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VITAMIN A DEFICIENCY AND ITS RISK FACTORS AMONG CHILDREN
AGED 6 MONTHS TO 15 YEARS IN ARSSI ZONE, ETHIOPIA //

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By


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A thesis submitted in partial fulfillment of the requirements for the award of a
Masters of Science Degree in Applied Human Nutrition, in the Applied Nutrition
Program, Department of Food Technology and Nutrition, College of Agriculture
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May, 2000

DECLARATION

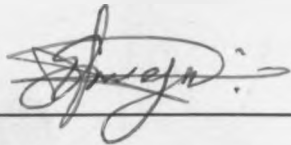
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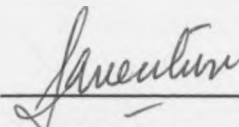
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DEDICATION

This work is dedicated to my parents, the late Mr. Taffesse Asrat and Mrs. Shewaye Alemayhu for sacrificing so much for my education.

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ABSTRACT

A cross sectional study which was descriptive and analytical in nature was carried out between February and April 1999 among children aged 6 months to 15 years in Dodotana Sire district of Arssi zone, Ethiopia. The main objectives of this study was to determine the vitamin A status of pre-school and school aged children and, determine the risk factors of vitamin A deficiency in the study area. The methodologies used in data collection included administration of questionnaire, anthropometric measurements, clinical examination and serum retinol measurement and stool examination. A total of 402 children were included in the study. Food frequency data was collected from 350 randomly selected children. Serum retinol concentration was measured in 49 children, including those with xerophthalmia and every twentieth of the remaining children.

Night blindness, Bitots spot, corneal xerosis, corneal ulceration and corneal scar were observed in 7.2%, 2.2 %, 0.2%, 0.5%, and 0.5% of the children respectively, based on the most severe eye signs. The prevalence of xerophthalmia was higher in school aged children than preschool children ($P < 0.0001$). Based on the WHO recommended cut-off level, serum retinol levels were in the "low" range ($< 20 \mu\text{l/dl}$) in 51% of the children. The mean frequency of consumption of animal sources of vitamin A was 1.5 days/week and weighted total of animal and plant sources of vitamin A was 1.9 days/week. Low frequency of consumption of vitamin A rich food was significantly associated with ocular signs of xerophthalmia ($P < 0.01$).

Of the under 10 years old children (305) 35.7% were stunted, 6.8% wasted and 5.6% both stunted and wasted. Intestinal parasites were observed in 16.6% of the children. The prevalence of diarrhea, respiratory tract infection and measles in the last one month was 10.2%, 4.7% and 0.25% respectively. The prevalence of diarrhea was twice as high in children with xerophthalmia than children without ($P < 0.05$). No statistically significant association was observed between respiratory tract infection or measles or intestinal parasite and occurrence of sign of xerophthalmia. Anthropometric measurements did not show significant association with clinical signs of vitamin A deficiency.

The results therefore, indicate that vitamin A deficiency is a public health problem in the area with higher prevalence among school aged children than preschool children. Inadequate intake of vitamin A rich foods and diarrheal diseases were the most important risk factors for vitamin A deficiency in the study area.

It is recommended that the on-going vitamin A capsule distribution program among the under six be strengthened and widened to include school children (up to 15 year olds) as a short-term intervention measure. However, increasing the availability and consumption of vitamin A rich foods through promotion of horticulture and nutrition education, and public health measures such as the control of diarrheal diseases, are the recommended as long-term control measures.

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DEFINITIONS

- Xerophthalmia** The general term applied to all ocular manifestation of impaired vitamin A metabolism, from night blindness to xerophthalmic scar.
- Night blindness** Maladaptation to dim light due to early stage of vitamin A deficiency.
- Conjunctival xerosis** The earliest, clinically detectable, structural changes on the surface of eye due to vitamin A deficiency. It consists of one or more patches of dry, non-wettable conjunctiva.
- Bitot's spots** A white foamy or cheesy like substance appeared on the conjunctiva due to vitamin A deficiency. It is no more than an extension of conjunctival xerosis.
- Corneal xerosis** Xerosis of the cornea due to hypovitaminosis A. The corneal surface has a rough, fine "pebbly" appearance and lacks luster. At the later stage the cornea may become hazy with a bluish, milky appearance present in the lower central part.

- Corneal ulceration** Ulceration of the cornea resulted from vitamin A deficiency. Ulceration indicates permanent destruction of a part or all of the corneal stroma, resulting in permanent structural alteration. Ulcers are classically round or oval "punched-out" defects, as if a cork-borer applied to the eye. The first signs of corneal ulceration usually occur at the edge of cornea and are characteristically small hole, 1-3 mm in diameter, with steep sides. However, the condition often develops and large defects appear which results in blindness. Large ulcer will cause loss of the anterior segment and occasionally intra-ocular contents as well.
- Corneal scar** Healed sequelae of prior corneal disease related to vitamin A deficiency includes opacities or scars of varying density, weakening and outpouching of the remaining corneal layer.
- Vitamin A** Generic term which includes all compounds with the biological activity of retinol.
- Provitamin A** Carotenoids which can be converted to the active vitamin A when eaten and digested by animals.

- Household size** The total number of people living in a household during the study period.
- Teff (*Eragrosis abyssinica*)** A tiny grain related to millet from which the staple food in Ethiopia, 'Injera' is made which is indigenous to Ethiopia.
- Ophthalmology** The branch of medical science which deals with the diseases and refractive errors of the eye.
- Diarrhea** This term was defined as three or more loose or watery stool passed in a day for at least five days.
- Respiratory infection** This term was defined by the presence of fever and cough for at least five days.
- Measles** This term was defined by the presence of fever and a blotchy rash.
- Household** All the people who live together and operate as a unit, including such members as unrelated servants, lodgers etc.

LIST OF ABBREVIATIONS

ACC/SCN	Administrative Committee on Coordination -Sub Committee on Nutrition of the United Nations.
CSA	Central Statistics Authority.
dl	decilitre
epg	Egg per gram
FAO	Food and Agriculture Organization
HKI	Helen Keller International
HPLC	High Pressure Liquid Chromatography
IVACG	International Vitamin A Consultative Group.
Kg	Kilogram
PEM	Protein Energy Malnutrition
SPSS	Statistical package for social scientists
µg	micro gram
UNICEF	United Nation Children's Fund
VAD	Vitamin A deficiency
WHO	World Health Organization

CHAPTER I

INTRODUCTION

1.1 Background

Vitamin A is a generic term for all retinoids that qualitatively exhibit the biological activity of all trans retinol. Vitamin A is found in food in two forms, as preformed vitamin A and provitamin A. Certain carotenoids have provitamin A activity, of these β -carotene is the most biologically active. Provitamin A carotenoids are found in both plant and animal products. The most important sources are yellow, yellow-red, and dark green leafy vegetables and fruits. Preformed vitamin A is found only in foods of animal origin such as fish, liver, butterfat and eggs. Preformed vitamin A is a better source of vitamin A compared to provitamin A.

The best-defined physiological role of vitamin A is in vision. But it is also involved in the immune system, reproduction, maintenance of differentiated epithelia, and in the formation of specific glycoproteins.

The most obvious consequence of vitamin A deficiency (VAD) is progressive damage to the eye. The general term for this is xerophthalmia, which ranges from the mildest form, night blindness to ulceration and destruction of the cornea and blindness. VAD occurs

when the dietary intake of vitamin A is insufficient to meet the bodies requirement or impairment of the absorption and utilization of vitamin A due to disease conditions. In addition, vitamin A deficiency is exacerbated by low intake of protein and fat.

There is a synergetic relationship between vitamin A deficiency and infections. Poor vitamin A status is likely to prolong or exacerbate the course of illness by impairing the immune system. Infections, on the other hand, reduce the intestinal absorption of carotenoids and vitamin A, increase the metabolic demand or reduce the efficiency of retinol transport and utilization. Infectious diseases that have an association with vitamin A deficiency include diarrhea, respiratory infection, measles and helminthiasis. A study conducted in Indonesia demonstrated that children with diarrhea or respiratory tract infection are twice likely to develop xerophthalmia than children who are free of infection (Sommer et al., 1987). It is also stated that serious infection can precipitate episodes of xerophthalmia (Reddy et al., 1986). Evidence from Africa and other part of the world indicate that about one quarter to one half of all cases of corneal blindness in young children are associated with measles (cited in McLaren D. and Frigg M., 1997).

An association of severe vitamin A deficiency with child mortality had been established long ago (IVACG, 1981) when the deficiency was seen as least a contributory cause of death. Recent studies, however, demonstrated that even mild vitamin A deficiency increases the rate of mortality. Sommer and his colleagues in their study in Indonesia showed that mortality rate among children with mild xerophthalmia (night blindness and

Bitot's spot) was on the average, four times higher than that of children without xerophthalmia (Sommer et al., 1983).

World wide, over 100 million preschool children suffer from vitamin A deficiency (UNICEF, 1998). Each year, it is estimated that between 250,000 to 500,000 preschool children go blind from vitamin A deficiency with about two-third of these children dying within months of going blind (Suharno D., 1994).

The World Health Organization classifies countries according to evidence of subclinical as well as clinical vitamin A deficiency in all or part of the territory (see appendix A1). Accordingly, there are 60 countries in which VAD is a clinically or subclinically significant public health problem (WHO, 1995). Ethiopia falls in this category. A national VAD survey conducted in 1981 revealed a Bitot's spot rate of one percent among preschool children, which is well above the criteria of 0.5 % laid down by WHO (1982). Since then, a number of localized studies have been carried out on vitamin A deficiency. The findings of these studies confirm that VAD is a public health problem in some parts of the country (De sole et al., 1987; Wolde-Gebriel et al., 1992; Yonas et al., 1996,97).

1.2 *Statement of the Problem*

The cause of vitamin A deficiency is complex. It depends on the type and the amount of vitamin A and provitamin A ingested, absorbed, transported and in the storage capacities and metabolic needs of the individual. Disease, more particularly measles and gastrointestinal, respiratory and urinary tract infection, can dramatically alter each of these factors, and in turn, the individual's vitamin A balance. For instance, episodes of acute infection are thought to deplete body hepatic reserves of vitamin A; gastroenteritis will decrease appetite and the absorption of any vitamin A that is ingested (Sommer, 1995). The contributions of these risk factors to vitamin A deficiency, however, vary from one community to another. In some communities availability and accessibility to vitamin A and provitamin A might be the major risk factors for vitamin A deficiency. In others where the prevalence of diarrhea or respiratory tract infection or both, is high, the contribution of these diseases to vitamin A deficiency might be profound. Still, in other protein energy malnutrition and low intake of fat can be precipitating factors. Thus, it is of paramount importance to know the risk factors of vitamin A deficiency in a given community to design an effective intervention program. Such information is in fact very crucial for a country like Ethiopia where the VAD problem is of public health significance.

Preschool children are the most susceptible group to vitamin A deficiency (IVACG 1981, WHO, 1982). However, some studies indicated that school age children are also vulnerable to vitamin A deficiency due to increased requirement to growth, especially

during the adolescent growth spurt (Mclaren D. and Frigg M.,1997). Although mortality rate in school age children is low compared to preschool children, frequent morbidity occurs among school-aged children, such as upper respiratory tract and febrile illnesses, parasitism, and diarrhea. Studies conducted in two Africa countries showed that VAD is a public health significant problem in school age children (WHO, 1993). Studies conducted in Ethiopia on preschool children demonstrated that the prevalence of xerophthalmia increases with age (De sole et al., 1987; Wolde-Gebriel et al., 1991). Furthermore, other studies have shown that corneal ulceration reaches its maximum in the fifth and sixth year of life (Wolde-Gebriel et al., 1993) while xerophthalmia reaches its peak in children aged 60 to 72 months (Yonas et al., 1996). These findings suggest that vitamin A deficiency may will be a public health problem among the school age children in Ethiopia. Yet, information on vitamin A status of school age in Ethiopia is rather scarce.

1.3 Justification

Vitamin A deficiency continues to be a major public health problem in Ethiopia. Over the last four decades, a number of studies on vitamin A deficiency were carried out in Ethiopia on under six years of age children. Few of these studies investigated the risk factors of vitamin A deficiency. No study investigated the vitamin A status of school aged children in spite of the fact that there is evidence that the prevalence of VAD increase with age. Presumably, the lack of this information is the basis for which the on-

going VAD control program in the country has focused much on vitamin A capsule distribution only to under six children. This study was designed to investigate the vitamin A status of both preschool and school age children and the associated risk factors for vitamin A deficiency, in order to provide the lacking information.

1.4 Aim of the Study

The risk factors of vitamin A deficiency in Ethiopia in general and in Arssi zone in particular are not documented. Information on the vitamin A status of school age children is also very limited. Thus, the aim of this study is to provide information on risk factors of VAD and vitamin A status of school age children in Arssi zone, Ethiopia, in order to contribute to the localized and national VAD control programs.

1.5 Objectives

The study is intended, particularly to investigate the risk factors of vitamin A deficiency and vitamin A status of children aged 6 months to 15 years in Arssi, Ethiopia. Eventually, it tries to draw up viable generalization based on the findings about the risk factors of vitamin A deficiency and vitamin A status of preschool and school age children in similar areas.

1.5.1 Specific Objectives

1. To determine the prevalence of VAD among children age 6 months to 15 years in the study area.
2. To determine vitamin A and provitamin A intake of subjects by food frequency.
3. To determine the prevalence of diarrhea, measles, respiratory tract infection, intestinal helminthiasis and protein energy malnutrition among the study subjects.
4. To describe the relationship between VAD and the risk factors (vitamin A intake, diarrhea, measles, respiratory tract infection, intestinal helminthiasis and protein energy malnutrition) in the study population.

