years in Indonesia for example, the use of vitamin A supplements reduced the rate of severe VAD by more than 75% (UNICEF, 1998).

A study carried out in Cebu in the Philippines among children aged 1-16 years showed a prevalence of VAD or low serum retinol levels of 47%. Children with serum retinol levels below 10 μg/dl were 17% and this is a state of vitamin A deficiency. Altogether, 67% of the children had wrinkling of the conjunctiva and many had some conjunctival thickening and xerosis, while a few had corneal xerosis. A statistically significant relationship was found between low serum retinol levels and low intakes of both vitamin A and protein (Solon et al, 1978).

A nationally representative survey carried in out Tanzania among children aged under six years indicated that 24% of the children had serum retinol levels which were below 20 μg/dl (Ballart et al, 1997 cited by Mugyambuso et al, 1999). According to the WHO criteria, these results indicate that Vitamin A deficiency is problem of public health significance in Tanzania .

A survey carried out in areas where a vitamin A intervention programme had commenced a few months prior to the study showed that vitamin A deficiency was a problem in Ethiopia. The survey carried out on children aged 6 months to 6 years in four regions of Tigray, Harari, Oromiya and Southern regions indicated high prevalence rates of Bitot's spots in all regions with children aged 5 and 6 years being most affected. Deficient Serum retinol levels i.e. $\leq$10 μg/dl were found in 16.1%, 4.6%, and 52% of the children in Tigray, Southern, and Harari and Oromiya regions respectively. Prevalence of low serum retinol values was highest among boys between age groups 5-6 years and in girls 2-3 years in all regions (Jemal et al, 1999).

In Pohnpei, State of Micronesia, 51% of the children were vitamin A deficient, as measured by serum retinol tests. This was revealed in Pohnpei Child Health Survey carried out in 1994 (Lois, 1999).

These studies show that vitamin A deficiency is a problem in different countries. This calls for the implementation of intervention programmes such as, vitamin A capsules supplementation, food fortification, dietary diversification and nutrition education with an aim of reducing the problem.

2.2 VITAMIN A DEFICIENCY IN KENYA

Vitamin A deficiency is a major problem as reflected by results of the national micronutrients survey carried out among preschool children in 14 districts. Bitot's spots and Corneal xerosis were reported in 1.0% and 0.1% of the children respectively. Serum retinol values of deficient, marginal and satisfactory status were reported in 7.7%, 32.9% and 59.4% of the children respectively (UNICEF & GoK, 1994). In general, VAD affects 41% of young children (GoK & UNICEF, 1998).

Results of the survey indicated that severe VAD was prevalent in Bungoma, Baringo, Garissa, Kitui, Kisumu, Kisii, Kwale, Mandera, Mombasa, and South Nyanza. Moderate VAD was prevalent in Nyeri, Nakuru, Meru and Kiambu. Mild VAD was not reported in any of the districts. The degree of severity was based on the revised WHO criteria (UNICEF & GoK, 1994; Donald & Martin, 1997); that states, if the prevalence of serum retinol values below 20μg/dl is >2≤10% , >10-≤20% and >20% then, respectively, the VAD is a mild, moderate and severe problem in that population.

Vitamin A deficiency studies have also been carried out at specific parts of the country for instance Ngare et al, 1994 as in Mosomi, 1998 did a study in South Nyanza that revealed an alarming high prevalence of VAD (57%) with rates of Bitot's spots standing at 1.3%. Recently, a study carried out among children aged 10-17 years in Siaya District indicated that 24% of the children were deficient with <20μg/dl of blood of vitamin A. The prevalence was higher among males (15%) than females (9%) and this decreased with age after twelve years (Mosomi, 1998).

2.3 THE ETIOLOGY OF VITAMIN A DEFICIENCY

According to ACC/SCN, (1997), the etiology of VAD is multifaceted. A combination of individual characteristics, family factors and macro level variables contribute to VAD (Figure 1).

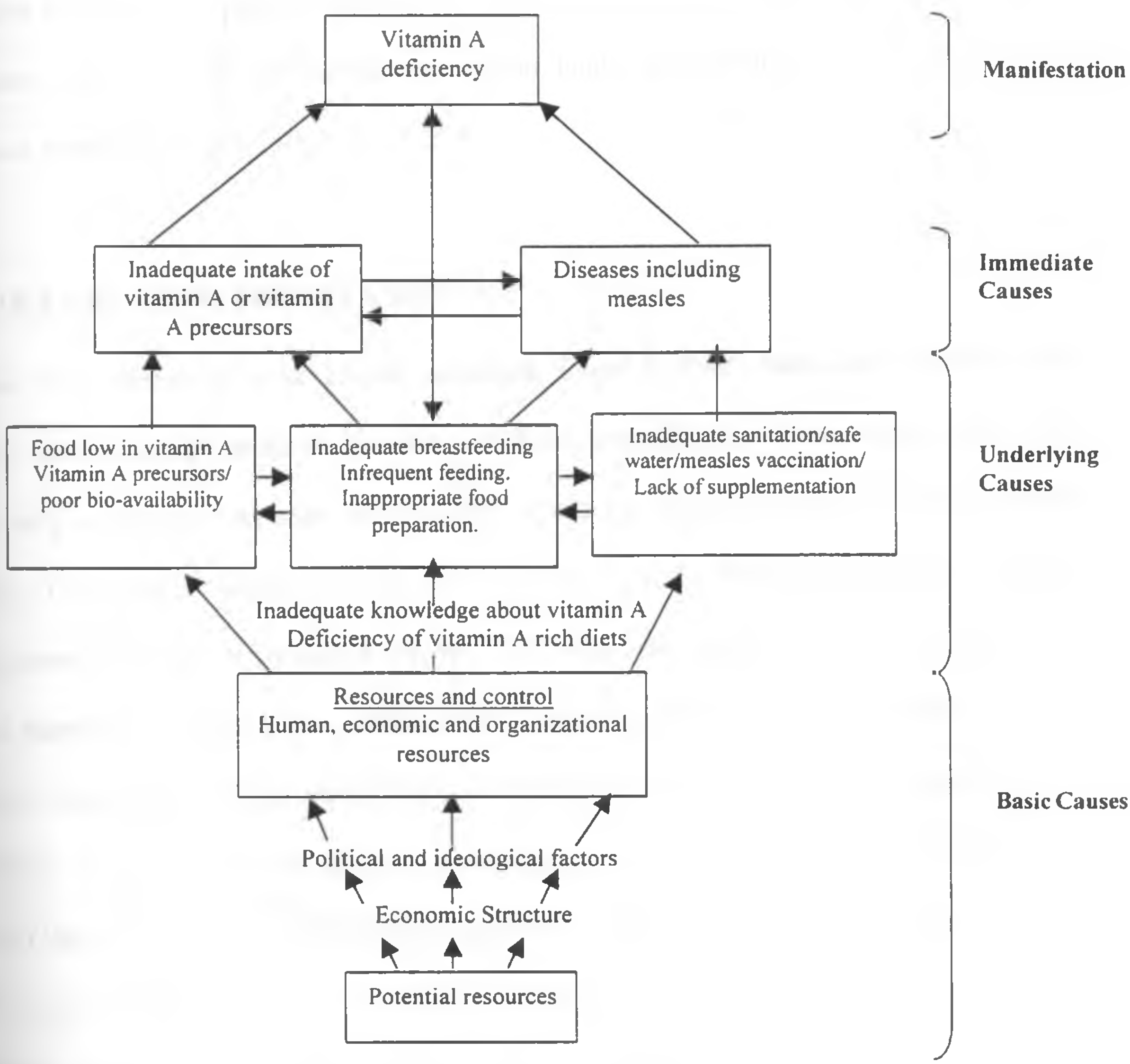

Figure 1: Conceptual Framework on the Causes of VAD

Source: (ACC/SCN, 1997).

Vitamin A deficiency is directly linked to inadequate intake of vitamin A or its pre-cursors in relation to requirement (including increased requirements for the vitamin at certain stages in the life cycle like in early childhood, pregnancy and lactation) and frequency of infections, which in turn result from an interaction of many underlying factors. Consumption of foods which are low in vitamin A or its precursors or of poor bio-availability, inadequate breastfeeding, inadequate sanitation and lack of supplementation are cited as some of the underlying causes of VAD. Economic, social and environmental deprivation limits accessibility to, and consumption of vitamin A containing foods (ACC/SCN, 1997).

2.4 METABOLISM OF VITAMIN A

Vitamin A, or retinol is a fat soluble substance found in liver, particularly fish liver, and in poultry, meat and dairy products. Carotenes that are potential precursors present in for example, green leafy vegetables, red palm oil and yellow fruits can be converted to retinol in the wall of the gut. The relative biological values of these various substances were formerly expressed in international units (IU) of vitamin A activity, 1 IU being equivalent to 0.3μg of retinol, 0.55μg of retinol palmitate, 0.6μg of Beta-carotene and 1.2μg of other Provitamin A carotenoids. Currently, they are expressed in retinol equivalents, whereby one microgram of retinol equals one retinol equivalent. Carotenes are not only less biologically active than retinol, but their dietary sources are also less efficiently processed and absorbed from the gut (Sommer, 1982). One must therefore ingest up to six times as much Provitamin A ß-carotene (by weight) as retinol for a similar degree of effect.

Most of the preformed vitamin A in food combines with the fatty acid, palmitic acid, to form retinyl palmitate. Before uptake by the intestinal cells, enzymes must split retinyl palmitate from either the pancreatic juice or mucosal cells to form free retinol. Once retinol is within the mucosal cell, it combines with a fatty acid usually palmitic acid and is incorporated into the small transport particles of fat called chylomicrons. These are then released into the lymphatic circulation, which eventually enters the regular blood system to be carried to the liver for storage (Guthrie, 1989). When needed, it is released into the bloodstream in combination with retinol-binding protein (RBP), a specific carrier protein elaborated by the liver. The retinol is then removed from the serum and utilized by epithelial cells throughout the body. Figure 2 gives a simplified schematic outline of these metabolic pathways.

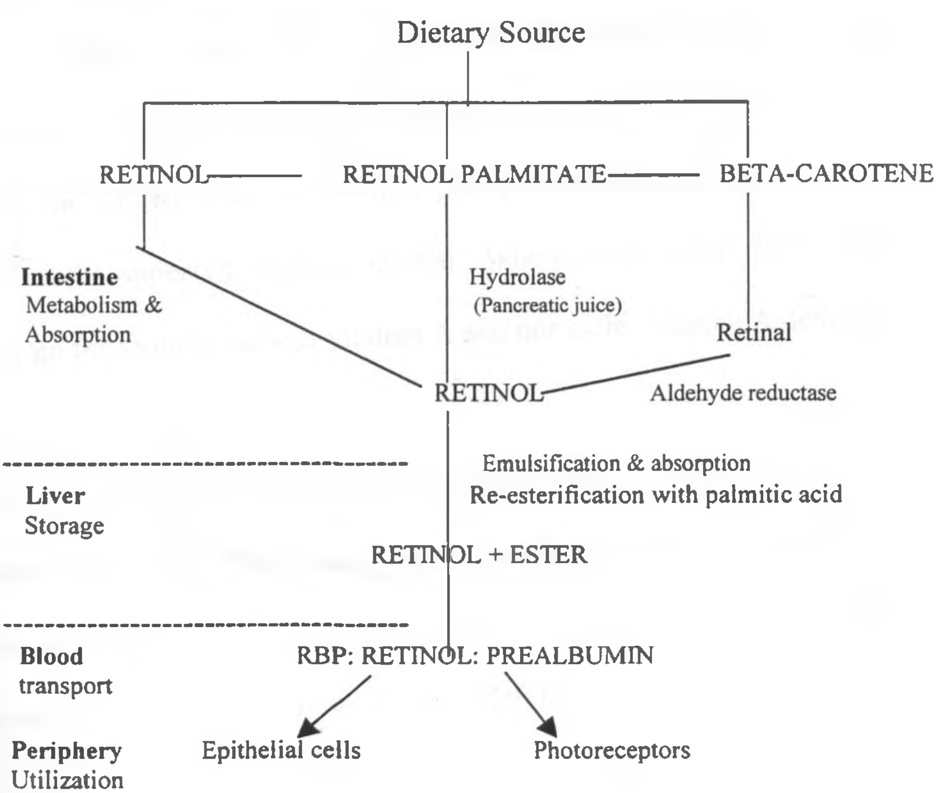

Figure 2: Schematic representation of vitamin A metabolism
(Source: Sommer, 1982).

The liver stores form an important buffer for variations in vitamin A and ß-carotene intake. When vitamin A intake surpasses 300-1200 μg/day of retinol or its equivalent, the excess is stored and liver reserves are increased. When vitamin A intake is less than this amount, liver stores are drained to maintain serum retinol at a normal level (above 200 μg/l). When intake remains low for prolonged periods of time the liver stores become depleted, serum retinol levels drop, epithelial function is impaired and xerophthalmia appears. The duration of inadequate intake required for this to occur depends upon the amount of vitamin A (or precursor) ingested, the extent of pre-existing liver stores, and the rate at which vitamin A is being utilized by the body (Sommer, 1982).

A child with borderline or marginal intake to begin with will have very limited stores. Any sudden drop in intake, either from a change in diet, interference with absorption (as in gastroenteritis) or a sudden increase in metabolic demand (febrile state or growth spurt), will quickly deplete the limited reserves and may precipitate frank corneal destruction, even in eyes that had previously appeared entirely normal. Where liver stores have been very high, an individual may go for months without vitamin A and not suffer vitamin A deficiency.

The availability of stored vitamin A also depends upon a child's general nutritional status. Severely malnourished, protein-deficient children, synthesize RBP at a much reduced rate. Serum retinol levels will therefore be subnormal, even if liver stores are high. Finally a diseased liver cannot store as much vitamin, or make as much RBP as a normal one.