1.6 Study Questions

1. What is the prevalence of vitamin A deficiency in the study area by clinical examination and laboratory assay?

2. Which of these risk factors (dietary intake, diarrhea, measles, respiratory tract infection, intestinal helminthiasis and PEM) has contributed to VAD in the study area.

1.7 Expected Benefits

In Ethiopia, the risk factors of vitamin A deficiency and vitamin A status of school age children are not well known. As a result, the national vitamin A deficiency control program and other localized control programs have not been designed to tackle the cause of the deficiency effectively. Moreover, they have been targeted only on preschool children. The findings of the present study will provide a good insight on the causes of VAD and the vitamin A status of school age children in the study area. It will enable health planners and policy makers at regional and national levels to design and implement short-term and long-term VAD control programs based on solid scientific data.

CHAPTER II

LITERATURE REVIEW

2.1 *Historical Background*

Night blindness was recognized as early as 1500 BC and different ways of treating cases were reported in ancient Egypt. The Ebers papyrus, written about 1600 BC in Egypt prescribed liver for those who suffered from night blindness (International Children Center, 1986). In ancient Greece the consumption of cooked liver was practiced following the experience in Egypt (Wolf G., 1978).

With increasing attention on the part of physicians to careful description of the disease and more precise consideration of the circumstance, the concept of xerophthalmia began to emerge. The French physician Jacque Gillemea gave a good description of xerophthalmia in 1585 (International Children Center, 1986). Later on, in 1800s the modern concept of xerophthalmia was established, when dogs that were “starved” on sugar and distilled water developed perforating corneal ulcer resembling those in “ill nourished infants” (Sommer A., 1995). Hubbert (1860) described the occurrence of epithelial dryness and scaling of conjunctiva and corneal in night blind and malnourished subjects who respond positively to ingestion of beef liver (cited in Sommer A., 1982). Later in 1863 Bitot described the foamy patches in the conjunctiva that bear his name. To date, Bitot’s spots are the most important clinical signs of vitamin A deficiency.

At about the same time, the relationship of poor general health and infectious diseases to xerophthalmia was noted in relation to intestinal disease and liver disease (cited in McLaren, 1999). Later in 1923, Werkman observed that rats fed vitamin A deficient diet were less resistant to infection with typhoid or anthrax bacilli (cited in Beaton G. et al., 1993). In 1925, Wolbach and Howe gave a classic account of the epithelial metaplasia and keratinization of the respiratory tract and other organs in vitamin A deficient animals (quoted in Sommer A., 1992). Despite these early findings, only in the 1980s did the present-day intense interest in the relationship of vitamin A and infectious diseases emerge.

Although the cure for night blindness had been known since time immemorial, it was not realized by scholars until the beginning of the 1900s that the condition was caused by lack of a specific nutrient. In 1913, Osborne and Mendel, and McCollum and Davis independently identified a fat-soluble growth factor, which later on proved to be vitamin A. In 1917, McCollum and Simmonds demonstrated that lack of vitamin A caused xerophthalmia in rats. Moore (1920) established a chemical relationship between a substance found in plant tissue called β -carotene and vitamin A (cited in Beaton G. et al., 1993). In 1936, Fuson and Christ, and Kuhn and Morris synthesized vitamin A. About a decade later, commercially feasible process for the synthesis of vitamin A from β -ionone was developed by Otto Isler and his team. Later on, Pommoer developed another excellent commercial process for the synthesis of vitamin A (cited in MacLaren, 1999). Currently, the synthesis of vitamin A is a very simple process, which makes the cost of

the vitamin very low. The cost of the UNICEF 200,000 IU vitamin A capsule is less than 2 US cents (Eastman, 1987; West K and Sommer A, 1993).

Night blindness was widespread in Europe in the medieval times. However, as the education level and income increases and diet becomes more diversified the disease dwindled. In the 1900s, the disease was observed in developed countries rather sporadically and under special circumstances. It occurred in Japan and Denmark in 1904 and 1917, respectively, due to the scarcity of food. According to FAO, the supply of vitamin A in industrialized countries is generally high and most derived from the readily available retinyl esters (cited in Beaton G. et al., 1993).

On the contrary, vitamin A deficiency continues to be the single most important cause of childhood blindness in developing countries. Recently, WHO reported that clinical and sub-clinical vitamin A deficiency are public health problems in 60 countries, and it is likely to be a problem in at least an additional 13 countries. An estimated 2.8 to 3 million preschool-age children are clinically affected, and 251 million are sub-clinically affected at a severe and moderate level based on serum retinol distribution (WHO, 1995). Most countries with clinical VAD are found in south and Southeast Asia and sub-Saharan Africa. However, due to high population density, the largest numbers of persons affected by VAD are in south and Southeast Asia.

In Ethiopia, vitamin A deficiency has long been recognized as public health problem. Back in 1958-59 a survey conducted by the United States Interdepartmental Committee on Nutrition For National Defense revealed a Bitot's spots rate of 1.5% (ICNND, 1959). Demeke et al (1982) reviewed the medical records of 188,737 outpatients that had been seen in two Addis Ababa hospitals with pediatric and ophthalmic services. A total of 685 (0.36 %) patients were identified as cases of hypovitaminosis A. Another study conducted in Gidole Hospital in Gamo Gofa administrative region, showed that out of 116 children admitted with measles, one case had corneal ulcer and two cases had keratomalacia (Lindtjorn, 1983). A Population based study carried out in a district bordering Arssi and Bale administrative region demonstrated a Bitot's spot rate of 5% (De Sole et al., 1987). The national VAD prevalence survey, which was conducted between 1980 and 1981 showed that 1% of preschool children, had Bitot's spot (Wolde-Gebriel et al., 1991). A number of other localized studies that have been carried out in different part of the country also indicated that VAD is a public health problem at least some part of the country (Wolde-Gebribe et al., 1993; Yonas et al., 1996; Yonas et al., 1997). Moreover, there are terms in the major languages of Ethiopia for night blindness: "dafent" in Amharic, "gahmi" in Tigrigna and "bebereti" in oromegana. These imply that the deficiency has been a well-recognized problem in the country. Although the existence of the problem among preschool children was established long ago, more than three decades elapsed before any type of control program was launched. Recently, a control measure mainly focused on vitamin A capsule distribution among the preschool children has commenced.

2.2 Food Sources of Vitamin A

In developed countries, the predominant source of vitamin A in the diet is pre-formed vitamin A, which is derived from animal products such as milk, butter, cheese, egg yolk and liver. In most developing countries, provitamin A carotenoids are the main source of vitamin A. Of all provitamin A carotenoids, β -carotene, which has a structure identical with retinol in both halves of the molecule, has the highest vitamin A activity. Provitamin A carotenoids are mostly present in fruits and vegetables. Some of these are particularly rich, especially yellow or red vegetables (carrots, pumpkins), dark green leaves such as spinach and amaranth leaves, and yellow fruit such as mango and papaya. Some grains, such as yellow maize and tubers such as sweet potatoes also contain notable amounts of provitamin A carotenoids. Red palm oil has the highest carotenoid concentration in the vegetable kingdom.

Due to the differential in efficiency between the retinol and carotenoids, distinction should be made between the vitamin from animal source and plant source. To express the biological activities of preformed and provitamin A in common unit, scholars developed a unit called retinol equivalent (RE).

$$1\text{RE} = 6\mu\text{g } \beta\text{-carotene} = 12\mu\text{g other provitamin A carotenoids}$$

Hence, preformed vitamin A has 6 times higher biological activity than β -carotene, and 12 times than other provitamins.

FAO (1993) indicated that poor people obtain most of their nutrients from plant foods, which are cheaper and more accessible than animal foods. In Africa, for example, 81 percent of the vitamin A supply is derived from plant sources (McLaren D. & Frigg M., 1997). In Ethiopia as in other African countries, the dietary supply of vitamin A is predominantly from plant sources.

General economic development may increase the supply of food rich in vitamin A, improve their distribution as markets expand, and improve the purchasing power of the at-risk population. As indicated earlier, gradual disappearance of vitamin A deficiency was observed in the developed country with economic development. Moreover, analysis of food balance sheet showed that the supply of vitamin A substantially increased in previously deficient South East Asia and South Asia. In contrast, the supply is low and probably not improving in Eastern and Southern Africa (Gillespie S. and Mason J., 1994).

2.3 *Functions of Vitamin A*

Although vitamin A was chemically identified in 1931, the exact mechanisms of vitamin A function in the body are not well understood except on eyes (McLaren, 1999). This might be due to the difficulty to study its function, since it is needed only by complex organisms. However, a number of metabolic roles of the vitamin have been identified.

2.3.1 Vision

The most completely understood function of vitamin A at molecular level, to date, is the role of retinyl aldehyde (retinal) in forming visual pigment in the photoreceptor cells (rods) of the retina of the eye. Rod cells contain many stacked, disk-like membrane vesicles, which serve as light receptors. The membrane of the vesicles contains the light absorbing protein, rhodopsin and the vitamin A derivative, 11-cis-retinal. When rhodopsin is exposed to light, the 11-cis-retinal is transformed to all-trans-retinal, and this is accompanied by change in the conformation of the protein. In the process of returning to the original conformation in the dark, there is a release of energy which result ultimately in the generation of electrical impulse that travel along the optic nerve to the brain to create a visual image. Thus, when vitamin A is deficient, the rhodopsin level decreases in the eye and night blindness ensues.

2.3.2 Reproduction

The role of retinol in reproduction is possibly mediated through its involvement as cofactor for the enzymes 11- β steroid hydroxylase and 5, 3 β -hydroxysteroid dehydrogenase. The latter enzyme converts pregnenolone to progesterone, which is a key intermediate in the synthesis of variety of steroid hormones including the glucocorticoids, androgens and oestrogen. Thus VAD gives rise to the production of abnormal sperm in males and, low rates of conception and increased rates of still births in females.

2.3.3 Maintenance of epithelial cells

Vitamin A helps to develop and maintain moist and healthy epithelial tissue, the tissue that lines the body's external and internal surfaces. Deficiency of vitamin A lead to keratinization of the epithelium tissue, such as conjunctival and corneal epithelium of the eye, and all mucus membranes of the digestive, urinary and respiratory tract. Furthermore, it affects the integrity of the epithelium barrier and makes the cells to lack normal secretions, with loss of cilia to keep the surface clean. Vitamin A deficiency, has been associated with diarrhea and respiratory tract infection, presumably related to a weakened condition of the respective intestinal or pulmonary lining (Eastman, 1987).

2.3.4 Immunity

Vitamin A status influences the ability of the immune system to respond. Hypovitaminosis A impairs the integrity of the epithelium layers by permitting keratinization, which could lead to increased penetration of bacteria, viruses and parasites through altered epithelial barriers (Eastman, 1987). In the intestine, a reduction in the number of goblet cells and in mucus production disrupts non-specific defence mechanisms of the gastrointestinal tract. VAD also decreases immune system in other several ways including changes in lymphoid cell maturation, abnormal production of cytokines and lymphokines that regulate the immune response, and alters the

membrane structures that could affect the cell's receptors antigens and regulatory molecules (Beaton G. et al., 1993).

A number of studies have shown the role of vitamin A in the immune system. Lysozyme activity in leucocytes from Indian children with VAD was observed to be decreased, returning to normal after treatment (Mohanram M. et al., 1974). Reduction in infection when vitamin A or β -carotene is given before or shortly after exposure to a bacterium is also documented (Somer E., 1992).

2.3.5 Growth

Vitamin A is essential for normal bone growth and the formation of soft tissue. The function of vitamin A in bone growth may involve the conversion of immature cells to osteoblasts, which are responsible for increase in the number of cells. In experimental animal where other variables can be controlled, dietary restriction of vitamin A showed a decrease in the velocity of growth (Eastman, 1987; Beaton G. et al., 1993). However, it is very difficult to observe such an effect on young children due to various reasons: specific restrictions can not be applied as in the case of experimental animals and VAD frequently accompanies infections and this influences nutritional status in several ways.

McLaren And Frigg (1997) noted that periodic mega dose vitamin A supplementation seems to have a significant impact on growth of xerophthalmic children but not in children with sub-clinical deficiency.

2.4 Epidemiology of Vitamin A Deficiency

The occurrence of xerophthalmia and vitamin A deficiency follows recognized patterns with respect to place, time and person. Those factors that have prominent association of xerophthalmia include age, sex, season and clustering.

2.4.1 Age

Preschool children: Both the clinical and sub-clinical vitamin A deficiency can occur at any age (WHO, 1995). However, VAD is most frequently encountered in preschool children in many areas of the world (IVACG, 1981). This is not surprising, since the requirement of children per kg of body weight is about three times higher than that of adults. Furthermore, preschool children are at increased risk of VAD due to higher incidence of intestinal infestations and respiratory tract infections, which impair vitamin A absorption, storage, transport and utilization. PEM incidence, which is high in this age group also, interferes with the transportation of the vitamin. Measles on the other hand increases these children's metabolic demand of the vitamin.

School aged Children: Vitamin A deficiency is a major public health problem among preschool children in much of the developing world. However, it has recently been recognized that its impact goes well beyond this age group. A publication from India showed that nearly 80% of school-aged children (5-15 years) had low serum retinol ($<20\mu\text{g}/\text{dl}$) accompanied by significant low intake of preformed vitamin A and provitamin A compared to Recommended Dietary Allowance (Pant I. and Gopaldas T., 1986). A study carried out on children aged 6-10 years in Burkina Faso demonstrated a Bitot's spots rate as high as 2.15% (WHO,1993). These findings suggest that VAD is a major nutritional problem among school age and pre-adolescent children. For these age groups visual impairment caused by vitamin A deficiency has deleterious effect on their education, which impacts upon family, community and national development. Hence, there is a need to provide adequate vitamin A for these children. While a clear priority exists to prevent VAD in preschool children, increased attention needs to be given to the extent and severity of VAD and its risk factors among school-aged and pre-adolescent children which has been focused in this study. This information will particularly be important for health planners of the Ministry of Health, Arssi zone and Dodottan Serie woreda health departments who are currently in charge of the vitamin A deficiency control program in the study area.

2.4.2 Sex

Investigations on the experimental animals and humans in general point toward the greater susceptibility of male to the effect of VAD (McLaren D. and Frigg M., 1997). In healthy human adults plasma retinol and retinol binding protein (RBP) are both higher in men than female (IVACG, 1981). Gender difference in risk of VAD has mostly been observed at milder stages. Higher risks of night blindness and Bitot's spots are frequently observed in boys than girls (Sommer A., 1995). This greater vulnerability of boys to mild Xerophthalmia has also been reported from Ethiopia and elsewhere (De sole et al., 1987; Wolde-Gebriel et al., 1991; Yonas et al., 1997; Bushra et al., 1987; cited in IVACG, 1981).

Conversely, a detailed longitudinal study by Sinha and Bang did not show any sex difference in the prevalence of mild xerophthalmia (cited in McLaren D. and Frigg M. 1997). Studies conducted on supplementary trials also demonstrated no major difference in the relative effectiveness of vitamin A between the sexes (Beaton G. et al., 1993). This indicates that study findings on the association between sex and xerophthalmia are not consistent. Corneal ulceration equally affects both sexes in most societies or culture (Sommer A., 1995). IVACG noted that male preponderance to mild VAD is more likely to be related with cultural factors rather physiological (IVACG, 1981).

2.4.3 *Season*

The occurrence of xerophthalmia follows certain seasonal patterns, which correspond to periodic availability of food and disease. Xerophthalmia is more prevalent during the hot dry season when, vegetables which are an important source of dietary vitamin A, are in short supply and measles and diarrhea are common (Sommer A, 1995). In South Asia xerophthalmia normally reaches peak in the late, dry season (Hennig A. et al., 1991). This peak is also associated with the "measles season" (Reddy V. et al., 1986). Xerophthalmia declines in summer with increase in availability and intake of provitamin A-rich food (Zeitlin M, et al., 1992).

2.4.4 *Clustering*

Vitamin A deficiency is usually found in clusters, i.e., children that are immediate neighbor of an active case of xerophthalmia are more likely to be deficient in vitamin A, and at higher risk of xerophthalmia than children of the same age, sex, and socioeconomic status residing in different parts of the same village or town (Sommer A., 1995).

It is also well documented that VAD clusters in the household and is more likely to occur in siblings. Children in the same household exhibit similar vitamin A status. Findings from four countries (Nepal, Smarta, Malawi and Zambia) demonstrated that if one child

in a household had xerophthalmia, another child in same household was 7.3 to 13.2 times more likely to develop xerophthalmia than if the index child did not have xerophthalmia (cited in IVACG, 1996). Furthermore, the clustering effect might extend to other vulnerable family members. A study conducted in Bangladesh showed that risk of mothers of xerophthalmic children having night blindness were between 5 and 10 times higher than mothers of children without xerophthalmia (Bloem M. et al., 1994).

2.5 Risk Factors of Vitamin A Deficiency

Vitamin A status of an individual principally depends on three factors: the intake, absorption and utilization of vitamin A. Interference at any of these processes can lead to the deficiency.

2.5.1 Dietary Intake

One of the major causes of vitamin A deficiency in developing countries is inadequate intake of foods rich in vitamin A. There is a wealth of evidence in the literature that indicates the inverse relationship of dietary intake of food rich in vitamin A and risk of xerophthalmia. For example, study done in the Sudan demonstrated that the risk of xerophthalmia was inversely associated with dietary intake of vitamin A among children (Fawzi W. et al., 1993). Xerophthalmic children in Indonesia were less likely than non-xerophthalmic children to consume green leafy vegetables and fruits (Tarwotjo et al.,

1982). In Bangladesh households with a small garden had fewer children who were night blind. Households with no garden had children 10 times more likely to have corneal lesions than household with a garden (Cohen et al., 1985). Other related studies also demonstrated similar beneficial relationship between dietary vitamin A intake and risk of xerophthalmia (Wilma et al., 1991; Ramana et al., 1991).

Recent findings, however, indicated that the bioavailability of plant source of vitamin A, especially from dark green leaf vegetable and to some extent also from fruits and tubers is much lower than what has been assumed. Controlled studies carried out in Indonesia demonstrated no improvement in vitamin A status of lactating women consuming additional daily portions of dark green leafy vegetables, though a similar amount of pure β -carotene from simpler matrix produced a significant increase in both β -carotene and retinol (De pee et al., 1995).

Although a number of studies have been conducted on VAD in Ethiopia, only few of these studies have documented the dietary intake of vitamin A. Gebre-Medhin (1975) studied the dietary intake of 10 privileged and 20 non-privileged Ethiopian women selected from two institutions in Addis Ababa. The result of this study indicated that non-privileged women consumed a diet that was, on the average, inadequate in all nutrients except iron and thiamin. Six of the women were found to have a level of vitamin A intake below 80 % and seven below 40% of the recommended intake. A survey done in southern Ethiopia where mono-crop (cereals) cultivation was practiced

revealed a Bitot's spots rate of 5%. One of the major reasons suggested by the authors for the high prevalence of the deficiency in the area was monoculture practice (De sole et al., 1987). Another study carried out in the area where enset (*Ensete vertricous*) is the staple diet demonstrated that the consumption of protein, vitamin A, iron and calcium were between 107 and 175 % of the requirement (Pijls L. et al., 1989). This finding is well in agreement with the result of the national clinical and biochemical survey of xerophthalmia. No cases of Bitot's spots and corneal lesion were found in this area during the national VAD prevalence survey.

Vitamin A does not work in isolation. Dietary fat is also necessary for metabolism and absorption of carotenoid and vitamin A in the intestine. Adequate protein and zinc status assists maintenance of vitamin A status. Vitamin E by the virtue of its anti-oxidant property may protect vitamin A and carotenoids from being oxidized (IVACG, 1979).

2.5.2 Morbidity

Diseases influence vitamin A by altering its absorption, storage, tissue utilization and conservation or recycling. Diseases such as measles, diarrhea, respiratory tract infection and protein energy malnutrition are the most important diseases that influence the vitamin A status of an individual. However, studies on the association between these diseases and vitamin A deficiency have given differing results (cited in Blome M. et al, 1998). Many factors such as under and over reporting, difference in the definition, stage

of infection and degree of VAD and difference in the underlying factors might be responsible for the inconsistent outcomes.

2.5.2.1 *Measles*

Measles precipitates vitamin A deficiency both by reducing dietary intake and absorption, and by increasing the demands for the repair of epithelial tissues including the cornea and conjunctiva. Previously marginal vitamin A store in the liver of malnourished children is rapidly exhausted during measles infection.

Evidence show that measles is an important risk factor for the development of VAD and blindness in Africa, as well as in some of the most densely populated countries of Asia. Study conducted in Bangladesh showed that 10 percent of the children with active corneal lesion had a history of measles within the previous four weeks (Eastman, 1987). In Indonesia, children who had a history of recent measles were eleven times more likely to get corneal xerophthalmia than children who had not had measles (Sommer A., 1992). Fifty percent of children in schools of the blind in the United Republic of Tanzania and Malawi, gave a history of measles immediately preceding the blinding episode (UNICEF, 1987). In undernourished children measles takes its severe form but it affects the cornea even in the well nourished child (IVACG, 1981).

2.5.2.2 *Diarrhea*

Diarrheal disease is one of the leading causes of childhood mortality and morbidity in developing countries and a major contributor to malnutrition. Diarrheal diseases claim four million deaths per year, or accounting for 28% of all under five deaths. In developing countries preschool children on the average have 2 to 5 episodes of diarrhea per year accounting for 10 to 25 days of illness (Northrup and Rohde, 1992). An analysis of fifteen studies on the incidence of diarrheal diseases in Ethiopia indicates that a child has five episodes of diarrhea per year on the average, which means he is sick at least twenty to thirty five days a year from this illness alone (Ministry of Health, 1986).

Gastroenteritis changes the type and amount of food offered to a child and his appetite. Furthermore, it decreases absorption of whatever amount of vitamin A that is ingested by shortening the transit time. Population based studies have not, however, demonstrated consistent findings with regard to the association between diarrheal diseases and xerophthalmia probably for the reasons mentioned earlier.

A number of studies that were carried out, especially in Asia showed that low level of vitamin A is associated with diarrheal diseases. The national survey of Bangladesh demonstrated that all children with either multiple corneal ulcers or keratomalacia had diarrhea, in the preceding four weeks (Cohen et al., 1985). In another study carried out in Bangladesh by Khan et al. (1984) it was revealed that 86 percent of cases of

xerophthalmia in the study gave a history of diarrhea in the month preceding the onset of the eye lesion. In a prospective study in west Java, children with diarrhea or respiratory infections were twice likely to develop Bitot's spots or night blindness than children who were free of infection (Sommer A. et al., 1987). De sole et al. (1987) also found in Ethiopia that the prevalence of diarrhea was twice as high in children with xerophthalmia than children without.

In contrast to the above findings, there are also studies where no association was demonstrated between xerophthalmia and diarrhea. Milton et al. (1987) in their study in India noted that mild xerophthalmia did not associate with the incidence of diarrhea. A study conducted in Philippines, by Salon et al. (1978) couldn't show any correlation between diarrhea and xerophthalmia. In a cross-sectional study carried out in Tigrai region, northern Ethiopia, no association was observed between incidence of diarrhea and occurrence of signs of xerophthalmia (Yonas et al., 1997).

2.5.2.3 *Respiratory infection*

Animal studies and observational studies in human population have demonstrated that respiratory infections worsen vitamin A status at all levels. A longitudinal study carried out in Indonesia showed an increased risk of respiratory disease (RR=1.8) in children with mild VAD (Sommer A. et al., 1983). The prevalence survey conducted in Cebu,

Philippines revealed that active xerophthalmia was positively correlated with having had pulmonary tuberculosis or recent whooping cough (Salon S. et al., 1978).

A meta-analysis of intervention trials on vitamin A and morbidity, however, indicated that supplementation in general does not decrease incidence, duration and/or prevalence of acute lower respiratory infection (ALRI). Evidences from some studies suggested that supplementation of vitamin A might reduce severity of respiratory infection (McLaren D. and Frigg M., 1997).

2.5.2.4 *Intestinal worms*

Intestinal worms cause the lining of the intestine to change, which reduces the surface membrane available for digestion and absorption. Studies have suggested intestinal helminthic infections impair the absorption of vitamin A. Children and adults suffering from ascariasis or giardiasis showed an impaired absorption of vitamin A (Machilin, 1991). Fat absorption, which is necessary for vitamin A metabolism can also be impaired by parasitic infection of the intestine (Mahalanabis et al., 1979).

2.5.3 *Protein Energy Malnutrition*

Vitamin A is mobilized from the liver stores and delivered to peripheral tissue by a highly regulated transport system. This system involves two plasma proteins: retinol

binding protein (RBP) and prealbumin (PA). For normal synthesis and function of these carrier proteins, adequate intake of good quality protein is necessary (IVACG, 1981). Both experimental and clinical studies suggest that low protein status can impair RBP synthesis and its release from the liver (McLaren D. and Frigg M., 1997).

Incidence of xerophthalmia in PEM varies greatly in different areas, however, PEM almost invariably accompanies xerophthalmia in the young children (IVACG, 1981). Moreover, high death rate among PEM children parallels their vitamin A status. In India, 175 children with kwashiorkor were admitted, all having low serum vitamin A levels. Eighteen (10.3%) of the 175 children died. Of the 18 deaths, five had keratomalacia, one had Bitot's spots and five other had vitamin A serum level below $10\mu\text{g}/100\text{ml}$ (Eastman, 1987).

2.6 *Assessment of Vitamin A Status*

Methods available to date for assessing vitamin A status can be grouped into clinical, biochemical and dietary intake. The clinical signs are the most important method of assessing vitamin A status. However, techniques that detect marginal vitamin A status before the onset of clinical signs are of significant value. In this regard, several techniques for assessment of vitamin A status have been developed. Of course, the most accurate indicator is analysis of liver sample obtained as autopsy or by surgical and needles biopsies. This method can only be applied in special, justifiable situations but is

not appropriate in a field situation. Other methods that have been developed to determine the vitamin A status of an individual includes relative dose response (RDR), Modified relative dose response (MRDR), isotope dilution and serum retinol. However, the only indicators so far approved by the World Health Organization are clinical signs of xerophthalmia, night blindness and plasma retinol level (IVACG, 1993). In this study clinical signs of xerophthalmia, plasma retinol level and dietary survey were employed to assess the vitamin A status of the study population. These methods are discussed in detail below.

2.6.1 Clinical Indicators

Xerophthalmia is the most readily recognized clinical manifestation of VAD and the most widely used indicator. A gradual depletion of vitamin A store results in xerophthalmia of increasing severity, manifest as night blindness (XN), Conjunctival xerosis (X1A), Bitot's spot's (X1B), corneal xerosis (X2), corneal ulceration/Keratomalacia (X3A & X3B) and corneal scar (XS).

Criteria for diagnosis of xerophthalmia and assessing the public health significance of vitamin A deficiency in the community has been laid by WHO (1982). The major signs and symptoms of xerophthalmia are classified in Table 1.