Hypervitaminosis A is rare especially that related to dietary intakes. However, if supplements are given in large amounts toxicity may occur for example long-term dosages of 16000 RE/day, or 40000 to 55000 RE/day to some people may result in toxicity symptoms while infants may exhibit these symptoms in 30 days following dosages of 8000 RE/day. Symptoms of toxicity for adults include headaches, drowsiness, nausea, loss of hair, dry skin, rapid resorption of bones, and diarrhoea; for infants, the symptoms are scaly dermatitis, weight loss, anorexia and skeletal pain (Guthrie, 1989). Recovery is rapid and complete after withdrawal of the vitamin with symptoms frequently subsiding within seventy two hours.

2.5 FUNCTIONS OF VITAMIN A

- **Vision:** The role of vitamin A in vision is the only clearly defined function of the vitamin. Retinol is essential for the elaboration of rhodopsin by the rods, which are the sensory receptors of the retina responsible for vision under low levels of illumination (Guthrie, 1989; Sommer, 1982; Garrow et al, 1993). Rhodopsin (visual purple) is responsible for the ability of the eye to see in dimlight. The retinol provided in the blood is oxidized to retinaldehyde. This then combines with the protein opsin to form rhodopsin, located in the rods found in the eyes retina. As light strikes the retina, the visual purple is bleached to visual yellow, and retinaldehyde is separated from opsin. This action triggers a stimulus from the retina through the optic nerve fibers to the brain. During the process, some vitamin A is split off from the protein and changed to retinol. Most of this retinol is reconverted to retinaldehyde, which in turn recombines with opsin to regenerate rhodopsin. A small amount of the retinol is lost in this process and must be replaced by the blood otherwise vision in dimlight is not possible until this whole cycle has been completed. The amount of retinol available in the blood determines the rate at which rhodopsin is regenerated and is available to act again as a receptor substance in the retina (Guthrie,1989).

- **Normal Growth:** Vitamin A is required for normal growth. It is needed in the dismantling of the old bone structure and replacing them with new bone parts (Antia, 1973; Guthrie, 1989). In essence vitamin A is involved in the conversion of immature cells to osteoblasts (cells that build bones) and to osteoclasts, which are necessary for the breakdown of bone cells as bone is remodeled during growth.

- **Epithelial Cells:** The formation of epithelial cells found in the outer protective layer of the skin, in the genitourinary and respiratory tracts, is dependent on vitamin A (Guthrie, 1989). The epithelial cells are always lost and replaced and as such the need for the vitamin A in maintaining their health is continuous. In absence of vitamin A, hardened and dry cells are produced which lack cilia and the ability to secrete mucous. Vitamin A is associated with the activation of the adenosine triphosphate (ATP) Sulfurlase and sulfate transferase which are involved in the synthesis of proteoglycans contained in mucous. A deficiency of vitamin A will thus lead to kerratinization.

- **Immune Response:** The body's defenses against infection and diseases partly depends on vitamin A (Guthrie et al, 1995; Donald & Martin, 1997). In addition to maintaining the epithelial tissues that are important barriers to infections, vitamin A is involved in maintaining immunocompetence. It helps maintain the lymphocyte pool and also functions in T cell-mediated immunity (Donald & Martin, 1997; Garrow et al, 1993).

2.6 CLINICAL LEVELS OF XEROPTHALMIA

Uncomplicated, gradual depletion of vitamin A stores results in xerophthalmia of increasing severity: night blindness, conjunctival xerosis, bitot's spot, corneal xerosis and corneal ulceration or keratomalacia (Sommer, 1982).

- *NIGHT BLINDNESS:* Vitamin A deficiency can interfere with rhodopsin production, impair rod function and result in night blindness (Sommer, 1982). This is generally the earliest manifestation of VAD. After dusk, children suffering from night blindness prefer sitting in a secure corner, often unable to find their food or toys. Among children in developing countries, night blindness can be reliably ascertained by history from a parent or guardian (Sommer et al, 1980). Where VAD is endemic, a local phrase such as "twilight blindness" or "chicken eyes" may exist which specifically relates to the child's inability to see in the dark. The latter has an anatomical basis in that chickens lack rods in the back of the eye).

- *CONJUNCTIVAL XEROSIS:* Changes in the epithelial architecture accompanying VAD are termed "keratinizing metaplasia". The epithelium of the conjunctiva is transformed from the normal columnar to the stratified squamous type, which result in loss of goblet cells, formation of a granular cell layer and keratinization of the conjunctival surface. Clinically, these changes are expressed as marked dryness or unwetability. The affected area appears roughened, with fine droplets or bubbles on the surface instead of smooth and glistening. This usually occurs in both eyes (Sommer, 1982). Conjunctival xerosis or drying, represents the earliest, clinically detectable, structural change on the surface of the eye due to VAD (Mclaren et al, 1981).

- ***BITOT'S SPOTS:*** In some individuals , fine bubbles or cheesy material, comprising keratinized epithelial cells, may accumulate above the conjunctival surface forming certain lesions known as Bitot's spots, which are merely an extension of the xerotic process. The overlying material whose amount varies from day to day can be easily wiped off. Although the presence of Bitot's spots, especially in preschool children generally present significant VAD, diagnostic sensitivity improves when Night blindness and Bitot's spots occur together (Sommer, 1982; WHO, 1982). With vitamin A treatment, Bitot's spots begin to regress within two to five days, and will disappear within two weeks in most cases. However a significant proportion may persist in shrunken form for months (Sommer, 1982).

- ***CORNEAL XEROSIS:*** Superficial depressions in the cornea begin to occur even during the early stages of Xerophthalmia, although these are not clinically apparent until VAD becomes severe. As cornea involvement increases, these lesions become denser, stromal edema develops and the cornea appears hazy, granular and pebbly upon examination with handlight (WHO, 1976). Treatment to vitamin A therapy, cornea xerosis responds within two to five days with corneal regaining its normal appearance in one to two weeks (Sommer, 1982).

- ***CORNEAL ULCERATION / KERATOMALACIA:*** Ulceration or keratomalacia indicates permanent destruction of part or all the cornea stroma resulting in permanent structural alteration. Ulcers are classically round to oval "punched out" defects, as if a cork-borer or trephine had been applied to the eye. The surrounding cornea is generally xerotic but otherwise clear, and typically lacks the grey, infiltrated appearance of ulcers of bacterial origin (Sommer, 1982). Blindness is usually inevitable. However if the ulceration involves less than one-third of the corneal surface (generally spares the central pupillary zone) prompt vitamin A therapy ordinarily preserves vision. More widespread involvement (X3B – refer to Table1), especially generalized liquefactive necrosis usually results in perforation, extrusion of intraoccular contents and loss of the globe. Prompt therapy may still save the other eye and the childs life.

Suggestions have been put forth that keratomalacia is not just the final stage of occular VAD because for this stage to be reached protein deficiency and local infection are necessary factors (WHO, 1976). PEM of both the kwashiorkor and marasmic types, commonly, if not invariably, accompany blinding due to VAD.

- ***SCARS:*** Healed cornea ulceration and keratomalacia result in scars of varying densities on the cornea. Permanent outpouching of the remaining cornea ("staphylom"), or, where intraoccular contents have been lost, a shrunken globe ("phthisis bulbi"). Although scars may have causes other than xerophthalmia, for example, trauma and infection, determining their prevalence and collecting pertinent history associated with their occurrence during surveys can provide useful information on the likelihood of their being attributable to VAD (Keith and Sommer, 1993).

- ***XEROPHTHALMIC FUNDUS:*** This is usually associated with night blindness in school age children or young adults and appears to be indicative of a chronic deficiency state (WHO, 1976). There are usually multiple lesions, sometimes glaring white, scattered profusely along the course of the vessels. When the spots are few in number they tend to have a yellowish appearance and the retina is reddish-brown in color. The spots may fuse together and are usually seen around the periphery of the fundus, the macula remaining free of spots. Spots are never seen on top of a vessel, but a vessel may run over them. Both eyes are always affected, but not necessarily to the same degree.

A classification of these occular signs of xeropthalmia has been developed as shown in table 1.

Table 1. Classification of Xerophthalmia

XN	Night Blindness.
X1A	Conjunctiva Xerosis
X1B	Bitot's Spot.
X2	Cornea Xerosis
X3A	Cornea Ulceration/Keratomalacia $<1/3$ cornea surface
X3B	Cornea Ulceration/Keratomalacia $\geq 1/3$ cornea surface
XS	Cornea Scar
XF	Xerophthalmic Fundus

(Source: Sommer, 1982).

2.7 ASSESSMENT OF VITAMIN A STATUS

Vitamin A status is best assessed by measurement of vitamin A stores in the liver (Guthrie, 1989). However, this is invasive (Robert et al, 1996) and not feasible in evaluations of populations. Vitamin A status can be viewed as a continuum from deficiency to excess, with obvious health consequences at either extreme (Figure 3).

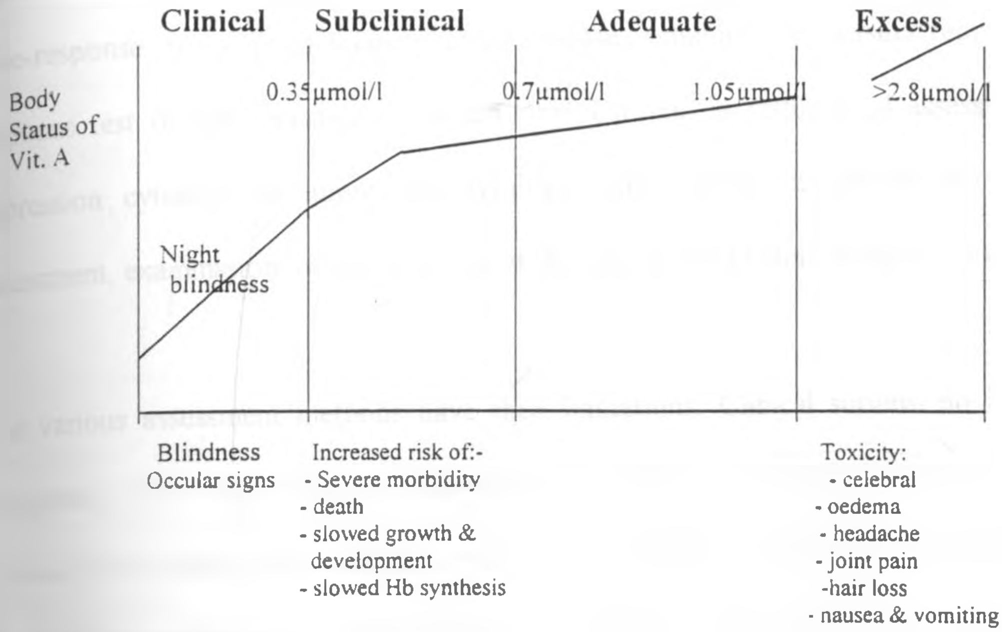

Figure 3: Stages of Vitamin A status
Source: (ACC/SCN, 1997)

As the vitamin A status becomes poorer, the total body reserves of vitamin A are first depleted, followed by a reduced concentration of plasma retinol. which in turn leads to abnormalities of tissue function. The extremes are marked by specific indicators, e.g. in the case of severe depletion. by occular signs (xerophthalmia, including night blindness) and very low serum retinol levels of <0.35 µmol/l. The subclinical stage is characterized by an increased occurrence in the severity of infectious illness and risk of death (ACC/SCN, 1997).

Vitamin A deficiency can be assessed using various methods or indicators namely, dietary, physiological. biochemical. histological and clinical methods (IVACG, 1993; WHO, 1996). Semiquantitative dietary assessments of vitamin A intake can be carried out to determine populations at risk based on their consumption frequency of vitamin A rich foods or 24 hour recall (IVACG, 1993). Physiological assessment involves finding out if there are any cases of nightblindness in the study population; biochemical assessment involves the use of either relative dose-response or modified relative dose-response techniques or plasma retinol-binding protein response test or determination of serum retinol levels; in histological assessment, conjunctival impression cytology or impression cytology with transfer is carried out while in clinical assessment, examination for the presence of the various VAD clinical signs is done.

The various assessment methods have their limitations. Clinical surveys do not detect mild or moderate VAD, which may still have negative effects on health. In essence, they detect the clinical VAD while as the subclinical state may be equally detrimental. The use of nightblindness may also be unreliable since this is subjective and can not be used in very young children. Serum retinol concentrations decrease in response to infection, and are thus unreliable indicators of VAD in populations with a high prevalence of illness. The relative dose response test requires two blood samples taken five hours apart and is therefore impractical for use in large community surveys (Flores et al, 1984). A recent modification of the relative dose response technique circumvents the need for two blood samples by dosing with a vitamin A analogue (Tanumihardjo et al, 1990), but unfortunately this analogue is not yet commercially available and, even when it is, the technique will still be impractical in large community surveys.

The choice of indicator to use should be governed not only by technical and financial feasibility but should also be consistent with a given demographic and cultural context (WHO, 1996). For general surveys, WHO and IVACG recommends the use of clinical signs of xeropthalmia, nightblindness and serum retinol values as indicators for vitamin A assessment (IVACG, 1993).

Additionally the three approaches, clinical, biochemical and dietary assessment form a package. Used as such, the package provides an ideal measure of relative vitamin A nutritional status of both populations and individuals (IVACG, 1989).

Using clinical and biochemical parameters, WHO has recommended a minimum prevalence criteria to assist in determining the extent to which vitamin A deficiency or xeropthalmia may be considered of public health significance among children in a given community as shown in table 2. The prevalence ranges from >0.01% to >1% for xeropthalmia and >5% for serum retinol levels.

Table 2: Criteria for Determining VAD or Xerophthalmia as Problems of Public Health Significance

Indicator	Prevalence
Functional	
Night blindness (XN)	>1%
Clinical	
Conjunctival Xerosis/with Bitot's spot (X1B)	>0.5%
Cornea Xerosis/Ulceration/Keratomalacia (X2/X3A/X3B)	>0.01%
Cornea Scar (XS)	>0.05%
Biochemical	
Serum Retinol less than 10μg/dl (0.35μmol/l)	>5%

(Source: WHO, 1996).

CHAPTER THREE

METHODOLOGY

3.1 STUDY AREA

The study was carried out in Gachoka Division in Mbeere District, Eastern Province, Kenya (Appendix A). Mbeere District came into existence in 1996 having been carved from Embu District (GoK, 1997-2001). The district has a total area of 2097 km^2 and is administratively divided into four divisions namely, Gachoka, Mwea, Evurori and Siakago (Appendix B). Gachoka Division is the largest of the four divisions taking up to 38.4% of the total area. The division has four locations namely; Mbeti South, Mavuria, Kiambere and Kianjiru (GoK, 1997-2001).

3.2 CLIMATE AND TOPOGRAPHY

The rainfall in the district is bimodal, unreliable and ranges between 640-1100mm per year. The altitude ranges from around 500 meters on the Tana river basin to about 1200 meters above sea level. The temperature ranges from 20°C to 32°C and the extensive altitudinal range usually influence this (GoK,1997-2001).

Variations in altitudes, rainfall, temperature and underlying geology in the district give rise to varying land potential and to different soil types which influence the different levels of development in the district. The central belt of the district has good black and red soils, whose fertility ranges from low to moderate. Marginal lands seem to take up a larger proportion of the district. Soils around the hills are mainly rocky hence difficult to cultivate (GoK, 1997-2001).

The main food crops grown in the district include maize, beans, millet, green grams, cowpeas and sorghum . "Githeri" is the staple food. During the wet season consumption of green vegetables especially cowpeas leaves is relatively high. The main cash crops grown are tobacco, cotton and to a less extent, sunflower. In view of the few cash crops grown, some of the food crops like green grams, cowpeas, sorghum, mangoes and pawpaws play the dual role of both cash and food crops. Among the crops grown in the district dark green leafy vegetables, mangoes and pawpaws are good sources of vitamin A. However, it's worth noting that availability of these foods is highly seasonal with limited natural water sources.

3.3 SOCIAL AMENITIES AND INFRASTRUCTURE

The district has 187 pre-primary, 183 primary and 22 secondary schools and most are in Gachoka Division (GoK, 1997-2001). Health facilities are inadequate, with only 1 hospital, 4 health centers and 24 dispensaries. However, some of these facilities are inaccessible due to transport, distance and the fees charged especially in private dispensaries (GoK, 1997-2001).

The district is served by five perennial rivers, namely, Tana, Thuci, Thiba, Ena, Rupingazi, sub surface water and the dams which also serve in generation of hydro-electric power (GoK, 1997-2001). Although there are abundant water resources, it's availability for domestic and livestock consumption is limited due to the capital required to harness it, long distances, uncleanliness and salinity in some areas. Thus, the community largely depends on shallow wells, springs, streams, dams and boreholes as a source of domestic water (GoK, 1997-2001).

3.4. HEALTH CONTEXT

The main prevalent diseases in Mbeere District are malaria, upper respiratory tract infections, skin diseases, intestinal worms, eye infections and diarrhoea (GoK, 1997-2001). Diseases influence vitamin A by altering its absorption, storage, tissue utilization and conservation or recycling. Diseases such as measles, diarrhoea, respiratory tract infections and protein energy malnutrition are the most important diseases that influence the vitamin A status of an individual (Martin et al, 1998)

3.5 STUDY DESIGN AND STUDY POPULATION

This was a descriptive cross-sectional study with an analytical component in which primary school children aged 6-10 years in Gachoka, Mbeere District were the study subjects. The study was carried out from January, 1999 to March, 1999 to establish the factors associated with vitamin A status of the study children.

3.6 ETHICAL CLEARANCE

A copy of the study proposal was submitted to the Ethics Committee, at the Kenyatta National Hospital who did approve the protocol and procedures for the study.

3.7 INCLUSION CRITERIA

All school going children aged 6-10 years were eligible for the study and thus constituted the sampling frame. In cases where siblings qualified, only one of them was randomly selected and included in the sampling frame.

3.8 SAMPLE SIZE DETERMINATION

Accurate data regarding the prevalence of VAD among children in Mbeere district are not available. Therefore, calculation of the required sample size was based on the 30.5% prevalence of moderate VAD for Kitui District for children aged between 6 and 72 months (UNICEF/GoK, 1994). This prevalence was used because Kitui District closely borders the area of study . The two districts have similar ecological conditions and consumption habits of the communities in both areas are practically similar.

The formula used to determine the sample size was:-

$$N = \frac{z^2(pq)}{d^2}$$

n = desired sample size.

z = standard normal deviate set at 1.96

p = proportion of VAD in the target population.

q = 1- p, estimated proportion of children with good vitamin A status children.

d = degree of accuracy desired usually set at 0.05

Taking the proportion of children with VAD as 0.305, the z statistic as 1.96 and degree of accuracy at 0.05 level, the estimated minimum sample size was:-

$$n = \frac{1.96^2\,(0.305)(0.695)}{0.05^2} = 325$$

Taking the rate of attrition to be 10% attrition (32.5 children), a total sample size of (325 + 33) 358 children was taken.

3.9 SAMPLING PROCEDURE

Multistage sampling was used (Figure 4). Non-probability sampling was used in the initial stages whereby Gachoka Division was purposively selected as the study area. The division is the largest of the four divisions in the district and has the highest number of schools in all categories and was deemed to be representative of the whole district.

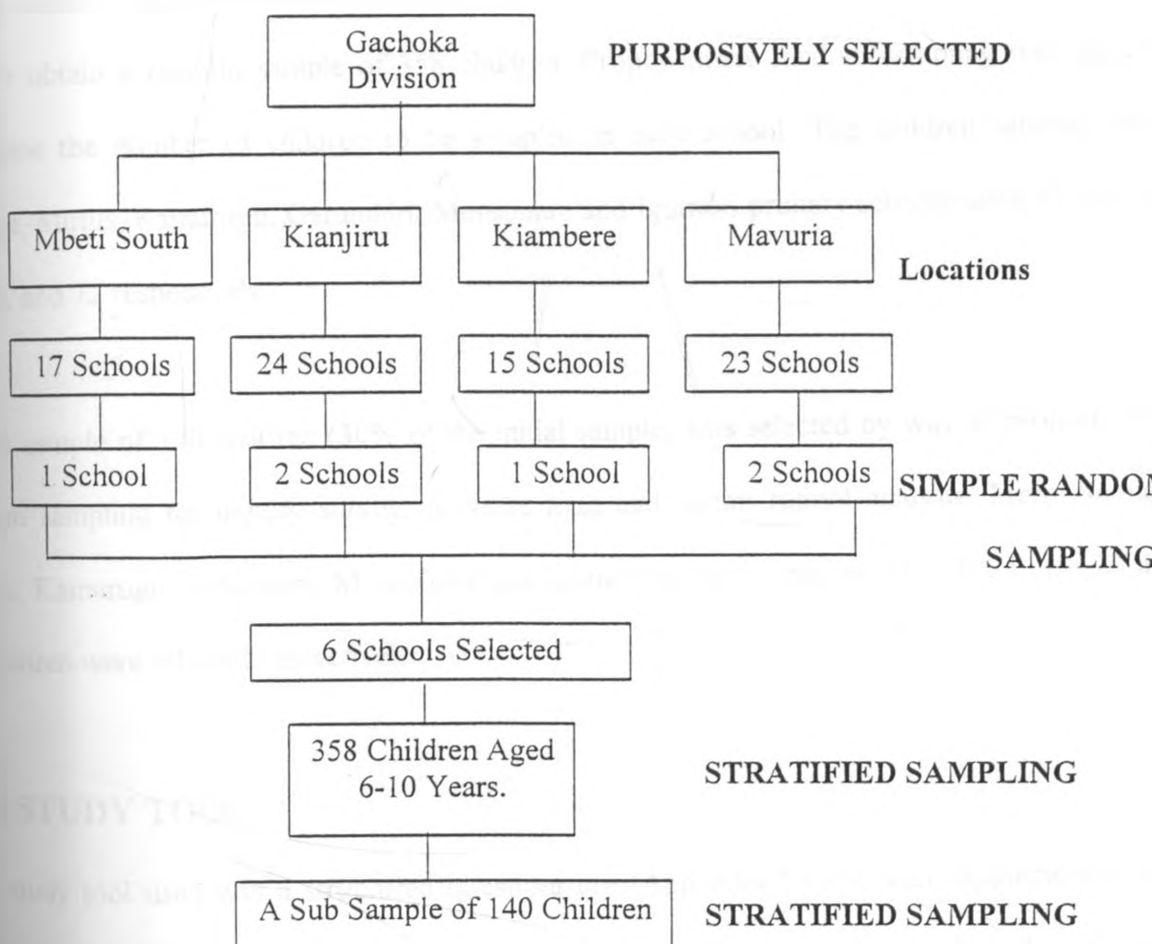

Figure 4: Sampling Procedure Framework

Gachoka Division is divided into four locations with a total of 79 primary schools. Kianjiru, Mavuria, Mbeti South and Kiambere locations had a total of 24, 23, 17 and 15 schools respectively. A total of six schools namely; Ngenge, Mutus, Kamurugu, Gatumbiri, Mutuobare and Igumori were selected. The number of schools selected per location was taken proportionate to the number in the Location through a random sampling process. Two schools each were selected from Kianjiru and Mavuria Locations while one school each was selected from Mbeti South and Kiambere Locations.

All the children aged 6-10 years in the six schools constituted the sampling frame, which was used to obtain a random sample of 358 children. Proportionate random sampling was used to determine the number of children to be sampled in each school. The children selected from Ngenge, Mutus, Kamurugu, Gatumbiri, Mutuobare and Igumori primary schools were 37, 94, 54, 26, 75, and 72 respectively.

A Sub sample of 140 children (30% of the initial sample) was selected by way of proportionate random sampling for dietary survey, parasitic load and serum retinol analysis. From Ngenge, Mutus, Kamurugu, Gatumbiri, Mutuobare and Igumori primary schools, 15, 37, 21, 10, 29 and 28 children were selected respectively.

3.10 STUDY TOOL

The study tool used was a structured questionnaire (Appendix C) and was supplemented with key informant interviews and focus group discussions. The questionnaire had the following sections:

- ***DEMOGRAPHY (CENSUS AND VITAL STATISTICS):*** Household size, sex, age, marital status, education level and occupation of household members.

- ***SOCIAL ECONOMIC STATUS:*** Households social economic status based on ownership of certain assets (radio cassette, bicycle, water tank, sofa set, hand plough, television set, cow cart, gas or electric cooker), type of wall and roof of the main house, number of rooms in the main house, form of lighting, cooking fuel, household income sources, monthly household income and the ownership of certain livestock units.
- ***CHARACTERISTICS OF INDEX CHILD:*** Attributes of the index child namely: age, sex, morbidity, dietary intake data and presence of any clinical signs of vitamin A deficiency.
- ***LABORATORY ANALYSIS:*** The gastrointestinal parasites infestation and serum retinol levels of the index children. These were determined as discussed in section 4.9.3.
- ***FOCUS GROUP DISCUSSION*:** Focus group discussions (FGD) were used to augment qualitative data obtained through the structured questionnaire (Appendix D). The FGD sought information on the communities' knowledge on vitamin A, vitamin A capsules supplementation and their perceptions about health and health resources.
- ***KEY INFORMANTS INTERVIEWS:*** These aimed at documentation of vitamin A activities. The information sought was on : implementation of the vitamin A policy, community programmes in the district which target micronutrients particularly vitamin A, whether nutrition education packages lay any emphasis on micronutrients, whether monitoring and evaluation took place on any of these activities (Appendix E).

3.11 THE FIELD STUDY TEAM AND TRAINING OF ENUMERATORS

The field study team consisted of the principal investigator, university supervisors, clinician, laboratory technicians, enumerators and field guides. The clinician and laboratory technician were qualified and experienced personnel from Kiritiri health centre. The clinician carried out examination on the study children for clinical signs of VAD while the technician did the collection of blood samples. The fieldwork was also under supervision of the University supervisors.

Four enumerators were recruited among candidates who had completed high school and were fluent in Kiswahili, English and the local dialect Mbeere. These were intensively trained for a week on interviewing techniques with emphasis on how to correctly ask questions in a standardized manner and fill in the questionnaires. The enumerators were also taught how to take and record the twenty-four hour dietary recall data accurately.

Field guides who were recruited for each of the schools before the interviewing process began were resident in the area and hence were familiar with the members of the study community. Their work was to guide the enumerators to the various households.

The researcher was involved in all the aspects of field work namely recruitment of staff, training of enumerators, administering the questionnaire, supervision and co-ordination of all staff, collection and analysis of blood samples, stool samples and conducting FGD and key informant interviews.

3.12 PILOT STUDY

Mbita primary school in Kianjiru Location, which is distant from the selected schools, was used for pilot study. Thirty school children were selected and asked to request their mothers to come for interviews in the school. The questionnaire was administered to each child's mother to test its clarity, acceptability, reliability, validity and ease of analysis. Changes were made appropriately and the corrected questionnaire was used for the definitive data collection.

3.13 DATA COLLECTION TECHNIQUES AND PROCEDURES

3.13.1 INFORMED CONSENT

To obtain informed consent from the parents of study children, the principal investigator held meetings with them in each of the respective schools and explained the purpose of the study and the procedures that would be undertaken. In all the schools parents approved the study. Additionally, during the actual data collection, the enumerators further explained the importance of assessing the childrens vitamin A status and the procedures that would be undertaken. At this point an oral consent was obtained and not a written one as this was found to cause tension among the parents. Parents were also invited to witness the actual blood and stool sample collection exercise in the schools. Majority of the parents did turn up to witness the blood and stool sample collection process.