Table 1 Classification of xerophthalmia

WHO code	Description
XN	Night blindness
X1A	Conjunctival xerosis
X1B	Bitot's spot
X2	Corneal xerosis
X3A	Corneal ulceration, Keratomalacia < 1/3 corneal surface
X3B	Corneal ulceration, Keratomalacia ≥ 1/3 corneal surface
XS	Corneal scar due to Xerophthalmia

Source: WHO, 1982

2.6.2 Biochemical Indicators

Measurement of circulating retinol level represents the most common biochemical measure of vitamin A status. Interpretation of individual values is limited by homeostatic controls that maintain serum retinol within normal ranges, except the extremes of the continuum, which represent either toxicity or hepatic depletion of vitamin A stores. Thus, serum levels of vitamin A are not considered as reliable index of subclinical vitamin A status of an individual. However, serum vitamin A the status of

population in terms of mean (\pm SD) and the proportions of individuals who are likely to be deficient (or in state of toxicity) is very important (IVACG, 1993). Conventional cutoff points for serum retinol level are presented in Table 2. Serum retinol level less than $0.35\mu\text{ mol/l}$ ($10\mu\text{g/dl}$) in more than 5% of the population at risk indicates a significant vitamin A deficiency problem.

Table 2 Relationship between vitamin A status and the concentration of retinol

Vitamin A status	Concentration in serum retinol $\mu\text{mol/l}$
Deficient	<0.35
Marginal	0.35-0.70
Adequate	>0.70

Source: IVACG, 1993

2.6.3 Dietary Assessment

The techniques available for the assessment of dietary intake of vitamin A are recognized to be imprecise. Many factors are difficult to control making the result obtainable by even conscientious workers inaccurate. Household consumption cannot be relied upon to provide an indication of the intake of individual members of the household, and this is especially true to for the young child.

Even though dietary intake survey is not an indicator of vitamin A status in the same sense that biochemical and clinical methods do, it can be used as supportive evidence to point out the inadequacy of vitamin A intake. One of the existing methods that can help in assessing the inadequacy of vitamin A and β -carotinoieds is the Helen Keller International Food Frequency Method (HKI-FFM). This method uses a cut off values for weekly frequency of consumption of key vitamin A-rich foods that has been validated against serum retinol as an indicator of risk of vitamin A deficiency in 15 communities drawn from Philippines, Guatemala and Tanzania (i.e 5 communities from each countries). The HKI-FFM is done by administering a questionnaire, which has a list of 28 food items to a randomly selected child mother, and evaluating the frequency of consumption of vitamin A-rich foods. Vitamin A deficiency is a public health problem in a given community if either of the following two threshold values is satisfied. Less or equal to 4 days per week mean frequency of consumption of animal source vitamin A or less or equal to 6 days per week mean frequency of total consumption of animal and plant source of vitamin A (weighted by source). If vitamin A deficiency is a problem of public health significance in at least 70 percent of community surveyed, vitamin A deficiency is likely to be a public health problem in the entire surveyed area (Rosen et al., 1993).

The above studies have shown that investigations carried out in Ethiopia on vitamin A deficiency have mainly described the situation among preschool children. However, studies conducted elsewhere reveal that vitamin A deficiency is a major nutritional

problem even among school age children in underprivileged population. These studies suggest that while investigations and control measures directed towards alleviation of vitamin A deficiency in a population should give priority to preschool children, a greater attention should also be given to school age children.

The studies described in this paper also point to various risk factors of vitamin A deficiency. However, the question regarding which of the risk factors significantly contributes to the vitamin A deficiency problem in any given community needs to be assessed in order to suggest an effective means of alleviating the problem. This study investigated the risk factors of vitamin A deficiency in Arssi zone, central Ethiopia.

CHAPTER III

METHODOLOGY

3.1 *Background of the Study Area*

3.1.1 *Country Profile*

Ethiopia is a country with an area of 1.14 million square kilometers (444,000 square miles). The diverse topography of the country generally features rugged mountains, flat-topped plateaus, deep river canopy, rolling plains and low lands. Ethiopia is bordered by Kenya on the south, Eritrea on the north, Somalia and Djibouti on the east and the Sudan on the west.

According to the 1994 census, the population of the country as of October 1994 was 39,947,533. The annual population growth rate is about 3 percent, and the economically active segment, between ages 14 and 60 is about 50 percent of the population. Approximately 85 percent of the population live in rural areas with agriculture being the main activity.

Although Ethiopia lies within 15 degrees north of the equator, owing to the moderating influence of high altitude, the central highlands, where the vast majority of Ethiopian

people live, generally enjoy temperate climate, with average temperature rarely exceeding 20°C (68°F). The average annual rainfall for the whole country is approximately 850 mm (34 inches).

Ethiopia has three seasons: The 'Belg' season (short rains) from February to May, the 'Keremet' season from June to September (long rains), and the 'Bega' season (dry period) from October to January. With the two rainy seasons, many regions are able to produce two harvests a year. Although approximately two-thirds of Ethiopia's landmass is arable, only 15 percent of its area is presently under cultivation. Only about 3 percent of the 3.5 million hectares of potentially irrigable land are being irrigated.

The main staples, cereals, pulses, oil crops and enset (*Enset Ventricosum*) pre dominate the diet of the Ethiopian people accounting on the average for about 75 percent of total calories during the 1980s. Among cereals, by far the most important are teff (*Eragrostis tef*), sorghum, maize, followed by barely and wheat. Ethiopia has the largest livestock population in Africa. Estimated per capita consumption of meat is 13 kg per annum, and this is reasonably high by the standard of developing countries.

The principal health problems in Ethiopia are communicable diseases and nutritional deficiencies. Available data indicated that 8 per cent of children under 5 years of age are wasted, 64 per cent are stunted and 47 per cent are under weight (CSA, 1992). Next to

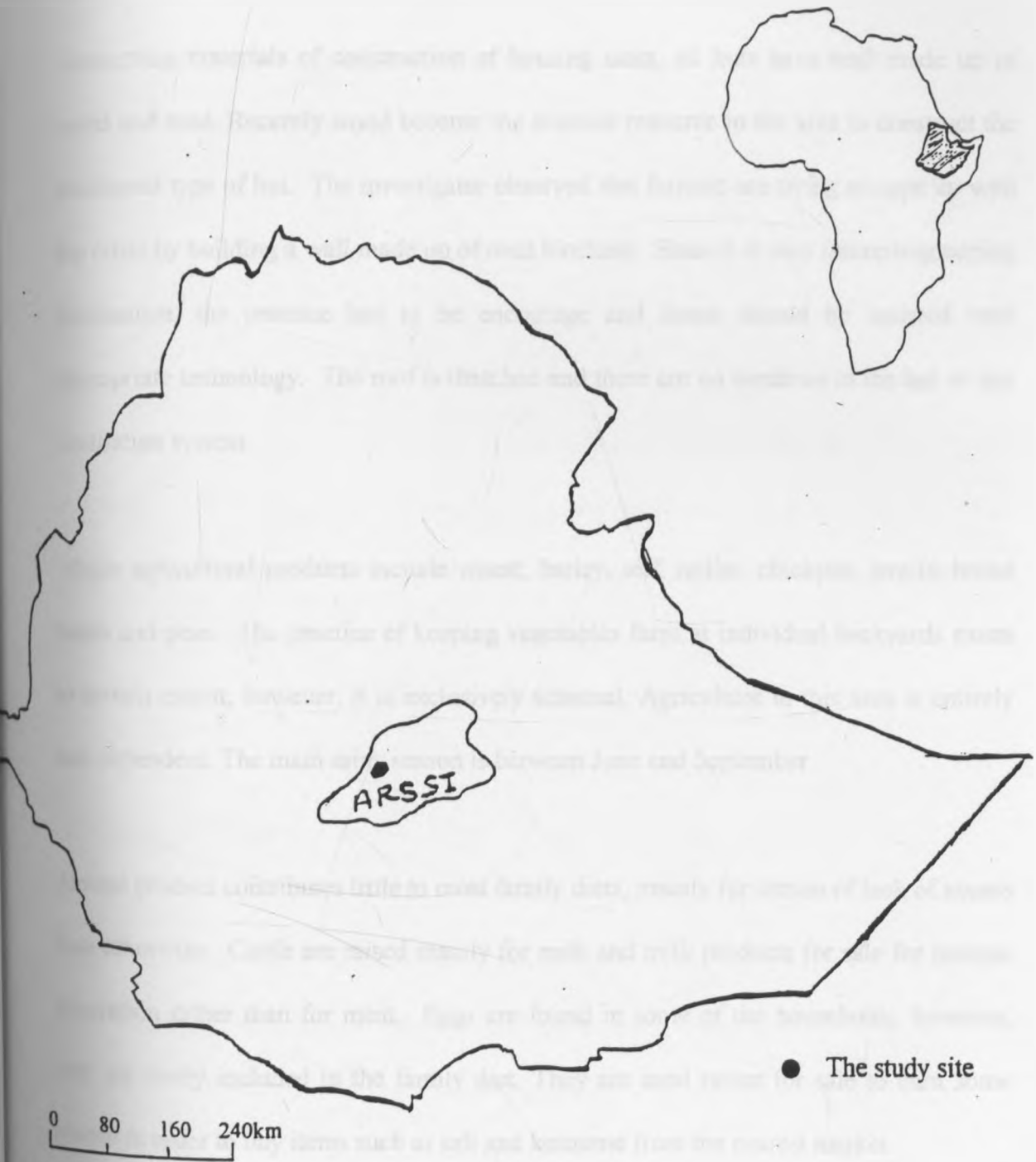
protein-energy malnutrition, deficiency of iodine and vitamin A and nutritional anemia are the commonest nutritional problems in Ethiopia.

3.1.2 *Study Site*

This study was conducted in Dodotana Sire wereda (district) of Arssi zone, central Ethiopia (figure 1). According to 1994 population and housing census, the population of Arssi zone as of October 1994 was 2,217,245 of which 1,105,439 (49.9%) were males. Administratively the zone is divided into 20 weredas. The overwhelming majority (90%) of the population of Arssi lives in rural areas and only 10% of the population of the zone live in urban center. The major ethnic groups of Arssi zone residents are 85 percent Oromo, 9.1 percent Amhara and 1.3 percent Guragie. Other ethnic groups constitute the remaining 4.6 percent. Since more than 85 percent of the rural part of Arssi zone inhabited by the Oromo ethnic group the feeding habit of the rural Arssi is similar. Over half (55.5%) of the Arssi population are Muslims and about 44 percent are orthodox Christian (CSA, 1996).

Dodotana Sire wereda is organized in three towns and 43 farmers associations. The population of the wereda as of October 1994 was 88,463, of which 45,316 (51.2%) were males. An asphalt road that connects Assela (the capital of Arssi zone) with Addis Ababa cuts across the Awash Melkasa and Diera Towns of the wereda. The third town of the wereda is located 25 kilometers off the asphalt road but is connected by all –weather road.

Figure 1 Map of Ethiopia showing Arssi zone and study site.



The actual study sites Tedecha Guracha and Badosa Betela farmers associations are found about 8 to 16 Km south of Diera town (the worda capital). They are located in the “kola” (lowland zone) featuring an arid hot land type of climate.

Concerning materials of construction of housing units, all huts have wall made up of wood and mud. Recently wood become the scarcest resource in the area to construct the traditional type of hut. The investigator observed that farmers are trying to cope up with the crisis by building a wall made up of mud blockets. Since it is very interesting coping mechanism, the practice has to be encourage and farms should be assisted with appropriate technology. The roof is thatched and there are no windows in the hut or any ventilation system.

Major agricultural products include wheat, barley, teff, millet, chickpea, lentils, broad beans and peas. The practice of keeping vegetables farm at individual backyards exists to certain extent, however, it is exclusively seasonal. Agriculture in this area is entirely rain dependent. The main rainy season is between June and September.

Animal product contributes little to most family diets, mainly for reason of lack of access than otherwise. Cattle are raised mainly for milk and milk products for sale for income generation rather than for meat. Eggs are found in some of the households, however, they are rarely included in the family diet. They are used rather for sale to earn some money in order to buy items such as salt and kerosene from the nearest market.

The source of water of all households is protected well which is made in different places with in the two farmer associations. Fetching water is a responsibility of mothers and females offspring. The wells are usually one to two kilometers away from home and further in dry season. Women fetch water two to three times a day. Water is mainly transported in traditional clay pot by women on their backs, and in a few cases donkeys are also used to transport water.

The hygiene is generally poor and washing is done infrequently due to the lack of water especially in the dry season. Latrines are unknown in the area.

Dera health center, the nearest health facility is about 8 to 16 kilometers from most households. The building, facility and staffing level of the health center is good. The nearest hospital is found in Nazareth town, which is about 30 kms west of the farmer associations, otherwise the people travel 50 kms east to reach zonal hospital in the zone capital.

3.2 Study Design

A cross sectional study with analytic and descriptive component was undertaken in Tedecha Guracha and Badosa Betela farmer associations, Dodotana Sire wereda, Arssi zone, central Ethiopia. The survey was conducted between February and April 1999.

A total of 402 children between the age of 6 months and 15 years comprised the study population. Demography and morbidity data was collected by administering a pretested questionnaire to mothers (for children under 6 years old) and to the children and their mothers in case of children older than the age of 6 years. Data on consumption frequency was collected from 350 randomly selected children using Helen Keller International (HKI) food frequency method.

Anthropometry measurements were taken for all children. All study subjects were clinically examined for symptoms and signs of xerophthalmia. Serum retinol level analysis was performed on all clinically positive cases and every 20th child with out signs.