3.13.2 INTERVIEWING PROCEDURE

Each study child was asked to give the name of the village they lived in and the parent's which were then filled in the child-household identification form (Appendix F). This information was used in locating the children's households except those households that could not be located, whereby the study children were requested to accompany the enumerators to their homes. The enumerators first introduced themselves before explaining about the study to the child's parents. Parental consent for child's participation in the study was then sought before administering the questionnaire to the child's mother. In cases of absenteeism, a follow-up appointment was made.

3.13.3 BLOOD AND STOOL SAMPLE COLLECTION AND ANALYSIS

A sub sample of 140 study children was selected from the initial sample size of 358 children and blood and stool samples collected. These samples were used for serum retinol and gastrointestinal parasites analysis respectively. Sample collection was carried out in the morning hours. The children were briefed on how to collect stool sample. Each was then issued with a half metre square sheet of paper, a poly pot with lid, wooden spatula, and tissue paper for stool collection. The children were dispatched in small numbers for the exercise with the supervision of the researcher and a field assistant.

When each child came to have blood drawn, he/she had a clearly coded questionnaire and stool sample in-hand. The child's questionnaire number and name were used to clearly label the aluminium foil-insulated centrifuging tubes (since serum retinol is photosensitive) both on the surface and on top of the cap. The questionnaire and stool sample were given to the person labeling the stool sample, who did the labeling appropriately while the blood sample was taken.

Five millilitres of venous blood was drawn using sterile disposable needles (21g) and syringes of 5mls capacity. The blood was removed from the antecubital vein after cleaning the area with surgical spirit swab, transferred into the centrifuging tubes and corked with a screw cap. The tubes were then kept in an upright position in a covered cool box and maintained at 8-10°C with ice packs. Stool samples were also placed in a cool box packed with a few ice packs.

The samples were then transported to Arimi Clinical Laboratory in Embu town for processing. Blood samples were carefully transported, that is with box resting on someone's lap in the vehicle to minimize jostling.

Blood Sample Analysis

Blood was centrifuged at 3000 revolutions per minute for 4-5 minutes to obtain serum. Working under the cleanest possible conditions, clean disposable polypropylene transfer pipettes were used to transfer serum samples into aluminium foil-insulated cryogenic vials (1.5ml volume) with screw top lids. These were appropriately labeled and frozen at -20°C. Using a cold vacuum flask the serum samples were then transported to Kenya Medical Research Institute (KEMRI) laboratories for serum retinol analysis. Serum retinol was determined using high liquid performance chromatography (HPLC) method as described later. This method is preferred for the accurate separation and determination of vitamin A compounds and individual carotenoids in low concentrations in tissues and foodstuffs (Garrow et al, 1993; Gibson, 1990).

Principle

The determination of serum retinol was done using the HPLC method as described by Kaplan et al. 1990. The vitamin A is extracted with a suitable organic solvent and an aliquot of the organic phase is injected onto a normal or reversed phase HPLC column, followed by an eluting solvent of suitable polarity. A sensitive UV detector set at 325-328 nm detects retinol, which is eluted as a sharp peak within 1-6 minutes. Retinol is quantitated by use of peak height ratios or peak area ratios relative to an internal standard (retinyl acetate or other appropriate analogs).

Procedure

The frozen serum samples were thawed at a temperature of 25°C. The extraction of serum retinol was then carried out at room temperature in dimlight (windows were covered with black curtains). The determination was then carried out as follows:

- 250 μl of homogenized serum was placed in an aluminium covered centrifuge tube with a teflon-sealed screw cap.
- 250 μl of internal standard (Retinyl acetate 0.5 μg/ml) was added.
- These were intermittently vortexed four times for 15 seconds for 1minute.
- 1.5ml of HPLC grade hexane was then added and vortexing done intermittently for 1 minute.
- Centrifuging at 3000 r.p.m. for 2 minutes was then carried out.
- The supernate was removed using a Pasteur pipette and saved in an aluminium covered tube that has the same labeling as the first one.
- 1.5 ml of HPLC grade hexane was added to first tube, vortexed for 1 minute intermittently, centrifuged at 3000 r.p.m. for 2 minutes, supernate removed and combined with the first extract.
- The total extract was then evaporated in a water bath at 37°C under a gentle stream of nitrogen gas.
- Resulting residue was reconstituted in 100 μl of HPLC grade mobile phase (95 parts methanol and 5 parts distilled water).
- 20μl each of the retinol standards and the extract were then injected into the HPLC using a Hamilton syringe. Retention time was used to identify the peaks. Peak area ratio was 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 verses the concentration of the retinol standards.

Stool Sample Examination

Stool was examined using both direct and concentration method.

i) Direct Method

A small amount of stool (1-2g) was emulsified with normal saline (0.85%) in a mortar. A drop of this mixture was placed on a slide and a cover slip applied. This was examined under a microscope using low power for trophozoites or vegetative forms.

ii) Concentration Method

A volume of 7 mls 4% formal saline was added into the same mortar for fixing the parasites. The solution was then filtered through four layers of gauze into a centrifuge tube and 3 mls of ether added into the filtrate. The centrifuge tube was stopped-up and centrifuged at 3000 rpm for 3 minutes. Detaching the supernatant and decanting the solution to remain with the deposit followed this. A wet slide preparation of the deposit was done and examined under a microscope for parasites.

3.13.4 DIETARY DATA

Dietary data was obtained by way of a twenty-four hour recall and food frequency. The questionnaires on consumption frequency of selected vitamin A rich foods were administered to all the mothers of the study children (Appendix C, Question 23).

Twenty-four hour recall was carried out on a sub sample of 140 households in which mothers were the respondents. The nutrient intake was estimated by weighing quantities of ingredients used in the preparation of the different dishes and for all the foods consumed by the subjects for the past twenty-four hours to the nearest one gram. The nutritive value of all the ingredients was determined by using an appropriate Kenyan Food Composition Table (Sehmi, 1994). The nutrients of interest in this study were energy, protein, iron and vitamin A. The nutrient intake of each subject was obtained by adding up their nutrient intake from the different ingredients eaten in the past twenty-four hours. To determine the level of nutrients intake in relation to the recommended dietary allowances (RDA), the subjects' intakes were compared to the RDA for children of the same age group given by Sehmi (1993).

3.13.5 CLINICAL EXAMINATION

Clinical examination was carried out by a qualified and experienced clinician on all study children. The clinician examined the children for presence of any clinical signs of VAD (See appendix C).

3.13.6 FOCUS GROUP DISCUSSIONS AND KEY INFORMANTS

A focus group discussion (FGD) with 10-14 participants was conducted in each location. Participants were randomly selected from the study households in each location. The researcher acted as the moderator while one of the enumerators recorded the responses. The FGD was used to validate and supplement the information from the structured questionnaire (Appendix D).

Key informant interviews were carried out on various personnel including the Medical Officer of Health (MOH), District Public Health Nurse (DPHN), Community Social Worker (CSW), Teachers and Nutrition staff. The interviews aimed at establishing the type of vitamin A interventions that are being implemented in Mbeere District. This included the implementation of the vitamin A policy, community programmes in the District which target micronutrients particularly vitamin A, the role of nutrition education packages in creating awareness on micronutrients and to determine whether these have evaluation and monitoring components (Appendix E). All the qualitative data has been integrated in different sections of this work.

3.14 DATA QUALITY CONTROL

The questionnaires were well designed and pretested before the study. Enumerators were trained for a week to ensure that they all asked questions correctly and in a standardized manner. The researcher cross-checked the questionnaires in the field to ensure completion and that there were no errors and omissions.

3.15 DATA ANALYSIS

The raw data was appropriately entered and cleaned using the computer facilities in ANP at Upper Kabete Campus, Nairobi University using the SPSS Programme. Using SPSS descriptive statistics, chi-squares and correlations were performed

CHAPTER FOUR

DEMOGRAPHIC CHARACTERISTICS, SOCIO-ECONOMIC FACTORS AND VITAMIN A STATUS OF SCHOOL CHILDREN

4.1 INTRODUCTION

Varying levels of VAD can occur at any age (WHO, 1995). The highest prevalence is found in preschool children, pregnant mothers and lactating women, but subclinical VAD has also been shown to be common in school age children and adolescents (David, 1992; Martin et al, 1998). Most countries prevalence data relate to VAD in preschools, which means that the prevalence data from other age groups are frequently not available (Martin et al, 1998).

No consistent sex differences in vulnerability to VAD have been demonstrated. The impression exists that xeropthalmia is more prevalent in males than in females. Different studies have reported a higher prevalence of Bitot's spots in males than in females (Solon et al, 1978 & Brink et al, 1979).

In general xeropthalmia is confined to children from the lowest social classes though this general rule is not always apparent especially in homogenous, peasant social class societies that account for the bulk of the population in the developing countries (James and Alfred, 1984). Families in lower social classes tend to have both poor access to preformed vitamin A rich foods and poor understanding of the role of proper nutrition in the well being of their children.

Education, especially knowledge on vitamin A status has been recognised as an underlying cause of VAD (ACC/SCN, 1997). Impoverished women, those of low education status tend to follow traditional ideas and practices, and are less confident in engaging in social interactions where more modern concepts and practices are promoted. Due to low education they are less likely to learn from educational materials typically displayed at health centres and used in health related community activities, including those concerned with appropriate child care and feeding practices. Males of low education status are also less likely to adopt within their household's new ideas and practices related to family care and feeding.

Considering the observations stated above it is important to study characteristics of study populations and effects of various socio-demographic characteristics on vitamin A status of the community. In this study, vitamin A status among school children was studied since most of the existing VAD data relates to preschool children and hence, that of school age going children and other groups is scanty.

4.2 RESULTS

GENERAL CHARACTERISTICS OF THE STUDY POPULATION

Data was obtained from 330 households, which had a population of 2322 persons. The average household size was 7.02 persons (SD=2.15) with the sizes ranging from 3 to 14 persons per household. The data indicated a high dependency ratio of 1:1.31. Slightly more than a half (51 5%) of the population were females while the rest were males. The under five year old children constituted 13.6% of the population while those aged 6 – 10 years were 24.7%.

Majority (92.1%) of the households were male headed while a minority (7.9%) were female headed. Additionally, 90.6% of the household heads were married while the remaining percentage was either single or separated/divorced or widowed/widower. Religion of the household head was mainly Protestants (made up of various protestant religious groupings) or Catholics. Only one household head reported being a traditionalist and another muslim.

With reference to education of the population in the study households, only a minority had either completed secondary school or attained tertiary education. The highest level of education attained by majority was primary school. The main occupation for persons in these households was either farming or housewife and farming. Only 14.8% of this population reported having been ill in the last two weeks to the study. Table 3 shows a summary of the various household characteristics.

Table 3: General Characteristics of Study Population

CHARACTERISTIC	PERCENTAGE (%)
Household headship	N = 330
♦ Female	7.9
♦ Male	92.1
Household head's marital status	N = 330
♦ Married	90.6
♦ Single (never married)	3.3
♦ Separated/divorced	2.4
♦ Widowed/widower	3.6
Religion of household head	N = 330
♦ Catholics	40.0
♦ Protestants	59.4
♦ Muslims	0.3
♦ Traditionalists	0.3
Education	N = 2322
♦ Completed lower primary	6.9
♦ Completed upper primary	18.9
♦ Attending primary	38.3
♦ Attended secondary	4.4
♦ Completed secondary	4.2
♦ Tertiary education	1.6
♦ Informal education	0.1
♦ Never attended school	5.7
♦ Preschools	19.8
Occupation	N = 2322
♦ Housewife & farming	13.0
♦ Herding	0.9
♦ Farming	9.1
♦ Salaried employed/civil servant	4.3
♦ Business persons/Artisans	2.9
♦ Student/pupil	41.3
♦ Casual labourer	5.1
♦ Unemployed	3.3
♦ Elderly/sickly person	0.7
♦ Preschool children	19.6
General morbidity	N = 2322
♦ Ill last two weeks	14.8
♦ Not ill last two weeks	85.2

STUDY CHILDREN

A total of 330 children were included in the study of whom 51.2% were females while as 48.8% were males. The children's age varied from 6 to 10 years with majority being in the 8 and 9 years category. Table 4 shows the distribution of children by sex and age.

Table 4: Distribution of Study Children by Age and Sex

N = 330

Age in Years	Males		Females		Total	
	n	%	n	%	n	%
6	23	7.0	23	7.0	46	13.9
7	32	9.7	30	9.1	62	18.8
8	40	12.1	45	13.6	85	25.8
9	42	12.7	48	14.5	90	27.3
10	24	7.3	23	7.0	47	14.2

(The ages presented represent 6 = ≥6<7yrs; 7 = ≥7<8yrs; 8 = ≥8<9yrs; 9 = ≥9<10yrs; 10 = 10yrs)

VITAMIN A STATUS OF STUDY CHILDREN.

Serum retinol levels analysis was successfully carried out on a total of 120 of the 140 targeted children, most of whom (59.2%) were females while 40.8% were males. However, the analysis was not possible on 20 children either due to refusal by child or parent to give blood or haemolysis or recovery of inadequate quantities of serum. Well over a third (37.5%) of the study children had deficient vitamin A status with serum retinol values of <10µg/dl while 62.5% had serum levels of ≥10µg/dl.

Clinical examination was successfully carried out on 287 of the 330 children. Examination was not carried out on 43 of the children due to child or parents refusal. Results indicated that 28 (9.8%) suffered from night blindness while the prevalence of Bitot's spots was (77) 26.8%.

VITAMIN A STATUS AND SEX OF STUDY CHILDREN

The prevalence of deficient vitamin A status, although not significant was higher among females (58%) than in males (42%) (Figure 5). As shown in Appendix H, there was no statistically significant association between serum retinol levels or xeropthalmia and child sex ($p>0.05$).

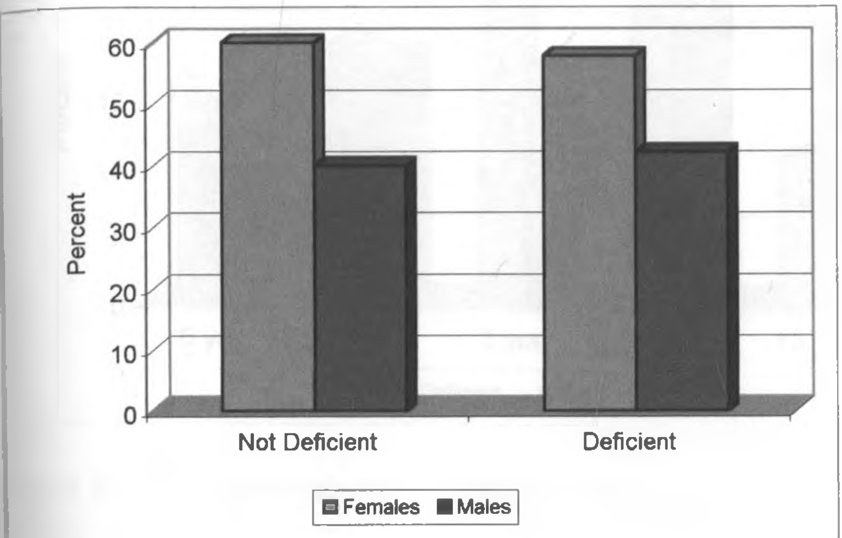

Figure 5: Distribution of Study Children by Sex and Vitamin A Status

VITAMIN A STATUS AND AGE OF CHILDREN

The results indicated that the prevalence of vitamin A deficiency as assessed by clinical signs (night blindness and Bitot's spots) increased with age. Of the children with Bitot's spots, 27.6% were below seven years of age while the remaining percentage were above 7 years of age. The most affected children were those aged 9 years with a prevalence of 28.9%. A highly statistically significant ($p=0.008$) association was observed between vitamin A deficiency and age of the study children (see Appendix H). This implies that the older the child the higher the likelihood of being VAD but this was true only for up to the age of nine years with a possibility of dropping thereafter (see Figure 6).

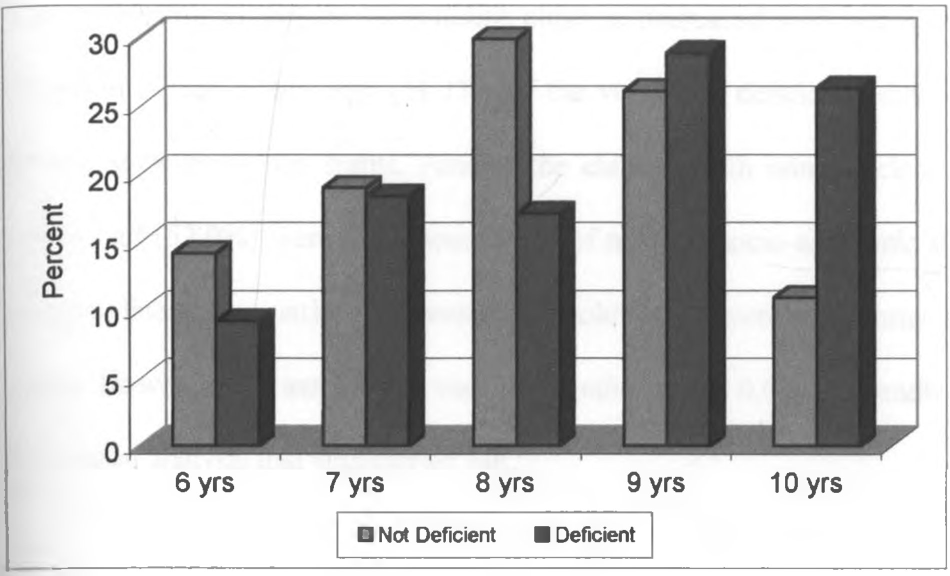

Figure 6: Distribution of Study Children by Age and Vitamin A Status

VITAMIN A STATUS AND SOCIO-ECONOMIC STATUS

A composite variable consisting of income sources, type of roofing, floor and wall materials of the main house and the number of rooms of the main house was developed to help assess the socioeconomic status of the population. The variables were weighted as shown in Appendix G and used to compute the composite variable that had scores ranging from 5-44 The weighting of the various variables was based on information generated from focus group discussions on their perception of households of good socio-economic status. The resulting scores were used to categorize the households into three socio-economic groups namely, low, medium and high. The low category had scores 5-18, 19-31 medium while 32-44 represented the high category. Based on this 49.1% (162), 46.7% (154) and 4.2% (14) of the households were of low, medium and high socioeconomic status respectively.

The proportion of vitamin A deficient children decreased with better socio-economic status as shown in Figure 7. Majority (51.1%) of the vitamin A deficient children were from households of low socio-economic status. Among the children with non deficient vitamin A status, more than a half (52.0%) were from households of medium socio-economic status. There was a weak positive linear association between household socio-economic status and children vitamin A status. However, the association was not significant (p> 0.05). Appendix H gives more details of the type of analysis that was carried out.

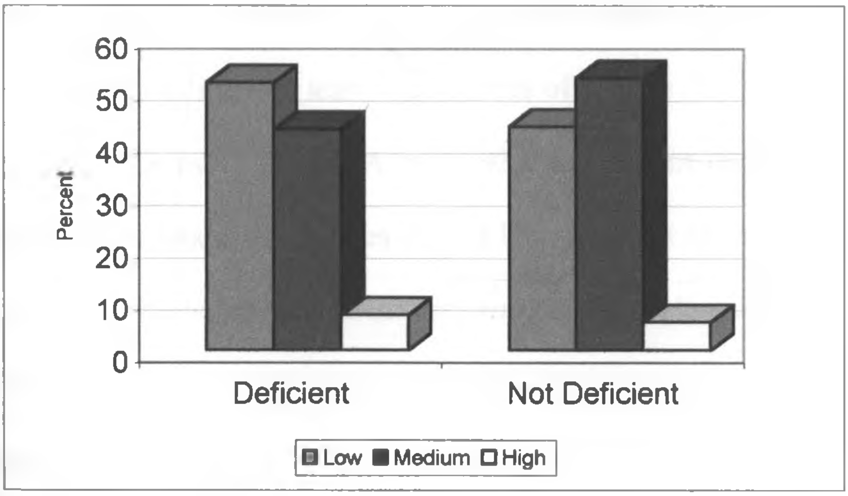

Figure 7: Distribution of Study Children by Vitamin A Status and Socio-economic Status

VITAMIN A STATUS AND HOUSEHOLD INCOME

The monthly household incomes ranged from 50 to 20,000 Kenya shillings. The proportion of children with vitamin A deficiency was highest (63.6%) in the households earning 1001-5000

Kenya shillings, while the lowest percentage of vitamin A deficient children were in the highest income category (Table 5). However, there was no significant difference in vitamin A status among monthly household income categories. Though not significant, the positive linear association between vitamin A status and household income, suggested that improvement in income can improve vitamin A status (see Appendix H).

Table 5: Distribution of Study Children by Household Income & Vitamin A Status

N = 118

Household Income KShs		**Deficient (<10μg/dl)**		**Not deficient (≥10μg/dl)**	
		N	%	n	%
<1000	**(n =36)**	13	29.5	23	31.1
1001-5000	**(n = 67)**	28	63.6	39	52.7
>5000	**(n =15)**	3	6.8	12	16.2
Total	**N = 118**	44	100	74	100

VITAMIN A STATUS AND MATERNAL KNOWLEDGE ON VITAMIN A

Mothers were asked to name at least four sources of vitamin A. The results show that only 6.7% were certain of sources of vitamin A while 93.3% were not definite. Children whose mothers were definite on the vitamin A sources did not have deficient vitamin A status as shown on Table 6. More than two-thirds (68.9%) of the deficient children belonged to mothers who knew one to three sources of vitamin A. However, the association between categories on maternal knowledge on vitamin A and children vitamin A status was not significant. A linear positive correlation existed between children vitamin A status and maternal knowledge on vitamin A though not significant. Appendix H gives more details of the analysis carried out.

Table 6: Distribution of Children by Maternal Knowledge on Vitamin A and Vitamin A Status

N = 120

Responses	Deficient (<10μg/dl)		Not deficient (≥10μg/dl)	
	n	%	n	%
None Correct (n = 33)	14	31.1	19	25.3
1 – 3 Correct (n =79)	31	68.9	48	64.0
All Correct (n = 8)	0	0.0	8	10.7
Total N = 120	45	100	75	100

MATERNAL EDUCATION AND VITAMIN A STATUS

Majority of the mothers (70.2%) were of primary education level, 16% had no formal education, 12% secondary education and a minority (1.8%) had tertiary level of education. About two-thirds (67%) of the vitamin A deficient children were being cared for by mothers whose highest education was primary level (Table 7). The association between vitamin A status of the study children and the categories of maternal education levels was not significant (see Appendix H).

Table 7: Distribution of Study Children by Maternal Education & Vitamin A Status

N = 120

Education	Deficient (<10μg/dl)		Not deficient (≥10μg/dl)	
	n	%	n	%
Non Formal (n = 22)	10	22.2	12	16.0
Primary (n =80)	30	66.7	50	66.7
Secondary (n =18)	5	11.1	13	17.3
Total N = 120	45	100	75	100

A summary of key findings:-

- The prevalence of Bitot's spots and nightblindness was 26.8% and 9.8% respectively.
- Serum retinal values <10μg/dl was prevalent in 37.5% of the children.
- Child age was significantly associated with vitamin A status
- Socio-economic status, household income, maternal knowledge on vitamin A and maternal education were not significantly associated with children's nutritional status.

4.3 DISCUSSION

In most parts of the country, predominant head of a household is the male. This is evident in the study area where 92.1% of the households were male headed while a minority 7.9% were female headed. As indicated in the results, the average household size was 7.02. This large household size could be due to the operational definition used for a household in this survey. The large 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. The high dependency ratio could possibly affect the vitamin A status of the study children since many persons are depending on a smaller economically active population.

The results of the study indicate that VAD is a public health problem in Gachoka, Mbeere District. The 26.8% prevalence for Bitot's spots and 9.8% for night blindness among study children is well above the WHO cut off point that signifies a public health problem in an area. The 37.5% prevalence of children with serum retinol values <10μg/dl is also well above the WHO threshold of >5% (WHO, 1996) implying that VAD.is a problem of public health significance in the study area.

Though not significant, prevalence of VAD was higher among females than in males. This is in contrast with observations made in Ethiopia that the prevalence of Bitot's spots and nightblindness was almost equal in both sexes (Yonas et al, 1996). Sommer (1995) reported that boys have a higher risk of nightblindness and Bitots spots when compared to girls and Jemal et al (1999) reported a higher prevalence of deficient serum retinol levels in boys than in girls. Similarly, in the state of Paraiba, Northeast Brazil Bitot's spots occurred twice as frequently in males as in females (Christiane et al, 1988). Males are almost always more affected than females and this almost consistent characteristic is not fully explained (Garrow et al, 1993). This indicates that study findings on the association between sex and VAD are not consistent. The differences reported in some cultures, are more likely to be related to sex differences in cultural practices of feeding and care rather than to physiological differences. Additionally, the relationship between vitamin A status and child sex was insignificant meaning that child sex was not a factor associated with vitamin A status in the study area.

The severity of eye lesions is generally inversely proportional to age (Garrow et al, 1993). The results of the study indicate a similar trend whereby the deficiency gradually increases with age up to nine years where a decreasing trend is then observed. There exists a statistically significant ($p=0.008$) association between vitamin A status and children's age. This strongly suggests that age is a factor associated with vitamin A deficiency among the study children. School children will usually be eating from the family pot. More often than not, these meals are limited in vitamin A rich sources. The food consumption frequency data further supports this since most of the vitamin A rich foods were consumed atleast once a week by less than 75% of the population.

In the study area socio economic status, and maternal knowledge on vitamin A was found to have a positive relationship with vitamin A status though insignificant. This is in agreement with the findings of a recent study on the socio-economic correlates of preschool children nightblindness, that found lower prevalence of nightblindness among illiterate (and also poor) families who somehow knew from radio and television about the importance of vitamin A and dark green leafy vegetables for a childs vision than it was in literate (school educated) families who did not (Islam and Yusuf, 1992 cited by Yusuf and Islam, 1994). The relationship between vitamin A status and maternal knowledge on vitamin A and socio-economic status was not significant. These results seem to suggest that socio-economic status and maternal knowledge on vitamin A might not be a major factor associated with vitamin A status in the study area.

Vitamin A deficiency is a public health problem in Gachoka, Mbeere District among school children aged 6-10 years. According to the conceptual framework, economic factors and knowledge on vitamin A are some of the factors that contribute to vitamin A deficiency. In this study, various socio-economic and demographic characteristics namely childs sex, household income, maternal education, socio-economic status and maternal knowledge on vitamin A were not associated with childrens vitamin A status. However, childs age was a factor found to be associated with the vitamin A status.

CHAPTER FIVE

GASTROINTESTINAL PARASITES, MORBIDITY AND VITAMIN A STATUS OF SCHOOL CHILDREN

5.1 INTRODUCTION

Mild VAD is associated with an increased rate of infections (Milton et al, 1987 and Sommer et al, 1984). Diseases such as measles, diarrhoea and respiratory tract infection influence the vitamin A status of an individual. A study on increased risk of respiratory disease and diarrhoea in children with mild VAD, demonstrated that children with mild xerophthalmia were more likely to develop respiratory disease and diarrhoea than were non-xerophthalmic children (Sommer et al, 1984). In a study on Ghanaian children, vitamin A supplementation reduced morbidity and mortality. Mortality decreased by 19% in the supplemented group, primarily because of decreased mortality from diarrhoea. Evidence for decreased severity of illness in supplemented children was provided by their decreased attendance at clinics admissions to hospitals (Suzanne et al, 1995).

The frequency, duration and severity of infections contribute directly and indirectly to vulnerability to VAD. Infections lessen efficiency of absorption of vitamin A since mucosal surfaces needed for absorption are damaged. Infections also influence appetite thus reducing dietary intake in addition to reducing conservation and utilization of vitamin A.