Before the data collection commenced, the purpose of the study was communicated to the wereda administrative and health officials. After that the principal investigator together with the health personnel of the wereda briefed the community leaders of the two farmer associations about the purpose of the study on their respective places. Through the community leaders the objective of the study was transmitted throughout the households in the villages.

Enumerators were recruited among candidates who completed high school and fluent in the local language, Oromegan. Further training was given to the enumerators on how to administer the questionnaire and how to approach the target respondent.

Piloting was done around the area not very far from the area where actual study was carried out. Twenty households with children under fifteen years of age were sampled for

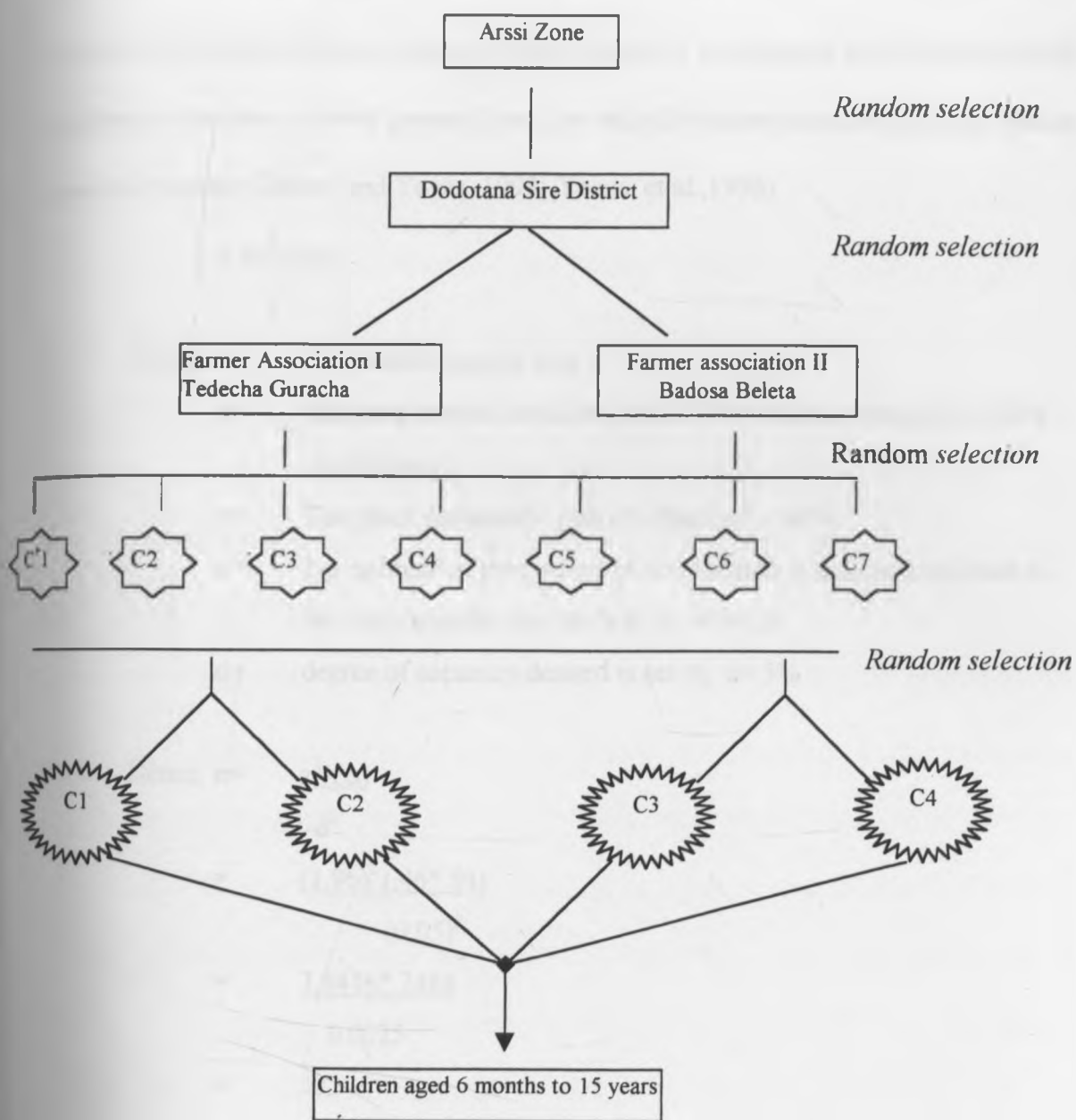
piloting. The result was discussed with health officials in the study area and minor change on the questionnaire was made.

3.3 Sampling

3.3.1 Sampling Procedure

Multistage, cluster sampling technique was used in selecting the study sample. Of 20 districts of Arssi zone Dodotana Sire district was selected at random for this study. The district has three towns and 43 farmer associations. The three towns of the district were purposely excluded from the sampling frame in order to get homogeneous group. Of the 43 farmers associations two farmer association were selected randomly. Census was carried out in the selected two farmer associations. Households with at least one under fifteen years old child were identified and grouped into clusters based on their geographical proximity. A total of 15 clusters were formed. Of these 7 clusters were randomly selected and used to collect information on consumption frequency. Each cluster had 50 randomly selected households. From the selected 7 clusters 4 clusters were selected at random and a maximum of three children age between 6 months to fifteen years per household were included in the study until the required sample size was achieved. The multistage, cluster sampling procedure was employed in this study because it is the most practical and popular means of sampling the population at risk of VAD (Sommer A., 1995). The details of the sampling procedure used are presented diagrammatically in figure 2.

Figure 2 Flow chart showing the sampling procedure



C* = Cluster

3.3.2 Sample Size Determination

The sample size was calculated using the formula shown below. Since the proportion of vitamin A deficient children in the area is not known, it is estimated that the extent of the problem in the area to be 46 percent based on the information obtained from the studies done in the zone (Tezera and Yonas, 1993; Yonas, et al., 1996).

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

Where n= The desired sample size

z= Standard normal deviation, set at 1.96 which correspond to 95% confidence.

p= The given prevalence rate of vitamin A = 46%

q = 1-p estimate of proportion of non vitamin A deficient children in the study area for this study q=1- .46 = .54

d= degree of accuracy desired is set at, d= 5%

$$\text{Hence, } n = \frac{z^2 (pq)}{d^2}$$

$$= \frac{(1.96)^2 (.46 * .54)}{(0.05)^2}$$

$$= \frac{3.8416 * .2484}{0.0025}$$

$$= 383$$

$$= 5\% \text{ allowance} = 19$$

$$n = 383 + 19 = 402$$

3.4 *Consumption Frequency of Vitamin A Rich Foods*

For assessment of consumption of vitamin A rich foods 7 community clusters were randomly selected. In each of these communities, 50 mothers or primary caretakers of children from 1 through 15 years of age (12 through 179 months) were interviewed. Before administering the HKI food frequency, food items that are rich in vitamin A content and those that were available in the locality were identified through qualitative market survey and group discussion. All food items in the preliminary food list of HKI food frequency method were included in the food frequency questionnaire even if some these foods were not available locally. Only few food items were replaced based on the criteria suggested by HKI food frequency method. The final food frequency questionnaire had 28 food items (see appendix). Mother's of the selected child was asked "How many days, in the past seven days, did (the name of child) eat (a specific food item)?" The question was repeated for 28 food items exactly as written each time. The questionnaire was exercised in a total 350 randomly selected mothers in the chosen 7 clusters. For each community the mean frequency of consumption of animal sources of vitamin A and the mean frequency of total consumption of animal and plant source of vitamin A (weighted) was calculated. The cut off points of HKI for inadequate consumption of vitamin A was employed in the analysis of food frequency data.

3.5 Breastfeeding and Weaning Practice

Information on breastfeeding and weaning practice was collected from each under three years of age child mother in the sampled households through a structured questionnaire. This task was done by the investigator. The trained enumerators recruited from the area were involved as translators.

3.6 Morbidity

The morbidity history of each child was assessed based on information from the mother. The mother was questioned about the history of illnesses that could have affected the vitamin A status of the child during the last one month. The diseases that the mother was asked included measles, diarrhea, cough, and fever. Respiratory tract infection in this study was defined by the presence of cough and fever for at least five days. Diarrhea was defined as three or more loose or watery stools per day for at least five days. Measles in this study was defined by the presence of fever and a blotchy rash.

3.7 Anthropometric measurements

Anthropometric measurements taken included weight and height of the children. All anthropometric measurements were taken by the investigator in order to minimize inter-individual variation in the measurement techniques. Weight for height and height for age

Z-score values were calculated for every child, using ANTHRO computer program (CDC, 1990).

3.7.1 Weight-for-Height and Height-for Age

Body weight was measured to the nearest 100 grams using UNICEF digital balance placed on a flat surface. The children wore light clothing, no shoe, and stood upright with the head in a horizontal plane. Children who resisted weighing were weighed in their mother's arms by twice weighing processes. A mother weighted and step down from the scale after her weight was taring to zero. She steps on the scale again carrying her child on her arm. The scale was checked at the beginning of each weighing session. Weight was recorded to the nearest 100gm.

Height measurement was done using a locally made graduated height/length board with movable headpiece and flat wooden base. Height was measured to the nearest 0.5 cm with barefoot and standing upright on a wooden board placed on a horizontal surface with heels together. The subject heels, buttocks and upper back were in contact with a graduated board and a sliding headpiece touched the crown of the head.

For children less than 24 months length was measured in recumbent position using length board. Maximum attention was give to maintain the subject's head in an upright

position, with legs stretched to full extent and feet at right angle with the legs. Length measurements were recorded to the nearest .5 cm.

Child documentation such as clinic card was used to record the exact age of the subject especially in the case small children. In the absence of this and in the case of older children effort was made to record the age in months as exactly as possible through exhaustive interviews of mothers with reference to a calendar of national and local events.

Weight-for-height and height-for-age as well as their corresponding standard deviation scores (Z-scores) were calculated with reference to National Center for Health Statistics (NCHS) population, using Anthro computer program (CDC, 1990). A ZWH score of 2 or -2 means that the child is 2 SD above or below the median weight-for-height respectively. Similarly a ZHA refers to the Z-score for height-for-age. Based on these scores, children were classified according to Waterlow (1973) as normal ($ZWH > -2.00$ and $ZHA > -2.00$), wasted ($ZWH < -2.00$ and $ZHA > -2.00$), stunted ($ZWH > -2.00$ and $ZHA < -2.00$) or wasted and stunted ($ZWH < -2.00$ and $ZHA < -2.00$).

3.7.2 *Body Mass Index*

WHO (1983) does not recommend to use of NCHS reference data for comparing the nutritional status of children greater than ten years of age because of the marked

difference in the age of onset of puberty among populations. For this reason the above indices were calculated only for children up to the age of ten years old. For those children between the age of 11 and 15 years body mass index (BMI) was calculated as the ratio of body weight (kg) and height in meters (Kg/m^2). The cut off values used in this study to classifying children as malnourished were <15.0 BMI for children between the age of 11 and 13 years, and <16.5 for children between the age of 14 and 15 years (Lee R. and Nieman D., 1996).

3.8 Ophthalmological examinations

House to house ophthalmological examination for signs and symptoms of xerophthalmia was conducted on all the sampled (402) children. The assessment was carried out using different stages of xerophthalmia. For night blindness, mothers (for children under 6 years of age) were carefully asked about whether the child has maladaptation to dim light or not. For child above the age of 6 years, each child himself or herself and his/her mother were asked whether he/she has a problem of maladaptation to dim light. The local term for night blindness was employed in interviewing all questions on night blindness. Conjunctival xerosis was identified by the dryness of the conjunctiva, Bitot's spot by an extension of foamy or cheesy patches forming on the conjunctiva, corneal xerosis by a hazy or granular surface and pebbly dryness apparent on the cornea, corneal ulceration when the ulceration is observed in the corneal surface and corneal scar by

observing a scarring on the cornea that associated with the previous xerophthalmia condition (Sommer A., 1995).

All clinical examination was done by the investigator (though not an ophthalmologist, he has been trained in the use of standard diagnostic criteria of xerophthalmia and has got extensive field experience in diagnosis of xerophthalmia through working with ophthalmologist and conducting field survey for a number of years) and a medical doctor who is experienced in diagnosis of xerophthalmia.

The prevalence criteria listed on Table 3 which is endorsed by the world health organization was used (WHO, 1982). The prevalence of xerophthalmia in the study population was determined by the proportion of individuals in the sample with clinical signs and symptoms of vitamin A deficiency at the time of examination. After the completion of the study therapeutic dose of vitamin A capsules were given to all clinically positive children.

Table 3 Indicators, WHO classification codes, and minimum prevalence criteria for assessing the public health significance of xerophthalmia and vitamin A deficiency in preschool aged children.

Indicator/WHO code	Description	Minimum WHO prevalence
		Criteria %
XN	Night blindness	1.0
X1B	Bitot's spot	0.5
X2	Corneal xerosis	0.01
X3A	Corneal ulceration, Keratomalacia < 1/3 corneal surface	0.01
X3B	Corneal ulceration, Keratomalacia ≥1/3 corneal surface	0.01
XS	Corneal scar due to xerophthalmia	0.05

Source WHO, 1982

3.9 Stool Examination

3.9.1 Stool Specimen Collection and Preparation

All stool specimens were collected between 7.15 am and 10.00 am. Enumerators went to each child house early in the morning and briefed mother in the case of children under the age 6 years and each child (in case of older children) on how to collect stool samples. Each child was provided with a label half meter square sheet of paper, a wooden applicator stick, a labeled plastic screw-top stool container and toilet tissue papers then released for the exercise of stool collection. Each child would defecate on the half meter

square sheet of paper then transfer a small portion of stool into the plastic stool container using the applicator stick. The used applicator stick and the remaining stool portion were wrapped in the square sheet of paper and discarded. The stool container with its contents would then be submitted and immediately transported by car to the laboratory. The samples were prepared within three hours of collection for Kato technique examination.

3.9.2 Stool examination using “The Kato Thick smear technique”

Stool examination for intestinal helminthiasis was carried out using Kato's smear technique (Cheesbrough M., 1981). This technique involves examination of 50 micrograms of fresh stool specimen by clearing the direct fecal and smearing pressed out thinly under glycerine impregnated cellophane.

A sample of fresh stool was pressed through a fine wire gauze sieve (#25) to remove fibrous tissues. A template hole of 50-microgram capacity was placed on a microscope slide. A portion of sieved stool was transferred to a microscope slide using a wooden applicator stick to carefully fill the template hole resting on the slide. The template was removed and a strip of cellophane impregnated with glycerine and a tincture of malachite green was pressed over the faces on the slide until it was evenly spread. The prepared slide was left to stand until the fecal background cleared. The preparation was examined after 30 minutes. Helminthes eggs were identified, counted using a digital telecounter and then recorded.

Although the Kato technique is slightly less sensitive compared to the concentration method of stool examination, it is quantitative, simple and rapid. This technique was chosen in this study mainly for its quantitative nature, which is vital in this study.

At the end of the study all children who had parasitic infestation received appropriate treatment.

3.10 Serum Retinol Measurement

The serum retinol determination was performed on all children with clinical signs of VAD and in every 20th children. The serum retinol was determined by high pressure liquid chromatography (HPLC).

3.10.1 Determination of Serum Retinol by HPLC

Principle

A given volume (100 μ l) of serum or plasma is diluted with ethanol or methanol, which denature plasma protein, and the vitamin is extracted with a suitable organic solvent. After centrifugation, an aliquot of the organic phase is injected onto a normal or reversed phase HPLC column, followed by an eluting solvent of suitable polarity. Retinol, which is eluted as a sharp peak within 1-6 minutes, is detected by a sensitive UV detector set at

325-328 nm. Retinol is quantitated by use of peak height ratios or peak area ratios relative to an internal standard (retinyl acetate or other appropriate analogs). This method is specific, owing to chromatographic step, and sensitive and fast owing to the own line ultraviolet detection at 328 nm.

Apparatus

Analytical microbalance, ultraviolet visible spectrophotometer, centrifuge, vortex mixer, rotary evaporator, high-performance liquid chromatography system equipped with a variable wavelength detector or suitable filters, nitrogen gas, water bath (40 – 50°C constant temperature), micropipettes 10µl, 15µl, 50µl, 100µl, conical centrifuge tubes with polyethylene screw caps, pasture pipettes, hamilton 710 syringe.

Reagents

- Retinyl acetate, all-trans (highest purity)
- Retinol, all-trans (highest purity)
- Hexane (HPLC grade)
- Absolute methanol (analytical grade)
- Absolute ethanol (analytical grade)

Samples collection

Venous blood (5-10ml) was collected by venous puncture without anticoagulant using vacutainer system (venoject; Terumo, Belgium). The blood sample collected in a venoject wrapped in aluminum foil (to protect vitamin A from light) and stored in cool box and transported to the field laboratory established at Dera Health Center and centrifuged within 3 hours. The serum samples were collected into cryo vials covered with aluminum foil and frozen using the refrigerator at the Health Center and transported to the Ethiopian Health and Nutrition Research Institute (EHNRI) in cool box containing dry ice. The serum samples were stored in the dark at -20°C until analysis.

Procedure

100 μl serum was transferred to 10x 75 mm glass test tubes. A known concentration of internal standard (retinyl acetate) and 90 μl of absolute ethanol were added to each sample and mixed gently on vortex mixer. After that, about 500 μl hexane (HPLC grade) was added and mixed with vortex mixer for one minute. It was then centrifuged for 5 min at 3000 rpm to separate the phases. The hexane layer was taken out very carefully and transferred into another tubes and evaporated under a gentle stream of nitrogen gas. It was then reconstituted in 55 μl of MeOH (HPLC grade) and 50 μl was injected on HPLC. The mobile phase was MeOH: H₂O (95:5), flow rate 1.5 ml/minute and the column was reverse phase C18. After each injection of samples or standards the loop was cleaned three or more times with MeOH. A series of retinol standards (prepared by serial dilution) and a known concentration of internal standard (which was constant) were

prepared and 50 µl of each were injected three times. Retinol, which was eluted as a sharp peak with in one to six minutes, was detected by a sensitive UV detector set at 325-328nm. Retinol was quantified by use of a peak area ration relative to an internal standard (Bieri G. et al, 1979).

3.11 Ethical Consideration

The study protocol was approved by Ethiopian Health and Nutrition Research Institute Ethical committee and by the National Ethical and Research committee of Ethiopia. Written informed consent was also obtained from each child's parent.

3.12 Data Quality Control

As indicated in the methodology section all the necessary quality control measures were taken for blood sample, anthropometry measurements and stool specimens. The data on the questionnaire was checked every day after work for completeness of information, consistency of answers and for proper filling of the forms by the enumerators. The enumerators were closely supervised through out the data collection.

3.13 Data Analysis

The Spss for Windows version 7.5 was used for all data entry and analysis except the anthropometric data. Before the analysis, the data was thoroughly cleaned with the help

of the same soft wear program. The Z-score value of the anthropometric data was calculated using Anthro soft wear program (CDC, 1990).

The statistical methods used in the analysis includes:

- ◆ Descriptive statistics
- ◆ Chi-square with cross tabulation was employed to assess level of significance between proportion.
- ◆ Unpaired t-test was used to compare mean serum retinol values between boys and girls, and preschool and school age children.

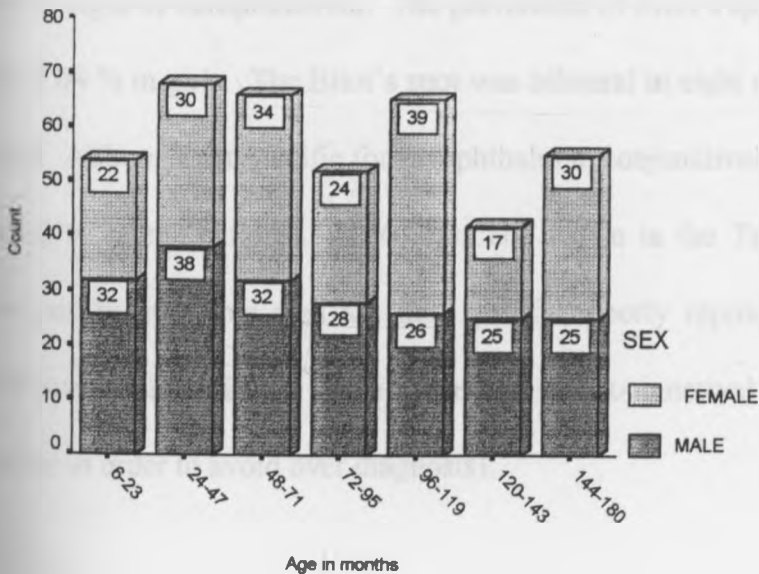
CHAPTER IV

RESULTS

4.1 Demographic Characteristics

A total of 402 children were investigated in the study. Age and sex distribution of the study population is presented in figure 3. The ratio of male to female was about 1:1. The mean age of male and female children were 6.3 ± 4 and 6.8 ± 4 years respectively. Further break down of the data showed that the mean age of the under six male children were 2.9 ± 1.5 years while 3 ± 1.5 years for females. The mean age of school children were 9.7 ± 2.5 years. The average household size for the study village was 5.7 persons which is higher than the average Oromia region household size of 4.9 persons (CSA, 1995). The proportion of mothers who can not read and write was 59.8 percent.

Fig 3 Study subjects by age and sex



4.2 *Prevalence of Vitamin A Deficiency*

4.2.1 *Clinical Examination*

A total of 188 (46.8%) preschool children and 214 (53.2%) school age children were examined for ocular manifestations of vitamin A deficiency. Of the children examined for clinical signs and symptoms of xerophthalmia 51.2 percent were boys and 48.8 percent were female. The over all prevalence of xerophthalmia was 10.7 percent. The occurrence of acute and long-standing xerophthalmia in relation to age and sex is presented in Table 4, which presents the most severe signs.

Night blindness (XN) was reported in 7.3 % of the boys and 7.14 % of the girls without other signs of xerophthalmia and in 1.9 % of boys and 1.5 % of the girls with more severe signs of xerophthalmia. The prevalence of Bitot's spot (X1B) was 2.4 % in males and 2.04 % in girls. The Bitot's spot was bilateral in eight children and unilateral in one child. Although not specific for xerophthalmia, conjunctival xerosis (X1A) was observed in 3.2 % of the children. (X1A, data not shown in the Table and not included in the analysis because this sign are non specific, poorly reproducible and highly variable. Moreover WHO (1982) suggests not to use conjunctival xerosis in prevalence field survey in order to avoid over diagnosis).

Table 4 Distribution of clinical symptoms and signs of xerophthalmia by age and sex

Symptom s/Signs	Sex	Age (months)						Total	
		<24	24-47	48-71	72-95	96-119	120-143		144-180
Night blindness	M	0	2	2	3	2	1	5	15
	F	0	1	1	1	4	4	3	14
	M+F	0	3	3	4	6	5	8	29
Bitot's Spot	M	0/0 ^a	0/0	0/1	0/1	0/1	0/0	1/1	1/4
	F	0/0	0/0	0/0	0/1	0/1	0/0	0/2	0/4
	M-F	0/0	0/0	0/1	0/2	0/2	0/0	1/3	1/8
Corneal xerosis	M	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
	F	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
	M+F	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
Corneal ulceration	M	0/0	0/0	0/0	1/0	0/0	0/0	0/0	1/0
	F	0/0	0/0	0/0	0/0	0/0	0/0	0/1	0/1
	M+F	0/0	0/0	0/0	1/0	0/0	0/0	0/1	1/1
Corneal Scar	M	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
	F	0/0	0/0	0/0	0/1	0/0	0/0	0/0	0/1
	M+F	0/0	0/0	0/0	0/1	0/0	0/1	0/0	0/2
Total eye symptom s & signs	M	0	2	3	5	3	3	7	23
	F	0	1	1	3	5	4	6	20
	M+F	0	3	4	8	8	7	13	43
Total examined	M	32	38	32	28	26	25	25	206
	F	22	30	34	24	39	17	30	196
	M+F	54	68	66	52	65	42	55	402

^a Monocular/binocular respectively

When the two severe signs of active xerophthalmia (corneal xerosis and corneal ulceration) were present together, 0.9 % of the boys and 0.5 % of girls exhibited these signs. The corneal ulceration was unilateral in the boy and bilateral in the girl while the ulceration in both cases covering less than one third of the corneal surface (X3A). Corneal scar (XS) was seen in 0.48 % in boys and 0.51 % in girls. Both of the children with the scar was reported not to have a history of trauma or any other events which could have contributed to the scarring of the cornea. The corneal scarring was observed in one eye in the girl while it occurred in both eyes in the boy and involved more than one-third of the corneal, which meant the boy, was blind. A higher prevalence rate of xerophthalmia was observed in boys (11.1 %) than girls (10.2 %), however, this difference was not significant. Of the children who had the ocular symptoms and/or signs, only 16 % were below the age of six while the remaining were above six. This difference is statistically significant ($p < 0.0001$). In addition all the severe form of xerophthalmia were observed in school age children. No xerophthalmic child was observed below the age of two. Children between the age of 11 and 15 years were the most affected.

4.2.1 Biochemical Assessment

Effort was made to perform blood analysis on 63 children which includes all children with clinical signs of vitamin A deficiency (43) and one in every 20th of the remaining children (20). However, the analysis was not possible on 14 subjects due to refusal to

give blood, haemolysis or recovery of inadequate quantities of serum. Vitamin A status of the study children based on serum retinol concentration is shown on Table 5. Serum retinol level was deficient ($<10\mu\text{g}/\text{dl}$) in 8.2 %, low ($10\mu\text{g}/\text{dl}$ - $20\mu\text{g}/\text{dl}$) in 42% and normal ($>20\mu\text{g}/\text{dl}$) in 49%.

Table 5 Distribution of serum retinol level of the children by sex

Serum retinol	Sex		
	M	F	M+F
$< 10\mu\text{g}$	2 (7.4%)	2 (9.1%)	4 (8.2%)
$10\mu\text{g}$ - $20\mu\text{g}$	11 (40.7%)	10 (45.4%)	21 (42.8%)
$>20\mu\text{g}$	14 (51.8%)	10 (45.4%)	24 (49.0%)
Total	27	22	49

Recent WHO report recommended that a cut-off level of $<20\mu\text{g}/\text{dl}$ be used and that the prevalence value below the cut-off be ranked to indicate the degree of public health significance (WHO, 1995). According to this cut-off value 51% of the children had low serum retinol level.

The mean serum retinol level of the children was 22.15 (SD 10.7). There was no statistically significant difference between the sexes in the mean serum retinol levels

($p > 0.05$). However, the mean serum retinol level of preschool children was found to be significantly higher than school age children ($p < 0.05$) (Table 6).

Table 6 Mean serum retinol level of the children by sex and age group

	Serum retinol level		t	df	P
	Mean	SD			
Sex					
M	22.11	(11.19)	-0.31	47	0.97
F	22.20	(10.50)			
Age group					
Preschool	29.34	(11.53)	2.51	47	0.016
School age	20.31	(9.80)			

SD= Standard deviation

t = t-value

df = degrees of freedom

p = 2-tailed probability

4.3 Risk Factors of Vitamin A Deficiency

4.3.1 Consumption of Vitamin A Rich Foods

4.3.1.1 Food Frequency

As indicated in Table 7, the consumption of vitamin A rich food in all community clusters was considerably lower than the HKI Food Frequency Method threshold values.