A study on the association of diarrhoea and low serum retinol in Peruvian children aged 6-18 months (Eduardo et al, 1993) showed that serum retinol among children with diarrhoea was significantly lower than that for those without diarrhoea. The majority of the children with diarrhoea (75%) had serum concentrations <20µg/dl compared with only 14% of the children without diarrhoea. Moreover, 40% of the children with diarrhoea had serum concentrations <10µg/dl, the value that defines frank deficiency, compared with only 2% of the children without diarrhoea.

Intestinal worm infections do have an impact on vitamin A status. They may directly compete for uptake of vitamin A in addition to their general impact on health by suppressing appetite. Studies have suggested intestinal helminthnic infections impair the absorption of vitamin A. Fat absorption, which is necessary for vitamin A metabolism can also be impaired by parasitic infection of the intestines (Mahalanabis et al, 1979).

5.2 RESULTS

GASTROINTESTINAL PARASITIC INFESTATION CHILDREN AND VITAMIN A STATUS

The incidence of gastrointestinal parasites among the children was quite high with about two thirds (61.7%) of 120 children having at least one or more gastrointestinal parasites. The prevalence of *Giardia lamblia, Entamoeba histolytica,* Hookworms and *Endolimax nana* was 23%, 23%, 8.8% and 10.6% respectively (Figure 8). Endolimax nana infestation showed a statistically significant relationship with vitamin A status as assessed by laboratory assay and clinical examination ($p<0.05$). Hookworms infestation also showed a statistically significant association with vitamin A status assessed through laboratory assay ($p<0.05$). Appendix H gives more details of these analysis.

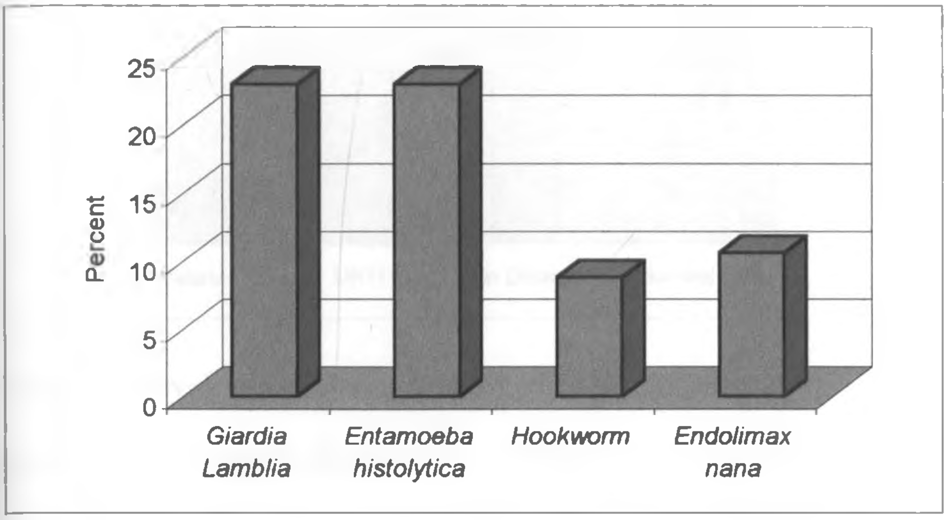

Figure 8: Prevalence of Gastrointestinal Parasites in Children

MORBIDITY STATUS OF CHILDREN AND VITAMIN A STATUS

Within a fortnight to the study 36.9% (121) of the children suffered from one or more of the following illnesses:- malaria, wounds, stomachache or headache, earache or discharge and cough or colds. The prevalence of malaria being 7% and that of coughs or colds, skin diseases, and stomachache or headache being 7.3%, 10.3%, and 10.3% respectively (Figure 9). However, none of these illnesses showed a significant association with vitamin A status. Appendix H gives more details of the analysis carried out.

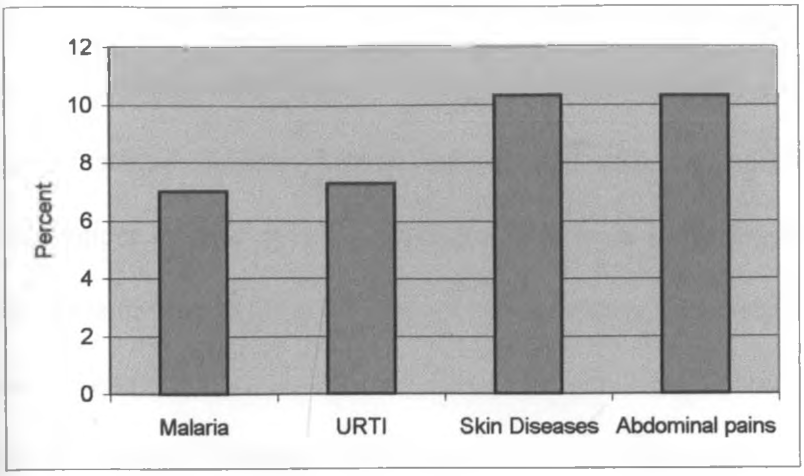

Figure 9: Prevalence of Diseases among Study Children

A summary of key findings:-

- Gastrointestinal parasites namely *Giardia Lamblia*, *Entamoeba histolytica*, hookworm and *Endolimax nana* were prevalent among the study children.
- Hookworm and *Endolimax nana* were significantly associated with vitamin A status.
- Child morbidity was not significantly associated with vitamin A status

5.3 DISCUSSION

The prevalence of malaria within a fortnight to the study among the study children was 7%. A study in Ghana among young children showed no correlation between serum retinol levels at the start of a supplementation trial and subsequent malaria parasitemia in those who had not received supplementation (Fred et al., 1995). However, the vitamin supplementation succeeded in improving the serum retinol levels of study children. Similarly the present study, though not a supplementation study showed no significant association between malaria and serum retinol values or xeropthalmia (see Appendix H). This indicates that malaria might not be a major factor associated with vitamin A among the study children.

Upper respiratory tract infections stood at 7.3%. Upper respiratory tract infections have been shown to correlate with vitamin A status. A prospective study carried out in South-Central India among preschool children showed that children with mild xeropthalmia were twice as likely to develop upper respiratory tract infections than were the nonxeropthalmic children (Milton et al, 1987). Person-time analysis in another study among preschool children revealed no association between xeropthalmia and the occurrence of upper respiratory tract infection (nasal discharge, wheezing, cough) (Sinha, 1976). Similarly the present study did not show a statistically significant association between vitamin A status and upper respiratory tract infections. This indicates that upper respiratory tract infections may not be a factor associated with vitamin A status among children in age group 6-10 years.

The high prevalence (62%) gastrointestinal parasites among the children is an indication of a serious problem in the area. Gastrointestinal parasites cause the lining of the intestine to change, which reduces the surface membrane available for digestion and absorption. Vitamin A status as assessed by both biochemical assay and clinical examination showed a significant association with hookworms and *Endolimax nana* but not with the other gastrointestinal parasites. This indicates that hookworms and *Endolimax nana* might be among the major factors associated with vitamin A status of children in the study area.

Hookworms and *Endolimax nana* were among the factors associated with vitamin A status of study children. *Entamoeba histolytica, Giardia lamblia,* malaria, upper respiratory tract infections, skin infections and abdominal pains were not associated with the childrens vitamin A status.

CHAPTER SIX

DIETARY CHARACTERISTICS AND VITAMIN A STATUS OF STUDY CHILDREN

6.1 INTRODUCTION

The main causes of VAD in the developing countries are insufficient intake of vitamin A and poor bioavailability of provitamin A (David, 1992; Martin et al, 1998; WHO, 1979). Communities where diets, which contain no carotene and where little fruit, green leaves or animal products are consumed, often have low vitamin A status. A number of studies in different countries show significant relationship between the prevalence of xeropthalmia and dietary intakes of vitamin A rich foods (Ramana et al, 1991; Mahboob et al, 1991; Fasil et al, 1991; Wilma et al, 1991, cited by Tefera AB, 1994).

Vitamin A can be ingested either as preformed vitamin A or Provitamin A (certain carotenoids). Substantial amounts of preformed vitamin A occur naturally almost exclusively in animal foods while Provitamin A occurs in plant foods. For most populations, animal food sources are relatively expensive and hence rare in the diet. On the other hand Provitamin A forms found in dark green vegetables, yellow vegetables, yellow cereals and tubers, yellow citrus and red and yellow fruits are universally available and cost less. In most low income populations, carotenoids constitute 80% or more of the foods eaten that contain vitamin A (IVACG, 1989). However, many of these carotenoids are seasonal foods, and this limits the frequency of intake over long time spans. Additionally, it has recently become evident that the bioavailability of Provitamin A from plant foods, especially from dark green leafy vegetables and to some extent also from fruits and tubers is much lower than what has been assumed (Martin et al, 1998). An intervention study in Indonesia among school children found that the apparent vitamin A activity of leafy vegetables and carrots was 23% of what had been assumed and that of fruits was 50% of what had been assumed (Dee Pee S. et al, 1995 cited by Martin et al, 1998).

A direct interaction exists between vitamin A status and protein. Retinol binding protein is required for the release of vitamin A by the liver and for its transport in the blood and the absorption at the target tissues (David, 1992). Fats or oils are also needed for optimal absorption of vitamin A by the body (David, 1992)

Dietary assessments that accurately reveal usual intakes of vitamin A are difficult to conduct even among literate, highly educated individuals (IVACG, 1989). Such surveys may not accurately indicate the level of preformed vitamin A and carotenoids as the biochemical and clinical methods do but they can be used as supportive evidence to point out the inadequacy of the nutrient. Existing approaches that can help in assessing the inadequacy of vitamin A are a food frequency checklist and twenty-four hour recall of dietary intake.

The food frequency checklist aims at assessing the frequency with which certain food items or food groups are consumed during a specified time period for example, daily, weekly, monthly or yearly and hence facilitates collection of qualitative, descriptive information about usual food consumption patterns (Gibson, 1990). The food frequency checklist consists of a list of foods that may focus on a specific group of foods (in this case vitamin A) and a set of frequency-of-use response categories. After administering this checklist, if the foods rich in vitamin A were not consumed by more than 75% of the households at least three times a week, this indicates an inadequacy of the nutrient in that community (WHO, 1996; WHO, 1976; Keith and Sommer, 1987).

The twenty-four hour recall method is the most attractive method used in field investigations in all Eastern European countries (Jadwiga, 1994). It is relatively inexpensive, can be used with illiterate individuals and is a quick way of assessing the mean consumption of foods and nutrients in a given population group in a specified time period (Jadwiga, 1994; Gibson, 1990). In carrying out a twenty-four hour recall, the subjects, their parents, or caretakers are asked to recall the exact food intake during the previous twenty-four-hour period or preceding day. Quantities of foods consumed are estimated usually in household measures.

6.2 RESULTS

DIETARY ADEQUACY AND VITAMIN A STATUS

Most of the children (92.1%) had at least 3 meals per day while 7.9% did not have any breakfast at all. The different types of ingredients that were consumed in the households ranged from 2 to 14 with a mean of 9 (SD=2.7). The mean caloric, protein, vitamin A, and iron intake was 2142.5

(SD=690.7), 62.1 (SD=22), 331.1 (SD=549.2), and 40 (SD=19) respectively. Table 8 shows the children's nutrient intake in relation to the recommended dietary allowances (RDAs). The results show that the children's intake for the various nutrients was well above 75% of the RDAs except for vitamin A that was 55% of the RDA. However no statistically significant association was observed between any of these nutrients and vitamin A status as assessed by laboratory assay or by clinical examination (see Appendix H).

Table 8: Mean Nutrient Intake of Study Children (N=140)

Nutrient	Intake		RDA	Intake as a % of RDA
Kilo Calories	2142	SD=690	2200	97
Protein (gms)	62	SD=22	34	182
Vitamin A (RE)*	331	SD=549	600	55
Iron (mg)	40	SD=19	10	400

*RE-Retinol Equivalents.

CONSUMPTION FREQUENCY OF VITAMIN A RICH FOODS AND VITAMIN A STATUS.

As indicated in Table 9 some food items were consumed more frequently than others, while others were not consumed at all by some children. The most frequently consumed vitamin A rich foods were cow's milk, pawpaws, mangoes and kales or spinach which were consumed at least once in the past seven days by 64.2%, 77.6%, 78.5% and 78.5% of the study children respectively.

ıble 9: **Frequency of Consumption of Vitamin A Rich Foods by Study Children**

Food	Consumes Frequently[a] (No)	(%)	Consumes Infrequently[b] (No)	(%)	Do Not Consume[c] (No)	(%)
ıw's milk	212	64.2	74	22.4	44	13.3
gs	150	45.5	116	35.2	64	19.4
rrots	68	20.6	100	30.3	162	49.1
wpaws	256	77.6	55	16.7	19	5.8
d Liver oil/Seven seas	3	0.9	26	7.9	301	91.2
wpeas leaves	150	45.5	147	44.5	33	10.0
ngoes	259	78.5	71	21.5	0	0.0
ıaranth	70	21.2	103	31.2	157	47.6
npkin	79	23.9	145	43.9	106	32.1
ı	77	23.3	137	41.5	116	35.2
er	14	4.2	80	24.2	236	71.5
ıpkin leaves	130	39.4	80	24.2	120	36.4
e's/Spinach	259	78.5	56	17.0	15	4.5
and Oils	320	97.0	10	3.0	0	0.0

[a] - Frequently consumed (consumes once a week to many times a day).

[b] – Not frequently consumed (consumes no more than twice a month).