According to HKI Food Frequency Method a community has a public health significance problem of VAD, if either the mean frequency of consumption of animal source of vitamin A is ≤ 4 days per week or the mean frequency of total consumption of animal and plant source of vitamin A (weighted by source) is ≤ 6 days per week.

Table 7 Mean frequency of consumption of vitamin A (n=350)

Community Cluster	Mean Frequency of Consumption (days per week)	
	Animal Source	Weighted Total
A	2.6400	2.9135
B	1.6400	1.8833
C	2.3600	2.6367
D	1.8600	2.2300
E	0.6000	0.9699
F	0.9400	1.3301
G	0.6600	1.0867

Dark green leafy vegetables (DGLVs) as a food group was consumed by 48.3 % of the children at least once in the past seven days. The mean frequency of consumption of DGLVs was as low as 0.8 days per week. The mean frequency of consumption and proportion of children eating vitamin A rich foods at least once per week for selected vitamin A-rich foods is presented in Table 8.

Table 8 Mean frequency of consumption and proportion of children consuming vitamin A rich foods.

Food Item	Mean Frequency of Consumption (day per week)	Proportion (%) of Children Eating at least once in week
Egg	0.44	22.0
Carrot	0.16	7.7
Amaranth leaves	0.12	6.0
Liver	0.03	2.6
Mango	0.03	2.8
Pumpkin	0.37	21.1
Small fish with liver	0.02	0.9
Butter	1.03	37.4
Sweet potato	0.03	2.9
Cod liver oil	0.00	0.0
Red palm oil	0.00	0.0

As depicted on the Table, some particular food items were consumed more frequently compared to others, while others were not consumed at all by the children. The most frequently consumed vitamin A-rich foods were butter, egg and pumpkin which were consumed at least once in the past seven days by 37.4 %, 22 % and 21.1% of the surveyed children, respectively. The average frequency of consumption recorded even in these food items, however, was found to be low. None of these food items, on average,

were consumed even once in previous week except butter, which was eaten about one day per week. The mean frequency consumption of fish and liver were also extremely low, at 0.02 days and 0.03 days per week respectively. No child ate cod liver oil and red palm oil. Frequency of consumption of vitamin A-rich foods demonstrated statistically significant association with clinical signs of xerophthalmia ($p < 0.01$).

The major sources of fat and oil in the study population were vegetable oil and butter. Foods containing fat or oil was consumed by about 98 percent of children at least once in the last seven days. Mean frequency of consumption of foods containing oil and fat were 5.7 days and 1 day respectively. Foods cooked in oil were consumed at least one day in the past week by 9.6 percent of the surveyed children. The average frequency of consumption of fried foods was found to be 0.2 day per week.

Lentils, pea, and bean were the principal source of protein. It was observed that these plant source of protein-rich foods were consumed by 97.7 percent of the children at least once in the past seven days. The mean weekly intake of plant source protein-rich foods was high, 5.9 day per week. The mean frequency of consumption of animal source protein-rich foods such as meat, milk and eggs was, however, found to be low, at 0.2 day, 1.8 days and 0.4 day per week respectively.

4.3.1.2 *Breastfeeding and Weaning Practice*

Data on breastfeeding and weaning practice were collected from all under 3 years of age children. Of the mother's of these children 68.5 percent were breastfeeding their children. Further break down of the data by age group showed that all children below the age of one year and 91.7 percent of children between the age of 12 and 24 months were found to be breastfed at the time of this study. Even amongst the older children 28.6 percent of them were being breastfed. Of the mothers who were breastfeeding their children, 98.4 percent started giving their breast to the baby immediately after birth while the remaining 1.6 percent started one to three days later. No clinical symptoms and signs of xerophthalmia were recorded among breastfed children.

Mothers (28) who had stopped breastfeeding their babies before the study team arrived in the study area gave various reason for stopping. Eight mothers (28.6 %) said due to another pregnancy, five (17.9%) due to birth of next child and five (17.9 %) due to their illness. Insufficient breast milk and the child was too old was also given as a reason for stopping breastfeeding by 14.2 % and 7.1% of the mothers respectively. The remaining four mothers had different reasons for stopping breastfeeding including divorce.

Of all the mothers interviewed, 20.2 percent believed that children should be exclusively breastfed until 4 months, 66.3 % for up to between 4 to 6 months while the remaining 13.5 said it could be done over 6 months. Regarding the period over which breastfeeding could be continued along with weaning foods, 68.5 % suggested 1 to 2 years while 30.3

% reported that the practice should continue above the age of two. Only one mother (1.1%) said it should be limited to below one year.

The average age at which foods other than breast milk were introduced was 6.1 months.

The main weaning foods were cows milk and porridge made from wheat or barley floor.

4.3.2 *Anthropometry*

4.3.2.1 *Weight-for-Height and Height-for-Age*

About 48 % of children between the age of 6 months and 10 years were observed to be malnourished with more stunting alone (35.7%) than stunting and wasting together (5.6%) and wasting alone (6.8%) (Table 9).

The preschool children (under 6 children) were most affected than the school age children (6 to 10 years old children). Only less than one-third of malnourished children were found to be school aged children. Moreover the highest wasting rate was recorded in children aged between one and three years old while the highest rate of stunting was observed in four to five years old children. The proportion of wasted alone, stunted alone and wasted and stunted together in school age children was 5.1%, 33.3% and 1.7% respectively. In preschool children the degree of stunting alone (37.2 %) was found to be higher than wasting and stunting (8.0%) and wasting alone (8.0%) (Table 9).

Table 9 Nutritional status of children aged 6 months to 10 years by sex and age group.

Age group	Sex	Normal	Wasted	Stunted	Wasted & Stunted	Total
Preschool (Under 6)	M	42 (41.2) ^a	10 (9.8)	41 (40.2)	9 (8.8)	102
	F	46 (53.5)	5 (5.8)	29 (33.7)	6 (7.0)	86
	M+F	88 (46.8)	15 (8.0)	70 (37.2)	15 (8.0)	188
School age (6-10 years)	M	32 (59.2)	4 (7.4)	17 (31.5)	1 (1.9)	54
	F	38 (60.3)	2 (3.2)	22 (34.9)	1 (1.6)	63
	M+F	70 (59.8)	6 (5.1)	39 (33.3)	2 (1.7)	117
All	M	74 (47.4)	14 (9.0)	58 (37.1)	10 (6.4)	156
	F	84 (56.4)	7 (4.7)	51 (34.2)	7 (4.7)	149
	M+F	158 (51.8)	21 (6.8)	109 (35.7)	17 (5.6)	305

^a Figures in parenthesis are percentage

There was no statistically significant difference in the weight-for-height Z-score and height-for-age Z-score values of the sexes. No statistically significant relationship was observed between nutritional status as assessed by anthropometry and various clinical signs of xerophthalmia.

4.3.2.2 *Body mass index*

For the reason mentioned in the methodology section body mass index was calculated for children between the age of 11 and 15 years. Based on their BMI children were grouped as normal and malnourished (Table 10).

Table 10 Proportion of malnourished children aged between 11 and 15 years old based on BMI.

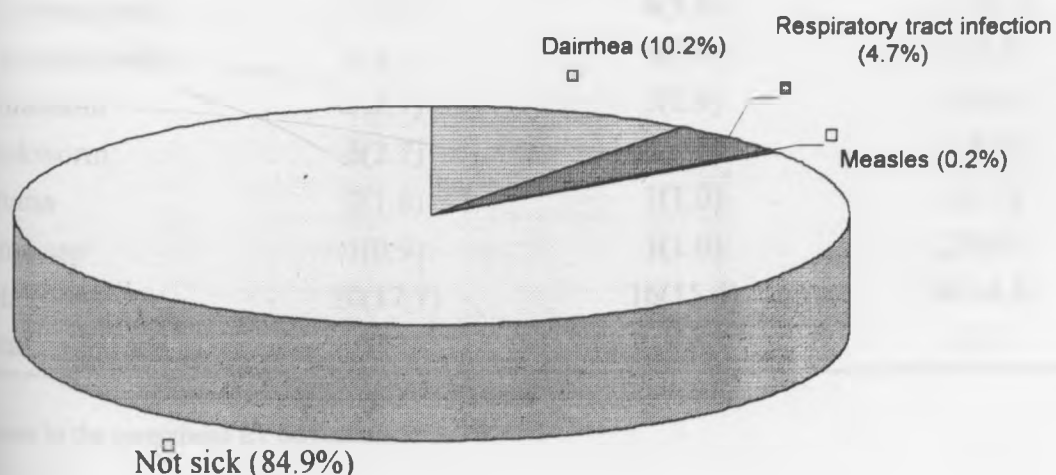
Age (years)	Normal	Malnourished	Total
11-13	31 (48.4%)	33 (51.6%)	64
14-15	14 (42.4%)	19 (57.6%)	33
All age groups	45 (46.4%)	52 (53.6%)	97

As depicted on the Table more than half of (53.6 %) of the children had protein energy malnutrition. However, nutritional status of the children as measured by BMI did not show significant association with clinical signs of xerophthalmia.

4.3.3 Morbidity

A history of diarrhea, measles and respiratory tract infection in the last one month were obtained from all children. More than 14 % of the children had a history of morbidity either from upper respiratory tract infection and/or diarrhea (figure 4). The prevalence of diarrhea in the last one month was 10.2 %, with higher prevalence (11.6%) in the age group 6 to 71 months than (8.9%) 72 months and above children. When all the active xerophthalmia (NB +X1B+X2+X3A+X3B) cases were presented together, 22 % were associated with diarrhea. The prevalence diarrhea in the last one-month was higher in affected children than nonaffected ($P < 0.05$).

Figure 4 Morbidity patterns in the study population



Nineteen children (4.7%) had the history of upper respiratory tract infection in the preceding one month. However, upper respiratory tract infection in the last one month did not show significance difference in xerophthalmic cases and non-cases.

The prevalence of measles in the last one month was as low as 0.25%. An active corneal lesion as a consequence of measles complication was also not reported. However, measles was responsible for corneal scars of both children with corneal scarring.

4.3.4 Stool Examination

Stool examination was carried out for all children of whom food frequency information was collected in the sample households and for all clinically positive cases. A total of 217 children were examined for intestinal helminthiasis. The overall prevalence of intestinal parasites was found to be 16.6 percent (Table 11).

Table 11 Distribution of children by type of parasite isolated

Parasites	Sex		Total
	Male	Female	
<i>E. vermicularis</i>	5(4.4)*	6(5.8)	11 (5.1)
<i>A. Lumbricoides</i>	6(5.3)	4(3.8)	10(4.6)
<i>S. mansoni</i>	3(2.7)	3(2.9)	6(2.8)
Hookworm	3(2.7)	1(1.0)	4(1.8)
<i>H.nana</i>	2(1.8)	1(1.0)	3(1.4)
<i>Tania ssp</i>	1(0.9)	1(1.0)	2(0.9)
Total positives	20(17.7)	16(15.4)	36(16.6)
Total examined	113	104	217

* Figures in the parenthesis are percentage

As depicted on the table the prevalence rate by type of infection was 5.1% for *Enterobius vermicularis*, 4.6% for *Ascaris lumbricoides*, 2.8 % for *Schistosoma mansoni*, 1.8% for hookworm, 1.4% for *Hymenopsis nana* and 0.9 % for *Taenia species*.

The wormload of the four most commonly encountered parasites is presented in Table 12. The detail criteria used in the classification of the intensity of infection are presented in the appendix. No child had heavy infection and more than 93% of the infected children had light infection.

Table 12 Wormload of the infected children

Parasite	Intensity of infection			Total
	Light	Moderate	Heavy	
E. vermicularis	9(81.8)*	2(18.8)	0(0)	11
A. Lumbricoides	10(100)	0(0)	0(0)	10
S. mansoni	6(100)	0(0)	0(0)	6
Hookworm	4(100)	0(0)	0(0)	4

* Figures in the parenthesis are percentage

No significant difference was demonstrated in the prevalence of the parasites between the sexes. Helminthic infection together or individually did not show statistically significant relationship with vitamin A deficiency as assessed by clinical signs.

CHAPTER V

DISCUSSION

5.1 Prevalence of Vitamin A Deficiency

This study looked at the prevalence of vitamin A deficiency among preschool and school age children in the study area using clinical and biochemical indicators. The threshold criteria developed by WHO (1982) and IVACG (1993) for determining vitamin A deficiency as a problem of public health significance are a prevalence of night blindness (XN), Bitot's spots (X1B), active corneal lesion (X2/X3A/X3B), and corneal scar (XS) exceeding 1%, 0.5%, 0.01% and 0.05%, respectively. The findings of the present study compared to the criteria is 7.2-fold for night blindness, 4-fold for Bitot's spots, 25-fold for corneal xerosis, 50-fold for corneal ulceration and 10-fold for corneal scar. These proportions signify the problem as being of public health significance in the area.

Studies conducted among preschool children in Arssi zone in general and Dodotana Sire district in particular (the district where this study was carried out) reported considerably high prevalence rate of xerophthalmia. In a community survey in Arssi zone, Bitot's spots were seen in 5% of children aged between 6 months and 6 years, corneal xerosis and ulceration with keratomalacia in 0.8% and corneal scar in 0.5% (De sole et al., 1987). Tezera and Yonas (1993) found out an overall xerophthalmia prevalence of 9.2 % among under six years of age children in Dodota district. In the same period an

alarmingly high prevalence rate of xerophthalmia was recorded among the same age group in one of the village of the same district. The prevalence of night blindness, Bitot's spots, corneal ulceration and corneal scar were 17%, 26.5%, 2.7% and 0.7% respectively (Yonas et al., 1996). Unlike the previous studies considerably lower prevalence rates of xerophthalmia were found in the present study among children aged between 6 months and 6 years. Night blindness was reported by only six children (3.2%) and Bitot's spot was observed only in one child (0.5%). No child was found with active corneal lesion (X2/X3A/X3B), and corneal scar (XS). Thus the present study shows that VAD problem has substantially decreased in the area.