[c] – Not Consumed/Never.

proportion of children who had consumed highly rich vitamin A foods like cod liver oil, fish or carrots in the last seven days was quite low and far much below the average cutoff set by WHO. WHO recommends that a given vitamin A rich food should be eaten by more 75% of the vulnerable group at least three times a week (WHO, 1996). Foods that were med above this cut off point were pawpaws, mangoes and kales/spinach. However it l be noted that the frequency of mangoes consumption could be high since the data was ed during the mango seasons, which is not true for the non-mango seasons. The nption frequency of dark green leafy vegetables (amaranth, pumpkin leaves, cowpeas and carrots, rich in beta-carotene was also below the WHO cut off point. No statistically ant association was observed between vitamin A status and food frequency consumption.

A summary of key findings:-

- Dietary intake of kilocalories, protein and iron was well above 75% of the RDA except for vitamin A. However none of these nutrients demonstrated a significant association with childrens vitamin A status.
- Consumption frequency of vitamin A rich foods had an inverse relationship with vitamin A status though this was insignificant.

6.3 DISCUSSION

Dietary intake of various nutrients among the study children was found to be well above 75% of the RDAs except for vitamin A. From literature, it is evident that protein and fat intake is vital in the metabolism of vitamin A. These two nutrients seem not to be limiting among the study children since their consumption exceeds 75% of the RDAs. Additionally, none of these nutrients had a significant association with vitamin A status of children. This suggests that protein, fat or vitamin A intake might not be one of the factors associated with the children's vitamin A status.

A study carried out in Ethiopia showed an inverse association between the frequency of consumption of foods rich in vitamin A and xeropthalmia (Tefera, 1994). Similarly this study has demonstrated an inverse relationship between the frequency of consumption of vitamin A rich foods and xeropthalmia though this is not significant. This indicates that the consumption frequency of vitamin A rich foods may be not a factor associated with the vitamin A status of children in Gachoka, Mbeere District.

ısumption of dietary fat is necessary for the absorption of vegetable sources of provitamin A ℲO, 1995). To ensure adequate intake of fat and oil that is required for the absorption of min A and provitamin A, food containing fat should be consumed daily. Majority (97%) of study children consumed fats and oils at least once a week. The frequency of fats and oils sumption suggests that the consumption seems to be sufficient to ensure adequate absorption itamin A in most of the children. Moreover, frequency of fat consumption is not significantly ciated with vitamin A status of children in the study area.

ddition to the dietary intake of vitamin A, it is important to consider the types of food being sumed. In cases where carotenes are the main vitamin A source, then the quantities of these g consumed is crucial. Carotenes are less biologically active than retinol; less efficiently essed and absorbed in the gut e.g. an individual needs to ingest up to six times as much itamin A beta carotene (by weight) as retinol for a similar effect (Sommer, 1982). In this y, vitamin A rich foods that were eaten more than three times a week by more than 75% of population were pawpaws, mangoes and kales /spinach. A large proportion of the study ılation did not largely consume retinol rich foods like eggs, liver and fish. Though these ry factors are not significantly associated with the vitamin A status of study children, the nin A that is available to the childrens body could be quite limited considering that carotenes he main source of vitamin A. Additionally, the high prevalence of gastrointestinal parasites ng the children impacts negatively on the limited amount of vitamin A ingested. The sites not only compete for the nutrient, but also reduce the surface membrane available for stion and absorption.

CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF FINDINGS.

Vitamin A deficiency is indeed a problem of public health significance as indicated by the results of the study. The prevalence of serum retinol values of <10μg/dl stands at about 37.5% while that of night blindness and Bitot's spots is 9.8% and 26.8% respectively. These prevalences are all above the WHO thresholds symbolizing a VAD problem of public health significance (see table 2).

In summary the study has shown that hookworm and *Endolimax nana* were significantly associated with vitamin A status as assessed by both clinical and laboratory assay while child's age was significantly associated with xeropthalmia. This suggests that hookworm, *Endolimax nana* and childs age were the most important factors associated with childrens vitamin A status in the study area. Additionally, there was no significant association between vitamin A status and the other factors (child's sex, socio-economic status, household income, maternal knowledge on vitamin A, maternal education, *Giardia lamblia, Entamoeba histolytica*, malaria, upper respiratory tract infections, abdominal pains, nutrients intake and consumption frequency of vitamin A rich foods) and this further support this.

CONCLUSIONS

The study investigated the prevalence of vitamin A deficiency among school children aged 6-10 years and some associated factors in Gachoka, Mbeere District. VAD is a significant public health problem in the study area, and it is highly probable that children 6-10 years in other ivisions in Mbeere District are also at significant risk. The findings of the study using both inical and laboratory assays highlight the VAD problem in the study area.

iven that VAD is associated with a wide range of consequences, from blinding xeropthalmia to parent compromises in growth, resistance to infection, and survival, it is pertinent that the ;tors associated with vitamin A status be addressed. The most important factors associated th vitamin A status of children in the study area are hookworm, *Endolimax nana* and child's :. Household socio-demographic and socio-economic characteristics, child morbidity and tary characteristics are not associated with childrens vitamin A status.

COMMENDATIONS

The study demonstrated that VAD is a significant public health problem among school age children. This indicates that the deficiency might also be a public health problem among school age children in other parts of the district or the country. Hence there is need to study VAD of school age children in other parts of the country to determine the magnitude of the leficiency.

Iookworm and endolimax nana were among the major factors found to be associated with itamin A status in the study area. Establishment of a regular deworming programme may go long way in improving the vitamin A status of children in the study area. Practicing of roper hygiene practices at household level may go a long way in reducing the prevalence of istrointestinal parasites, which have a negative impact on the vitamin A status of study uildren.

- Since VAD is a severe problem among school children in the study area, provision of the vitamin A capsule supplement may help improve the children's vitamin A status. Increasing the availability and consumption of vitamin A rich foods through promotion of horticulture and nutrition education are feasible approaches in addressing the VAD in the long run.

- It is also advisable to carry out an intervention study in the study area with an aim of addressing some of the factors associated with the childrens vitamin A status for example setting up an education programme on proper hygiene or initiating a horticulture related programme.

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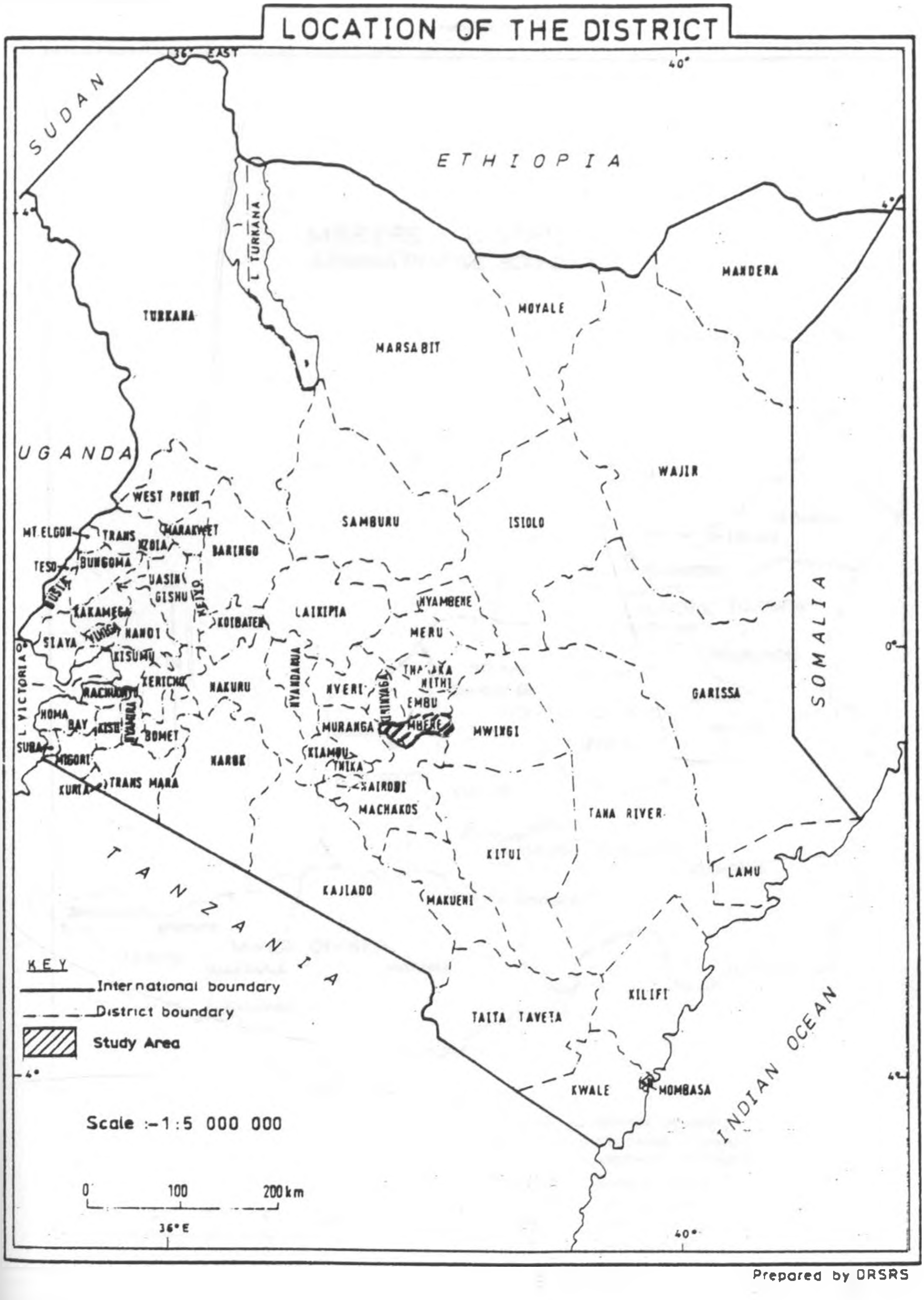
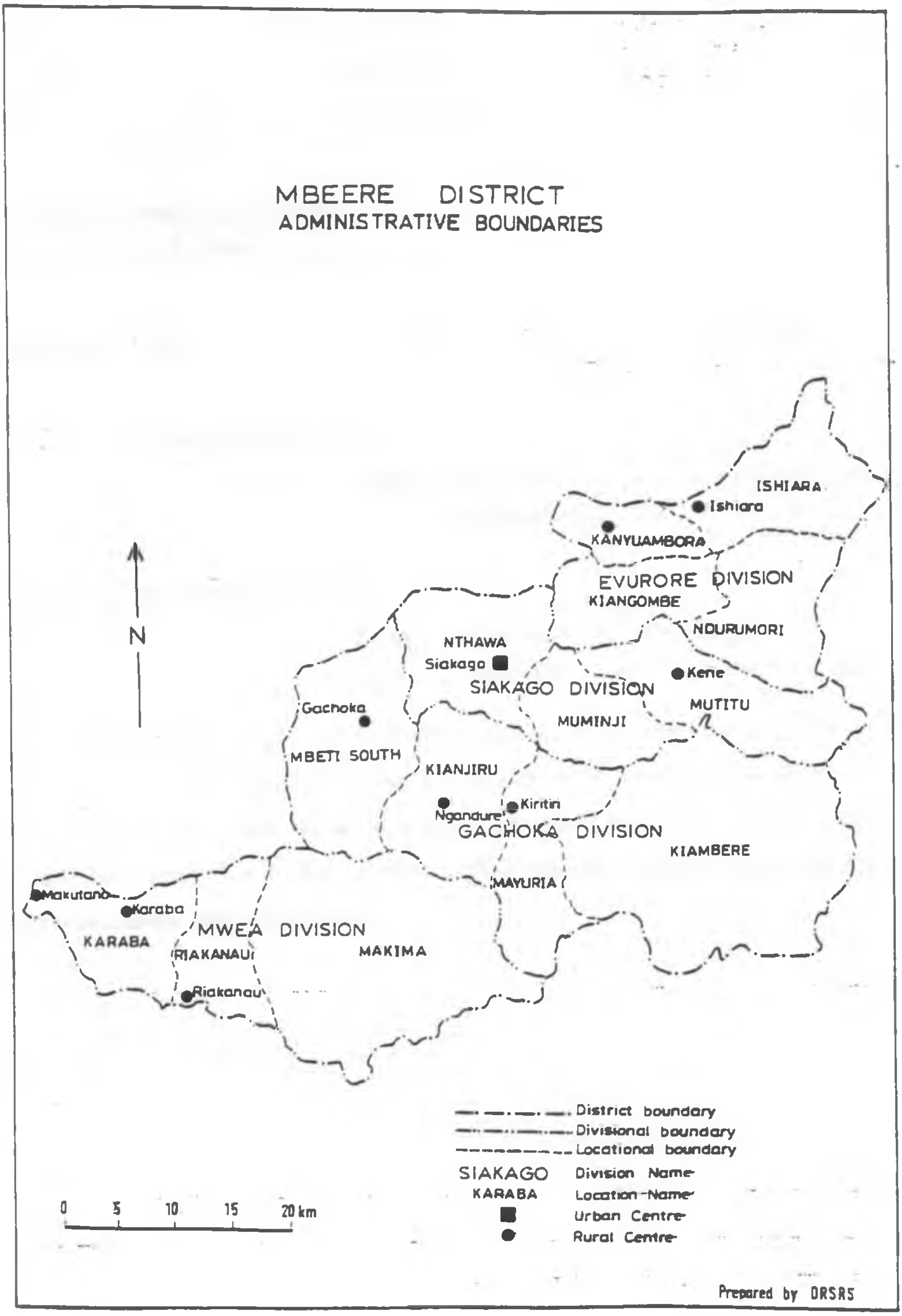
APPENDIX A: MAP OF THE STUDY SITE



APPENDIX B: MAP ON THE ADMINISTRATIVE BOUNDARIES OF THE STUDY AREA



APPENDIX C: STRUCTURED QUESTIONNAIRE

NAME OF INTERVIEWER: ____________ DATE OF INTERVIEW:

LOCATION: ___________ SUB-LOCATION: ___________ VILLAGE: _______

CHILD'S NAME:______________ SCHOOL'S NAME: ___________ CODE: _____

QUESTIONAIRE NO. ________ HOUSEHOLD NO. ________ CHILD NO. ____

DEMOGRAPHY SECTION

1. Name of Respondent (Mother): _______________ Age:_________ (Yrs).

2. Household heads' name: _____________ Age:_____(yrs) Sex: ___ (1=M 2=F).

3. Marital status of household head (Circle)

Codes: 1=married 2=single (never married)
3=separated/divorced. 4=widowed.

4. What religion do you belong to? (Circle)

Codes: 1=Catholic 2=Protestant
3=Muslim 4=Others (specify sect)

5. How many people are there in your household, that is, those who depend on the household for their livelihood, you have cooked and eaten together from the same pot for the last 3 months?

Please give me their names, ages, relationship to the household head, their level of education, occupation, sex and if they have been ill in the last 14 days. (Fill in the following table and **remember to include the respondent who should take serial No.1).**

Serial No.	Name	Sex	Age	R\ship to HHH	Education	Occupation	Illness
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

CODES:

Sex	**Relationship to HHH**	**Education**	**Occupation**	**Illness**
1=Male	1=Head of HH	1=Completed 1-4 of primary	99=Preschool child	1=Yes
2=Female	2=Wife	2=Completed 5-8 of primary	1=Housewife/farming	2=No
	3=Child	3=Attending primary	2=Herding	
	4=Grand child	4=Attended secondary school	3=Farming	
	5=Parent to HHH	5=Completed sec. school	4=Salaried employed/civil servant	
	6=Other relative	6=Tertiary education	5=Artisan, Businesswoman/man	
	7=Servant	7=Adult/informal education	6=Student/pupil	
	8=Other(specify)______	8=Pre -school children	7=Casual labourer	
		9=Not attended school	8=Others (specify)	

6. Among your children aged 0-10 years are there some that you feel do not see well in dim light? (Circle) **1=Yes 2=No.** (If **yes**, then circle their names in the list on the previous page and ask **questions No. 7,8 & 9**; if **no**, move to **question No.10**).

7. What indicators or reasons make you feel that these children (child) do not see well in dim light?

____

____

8. What is the possible cause of this failure to see in dim light?

____

____

9. Have you done anything to assist the child as far as this problem/issue is concerned?

____

____

10. What are the food sources of vitamin A that you know of?

____

____

11. Has any of your children received vitamin A capsules supplementation? (Circle) **1 =Yes 2 =No**
(If Yes, ask question no.12, if No move to question no.13).

12. Where was the supplementation given? ____________________

13 a). What is or are the sources of income for the household?

(Circle appropriately).	**Rank**
1= Sale of food crops grown	_____
2= Sale of animals /their products	_____
3= Casual employment	_____
4= Permanent employment	_____
5= cotton	_____
6= Given by children /Relative	_____
7= Business (self employment)	_____
8= Others (specify) ________________	

b) Of these sources please rank them from the one that gives you the highest to the lowest amount of money.

14. What is your total household income per month? ________________ (Kshs).

15. Do you own any of the following items? **(Circle those owned).**

1.Television set
2. Bicycle
3.Sofa set
4.Cow cart
5.Water tank
6.Radio cassette
7.Hand ploughs
8.Gas/electric cooker

16. What type of energy is usually used for lighting?

1. Fuelwood
2. Electricity
3. Paraffin (Hurricane lantern)
4. Paraffin (Tin with wick)
5. Pressure lamp
6. Solar

17. What cooking fuel do you use?

1. Kerosene
2. Electricity
3. Gas
4. Charcoal
5. Firewood
6. Others (Specify) _______________

18. What is the number of rooms of the main house? ______________________

19. What materials have been used to make the main house's roof, floor and walls? **(Fill in the table accordingly).**

ROOF (Circle)		WALL (Circle)		FLOOR (Circle)	
Thatched	1	Mud	1	Mud	1
Tin	2	Plastered	2	Wood	2
Iron Sheets	3	Bricks	3	Cemented	3
Tiles	4	Stones	4	Tiles	4
Other (Specify)		Other (Specify)		Other (Specify)	

20. Find out and record the type and number of livestock owned .

LIVESTOCK	NO. (INDEGENOUS)	NO. (EXOTIC)
1. Cows		
2. Goats/Sheep		
3. Chickens		
4. Donkeys		
5. Rabbits		

CHILD INFORMATION

(All questions in this section refer to the index child).

Name of index child ________________________________ Serial No. _________

21. Date of birth _______________ Means of verification (Circle)

Codes: 1= Birth certificate 2= Clinic card 3= Baptism card
2= Memory 5= Others (Specify) __________

22. For the past two weeks, has (mention name of the index child) had any illness? (Circle)

1 =Yes 2 =No **(If no, go to Q23; If yes fill in the table below).**

Illness	Where Treated	Treatment	Effective
1. Malaria/Fever			
2. Skin diseases			
3. Mouth sores			
4. Boils			
5. Cough/Cold			
6. Ear ache/discharge			
7. Diarrhoea			
8. Stomachache/Headache			
9. Eye diseases			
10. Wounds			
11. Vomiting			
12. Others (Specify)			

23. How many times is **(mention name of the index child)** fed on the following foods?

FOOD	FREQUENCY	SOURCE
1. Cow's milk		
2. Eggs		
3. Carrots		
4. Pawpaws		
5. Cod Liver oil/Seven seas		
6. Cowpeas leaves		
7. Mangoes		
8. Amaranth (Terere)		
9. Pumpkin		
10. Fish (Makuu)		
11. Liver (Itema)		
12. Pumpkin leaves		
13. Kales/Spinach		
14. Fats and Oils		

Codes:

Frequency: 0 =Not consumed/Never.
1 =Frequently consumed (Once /wk to many times a day).
2 =Not frequently consumed (No more than twice a month).

Sources: 1 =Harvested by the family.
2 =Bought.
3 =Harvested & bought.
4=Inapplicable (Item not consumed).

CLINICAL EXAMINATION.

(To be filled by the clinician). **Codes: 1 =Yes 2 =No.**

26. Oral mucosa: Lesions present: ________ Bleeding gums: _______ Abscess: _________

27. Physical abnormality _____________

28. Pallor ______________

29. Jaundice ___________

30. Skin abnormalities ___________
If yes, specify __________

31. Does the child have any problem seeing in dim light? **(Refer to mother's response in question No.6).**

32. Bitot's spot _________

33. Conjunctiva xerosis ________

34. Corneal xerosis __________

35. In the last 24 hours, (yesterday morning to the time the child woke up this morning) what are the foods that (mention name of the index child) ate?

Time	Dish	Total Vol. of dish	Name of ingredient	Amt. of ingredient in family meal.	Amt. of food served to child (a)	Amt left over by child (b)	Amt cons.by child (a-b)
B\Fast							
Snack							
Lunch							
Supper							

TABLE FOR OFFICIAL USE ONLY DURING ANALYSIS

Time	Prop. of dish taken (Amount eaten/cooked)	Name of ingredients	Amount of ingredients eaten by child	Vitamin A consumed by child (RE)	Energy consumed by child (Kcal)	Protein consumed by child (gms)	Iron consumed by child (mg)
B\Fast							
Snack							
Lunch							
Supper							

FORM NO.1 STOOL SAMPLE EXAMINATION FOR PARASITOLOGY

LOCATION ________________

SUBLOCATION ____________________

VILLAGE ____________________

NAME OF SCHOOL ____________________

QUESTIONNAIRE NO. __________________

CHILD NO. ______________________

NAME OF CHILD __________________ SEX _____ **(1=M 2=F).** AGE _____(Yrs).

DATE OF SPECIMEN COLLECTION ______________________

RESULTS __________

Codes: 1 =Positive
2 =Negative

If positive, parasite type: ____________

Parasitology code:

1. Ascaris
2. Hookworm
3. Trichuris
4. Enterobius
5. Strongiloides
6. E. Histolytica
7. S. Mansoni
8. Others ________________

COMMENT: ____

____

Signed: __________________________________

FORM NO.2 BLOOD SAMPLE ANALYSIS FOR SERUM RETINOL

LOCATION ______________________

SUBLOCATION ______________________

VILLAGE ______________________

NAME OF SCHOOL ______________________

QUESTIONNAIRE NO. ______________________

CHILD NO. ______________________

NAME OF CHILD ____________________ SEX ____ **(1=M 2=F).** AGE _____(Yrs).

DATE OF SPECIMEN COLLECTION __________________

RESULTS: ______________ μg/dl.

COMMENT:____

____

Signed: ____________________________

APPENDIX D: FOCUS GROUP DISCUSSION GUIDE

PARTICIPANTS _________ DATE __________

VENUE ___________

NAME OF MODERATOR ___________ NAME OF OBSERVER / RECORDER ____________

NAME OF PARTICIPANT	AGE	OCCUPATION	MARITAL STATUS	HOME PLACE (Village & school)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				

GUIDELINE QUESTIONS:/

1. What are the main health problems in this region?
2. What medical facilities are available in this area?
3. Are there any factors that either prevent you going to the clinic (health facility) or make it easy for you?
4. What factors do you consider in determining a given households socio-economic status? (Rank them)
5. Are there any existing community programmes here? (If yes which ones, by who and what are their activities).
6. What are the possible causes of night blindness? (Any special name for the problem in this area)?
7. What is vitamin A? (What do you know about it).
8. Have you had any vitamin A capsules supplementation carried out in this region?
9. How do people in this area perceive intake of vitamin A capsules supplementation?
10. 9.What period do you normally experience a shortage of vegetables here?
11. Do you employ any form of food preservation for the lean seasons? (Which ones and on what foods)?

APPENDIX E: KEY INFORMANT INTERVIEW GUIDE

AIM: To determine what is happening in Gachoka as far as Vitamin A interventions are concerned.

- How is the vitamin A policy being implemented in this region?
- Do school children receive vitamin A capsules as form of supplementation of their vitamin A status?
- What are the locally available foods rich in vitamin A that have been identified in this area?
- Are there any projects that have been started/ that are going on in this area that are targeted at alleviating/preventing Vitamin A deficiencies?
- Among the cases treated in hospitals (eye clinics) are there cases of Vitamin A clinical signs?
- How many micronutrient- related barazas/seminars/workshops have been carried out in the area?
- How many vitamin A capsules have been distributed in this division so far? who are the recipients?
- Is there a manual/curriculum developed to help in training of vitamin A deficiencies?
- Is supplementation of vitamin A going on? who gets? How many times per what period?
- Do we have any existing nutrition related community programmes in this area? If so which ones? Any evaluation on the progress? How? How often? By who?
- During health education sessions, is there specific emphasis on micronutrients education?
- Suggestions on alleviation of vitamin A deficiencies (i.e. made by key informants and the health personnel.

APPENDIX F: CHILD-HOUSEHOLD IDENTIFICATION FORM

Please take this form home with you and fill in your Father's name, Mother's name, your Village and your Date of birth.

Child's Name ______________________________

Father's Name ______________________________

Mother's Name ______________________________

Village name ______________________________

Date of Birth ______________________________

THANK YOU!

APPENDIX G: VARIABLES FROM WHICH SOCIO-ECONOMIC STATUS SCORE WAS COMPUTED

1. Sources of income for the household. — Scores

❖ Casual employment	(1)
❖ Given by children or relatives	(2)
❖ Small businesses e.g. selling water, herbs, firewood	(3)
❖ Artisans e.g. selling ropes, baskets, gourds, winnowing trays	(4)
❖ Sale of food crops grown	(5)
❖ Sale of animals or their products	(6)
❖ Cash crops e.g. Miraa, tobacco, cotton	(7)
❖ Business	(8)
❖ Permanent employment	(9)

2. Number of rooms of the main house.

3. Types of materials used to make the main house's roof.

❖ Thatched	(1)
❖ Tin	(2)
❖ Iron sheets	(3)
❖ Tiles	(4)

4. Types of materials used to make the main house's wall.

❖ Mud	(1)
❖ Plastered	(2)
❖ Bricks	(3)
❖ Stones	(4)

5. Types of materials used to make the main house's floor.

❖ Mud	(1)
❖ Wood	(2)
❖ Cemented	(3)
❖ Tiles	(4)

APPENDIX H: STATISTICS SUMMARY OF VARIABLES AND VITAMIN A STATUS

Variable	Correlation	Chi-Squares	P-value**
Childs Age		13.56	0.008
Childs Sex		0.0574	0.8105
Socio-economic Status		1.0796	0.5828
Household Income		2.9142	0.405
Maternal Knowledge on Vitamin A Status		12.899	0.1153
Maternal Education		1.3198	0.5168
Giardia lamblia		0.3164	0.5737
Entamoeba histolytica		0.705	0.4011
Endolimax nana		5.74	0.016
Hookworms		3.094	0.078
Malaria		0.0987	0.7533
Skin Diseases		2.769	0.096
Coughs or Colds		0.029	0.8645
Caloric Intake	0.029.	3.282	0.1937
Protein Intake	0.066	2.646	0.266
Vitamin A Intake	0.1779	2.862	0.238
Cow's Milk Consumption Frequency	-0.0274	2.192	0.3341
Eggs Consumption Frequency	-0.0787	3.863	0.1449
Carrots Consumption Frequency	0.0437	1.093	0.5788
Pawpaws Consumption Frequency	-0.131	2.34	0.31
Cod liver oil Consumption Frequency	0.0718	1.709	0.191
Cowpeas leaves Consumption Frequency	0.0847	1.717	0.4236
Mangoes Consumption Frequency	-0.0382	1.463	0.4811
Amaranth Consumption Frequency	-0.1109	3.262	0.1957
Pumpkin Consumption Frequency	0.0044	1.125	0.569
Fish Consumption Frequency	0.0478	3.472	0.176
Liver Consumption Frequency	-0.003	1.072	0.456
Pumpkin Leaves Consumption Frequency	0.0026	0.5371	0.7644
Kales/Spinach Consumption Frequency	-0.0124	0.8003	0.67
Fats/Oils Consumption Frequency	-0.0434	0.0467	0.8287

* - Significant at P-value 0.01

** - P-values presented are based on Chi-squares.