In the literature it is stated that mega dose vitamin A capsule (200,000 IU) has at least 90% prophylactic efficacy for 4-6 months among recipient children against developing mild xerophthalmia and corneal disease (West K. and Sommer A., 1993). Impact evaluation study on universal vitamin A capsule distribution carried out in India demonstrated more than four fold reduction in the prevalence of Bitot's spot in two distribution cycle (West K. and Sommer A., 1993). A study conducted in Ethiopia noted a reduction of prevalence of xerophthalmia from 11% to 2% in one round mega dose of vitamin A capsule distribution (Yonas and Tezera, 1994). Hence, the observed encouraging result in decreasing VAD in the area could be attributed primarily to universal vitamin A capsule distribution that has been carried out in the area in conjunction with polio eradication campaign.

Although studies conducted on VAD in Ethiopia and elsewhere concentrated on preschool children there is evidence that revealed vitamin A deficiency is also a public health significance problem among school aged children. Pant and Gopalas (1986) found out a prevalence rate of xerophthalmia between 9% and 12% among underprivileged schoolboys in India. Similarly, in the present study, a public health significant level of VAD was observed among school aged children in the study area. Of the total number of school age children (214) examined, 36 (16.8%) had at least one ocular manifestation of xerophthalmia. Thus, night blindness was reported in 10.7%, Bitot's spots was observed in 3.7%, corneal xerosis in 0.5%, corneal lesion in 0.9% and corneal scar in 0.9% of the children. These findings confirm a speculation made by a previous study, which suggested that VAD could also be a problem of public health significant in school age children in Dodota district (Yonas et al., 1996). The high prevalence rate of xerophthalmia reported in the present study might be due to a chronic shortage of vitamin A rich foods in the area and to the fact that school age children do not receive vitamin A supplementation.

In the literature, it has been indicated that the availability of dark green leafy vegetables and fruits is low during dry seasons (Fawzi W. et al., 1997; IVACG, 1981). Since the study was conducted in the dry season, may be poor dietary intake might partly account for the recorded high prevalence.

Of the children who manifested clinical symptoms and/or signs, only 16% were below the age of six years while the remaining were above six. The difference is statistically

significance ($P < 0.0001$). This indicates that vitamin A deficiency is a more serious problem among school age children than preschool children in the area. This can be a result of the on-going vitamin A capsule distribution targeting preschool children.

The prevalence of night blindness and Bitot's spots is almost equal in the two sexes, which is in accordance with the observations reported earlier in Ethiopia and elsewhere (Yonas et al., 1996 and Wolde-Gebrile et al., 1993; Sinha and Bang, 1973). No major difference in the relative effectiveness of vitamin A between the sexes was also demonstrated in supplementary trials (Beaton G. et al., 1993). These observations are in direct contrast to reports which suggest greater vulnerability of boys to mild xerophthalmia than girls (De sole et al., 1987; Wolde-Gebriel et al., 1991; Yonas et al., 1997; Bushra et al., 1987; cited in IVACG, 1981). However, there is no readily available explanation for the contrast, since the issue of male preponderance to mild xerophthalmia is not yet well understood and study findings on this line are inconsistent. In the literature, it has been indicated that in most societies children of both sexes are equally affected by active xerophthalmia (X2/X3A/X3B) (Sommer A., 1995). Although a similar finding was recorded in the current study, the numbers of children in the present study with these severe signs of vitamin A deficiency was too small for a definite conclusion to be made.

The extent of vitamin A deficiency in the study area is confirmed by the finding that 8.2 percent of the children had serum retinol levels less than $10\mu\text{g}/\text{dl}$ which is higher than the threshold value (5% with less than $10\mu\text{g}/\text{dl}$) set by WHO (1982) in determining the

public health significance of vitamin A deficiency. Recently WHO (1995) recommended that when the proportion of the population with low serum retinol levels ($< 20\mu\text{g/dl}$) is $\geq 20\%$, vitamin A deficiency can be regarded as a severe public health problem. According to this criteria the study population is severely vitamin A deficient, since 51% of the children had serum vitamin A concentration below $20\mu\text{g/dl}$.

No statistically significant difference was observed in the mean serum retinol level of the sexes, which is well in agreement with the clinical findings. Comparison of mean serum retinol level by age groups, however, revealed that preschool children had a significantly higher mean serum retinol level than that of school aged children ($p < 0.05$). This is not surprising, since preschool children have been periodically supplemented with a mega dose of vitamin A capsules and they had received the capsule four months before the survey.

In summary, both clinical and biochemical findings revealed that vitamin A deficiency is a public health problem in the area. Furthermore, the results indicate that school aged children are more affected than preschool children. As mentioned earlier the observed difference in the vitamin A status of the two age groups was mainly attributable to the vitamin A capsules supplementation to preschool children. It is quite true that preschool children are the most at risk group to VAD and deserve priority in vitamin A intervention program but it does not follow that school age children are immune to VAD as shown in the present study. The findings of this study, therefore, suggest that the on-going vitamin A intervention program in the study area should also give due attention to school aged children.

5.2 Risk Factors of Vitamin A Deficiency

Inadequate intake of vitamin A rich food, low intake of fat, PEM, respiratory tract infection, diarrheal diseases, measles and intestinal helmenthiasis are important risk factors for vitamin A deficiency. However, the contribution made by these factors may vary from one community to another. This study investigated which of these risk factors had significant contribution to vitamin A deficiency in the study area.

Food frequency: The frequency of consumption of vitamin A rich foods was found to be well below the threshold values of the HKI Food Frequency Method. According to this method vitamin A deficiency is a public health problem in a given community if either of the following threshold values is satisfied. Less or equal to 4 days per week mean frequency of consumption of animal source vitamin A, or, less or equal to 6 days per week mean frequency of total consumption of animal and plant source of vitamin A (weighted by source). The food frequency results suggest that all community clusters studied had very infrequent consumption of vitamin A rich foods. The community cluster with highest mean frequency of consumption of animal source vitamin A consumed 2.6 days per week which is still very low compared to the HKIFFM cut off point of greater than 4 days per week. Also the mean frequency of total consumption of animal and plant source of vitamin A by the community clusters, which ranges from 0.9 to 2.9 days per week is far below the threshold value of HKIFFM which is greater than 6 day per week. This indicates that low intake of vitamin A rich foods might be the major risk factor of vitamin A deficiency in the area.

Dark green leafy vegetable as a food group consumed at least once in a week by about half (48.3%) of the children, however, the mean frequency of consumption was low at 0.8 days per week. The finding seems to be in agreement with other investigations, which have reported that the frequency of consumption of dark green leafy vegetables in Arssi zone is low. De sole et al. (1987) reported once in a week average frequency of consumption of dark green vegetables. Another study in the same zone, indicated that only 13.1% of households consumed dark green leafy vegetables three times a week (Tefera, 1994).

The result of an earlier community survey in Arssi zone showed that carrot is consumed irregularly (De sole et al., 1987). Similarly, in the present study, carrot is consumed at least once in a week only by 7.7% of the children and the average frequency of consumption was as low as 0.16 days per week. The mean frequency of consumption of other plant sources vitamin A rich foods are also very low. Exclusively seasonal vegetables backyard gardens and reduction of availability of cash for the purchase of these food items during dry seasons might be the possible explanations for this low-level of intake of plant source vitamin A rich foods the area.

Only 37.4% and 22% of the studied population consume butter and eggs at least once in a week. Furthermore the average frequency of consumption of eggs and butter was low at 0.44 and 1.03 days per week respectively. The consumption of other animal source of vitamin A rich foods was also found to be extremely low. The mean frequency

consumption of fish and liver were 0.02 and 0.03 day per week. This finding seems consistent with the results of earlier studies in the zone (Tefera, 1994).

In the literature, it is stated that dietary fat and oil are important for the absorption of vitamin A (IVACG, 1979). Especially dietary fat is necessary for the absorption of vegetable sources of provitamin A (WHO, 1995). To ensure adequate intake of fat and oil that is required for the absorption of vitamin A and provitamin A, food containing fat and oil should be consumed daily. It is interesting to note that majority (98%) of the children in the present study consumed food containing fats or oil at least once in the last seven days. Mean frequency of consumption of foods containing oil or fat was 6.7 days per week. The frequency of consumption of food containing fat and oil and food cooked in oil suggests that consumption seems sufficient to ensure adequate absorption of vitamin A in most of the children. Hence, it seems very unlikely that low intake of fat significantly contribute to the problem of vitamin A deficiency in the area.

Dietary intake of food rich in vitamin A and risk of xerophthalmia are inversely associated. In a cross sectional study carried out in Aris zone, an inverse association was observed between the frequency of consumption of foods rich in vitamin A and xerophthalmia (Tefera, 1994). Similarly, this study has demonstrated an inverse association between the frequency of consumption of foods rich in vitamin A and xerophthalmia ($P < 0.01$). This also strongly suggest that inadequate intake of food rich in vitamin A might be the important risk factor of vitamin A deficiency in the area.

Breastfeeding: Studies have shown that breastfed infants are protected from vitamin A deficiency (Tarwotijo et al., 1982). This might be partly due to the regular supply of preformed vitamin A in the milk. It may also be due to lower rate of infection compared with artificial fed children. Breast milk provides sufficient vitamin A to prevent clinical manifestation of vitamin A deficiency throughout the first year of life even in poorly-nourished population in developing countries (Sommer A., 1995). Such protection of breast milk against vitamin A deficiency in under-one children was also reported from Ethiopia (Yonas et al., 1996; De Sole et al., 1987) and the Sudan (Bushra et al., 1987). Similarly, in the present study, no xerophthalmic child was found below the age of two. The data shows that more than 94% of the under-two children were breastfed at the time of the study. This suggests that breastfeeding is protective against vitamin A deficiency.

Of the children who manifested clinical symptoms and/or signs, only 2.3% were below the age of three years while the remaining were above three. The difference is statistically significant ($P < 0.001$) which is in accordance with the observations reported earlier in Ethiopia (Wolde Gebreil et al., 1993; Yonas et al., 1996). However, this proportion is much lower than the observation in Asia (Brink et al., 1979; Solon et al., 1978). The contrast may possibly be explained by the extended breastfeeding practice of the rural Ethiopian women. Interestingly, prolonged breast-feeding is generally a norm and considered as a natural phenomenon in the study area. As mentioned earlier, more than 94% under two children were found to be breastfed. Furthermore, amongst the older children almost 29 % of them were breastfed. Presumably breast-milk is a major source of vitamin A which grants considerable protection against vitamin A deficiency for children of this age group in the study area.

Protein energy malnutrition: About 48 % of the under 10 years old children were found to be malnourished with 12.4% wasting and 41.3% stunting. The problem is more severe amongst preschool children of whom 16% and 45.2% were found to be wasted and stunted respectively. The prevalence of wasting in the under six years old children is considerably higher than the national figure which is 8% (CSA, 1992). This disparity in the prevalence of wasting suggests that the study area could be a pocket of higher prevalence of acute malnutrition than most part of the country. The highest prevalence of wasting is recorded between the age of 12 and 23 months which is in accordance with the literature (Gibson, 1990). This may be explained by the improper weaning practice of mothers of the study area. The data shows that the mean weaning age in the study population was 6.2 months which is consistent with earlier report from the same zone that showed the average weaning age of 6.6 months (De sole et al., 1987). This implies that children in this area seem to be at risk of late weaning. Moreover, the quality and inadequacy of the weaning food might also be important factors for the observed high rate of wasting in this age group.

There are interesting although inconsistent observations in the literature on the association between PEM and incidence of xerophthalmia. IVACG (1981) has stated that PEM almost invariably accompanies xerophthalmia in young children. A study conducted in Sri Lanka revealed that the prevalence of xerophthalmia was higher in children with stunting alone and stunting and wasting together than their normal counterparts (Brink et al., 1979). In India, 175 children with kwashiorkor were admitted,

all having low serum vitamin A levels. Eighteen (10.3%) of the 175 children died. Of the 18 deaths, five had keratomalacia, one had Bitot's spots and five other had vitamin A serum level below $10\mu\text{g}/100\text{ml}$ (Eastman, 1987). In contrast, McLaren and Frigg (1997) indicated that clinical manifestation of severe PEM, (marasmus, marasmic-kwashiorkor, or kwashiorkor) are not necessarily associated with ocular signs of vitamin A deficiency. Publications from Ethiopia also have shown no association between anthropometric values of the children and clinical signs of xerophthalmia (Wolde- Gebrile et al., 1993; Yonas et al., 1997). In the present study, there was no significant association between nutritional status as assessed by anthropometric measurement and ocular manifestation of vitamin A deficiency. This indicates that protein energy malnutrition might not be the risk factor to vitamin A deficiency in the study area.

Morbidity: More than 10% of the children had a history of diarrhea in the last one month. In the literature, it has been stated that diarrhea, especially repeated and prolonged diarrhea, is one of the risk factors for vitamin A deficiency in children whose liver store are low (WHO, 1988). Several studies from Ethiopia (De sole et al., 1987; Yonas et al., 1996) and elsewhere (Sommer A. et al., 1987) have shown association between vitamin A deficiency and diarrhea. This study seems to be in agreement with these findings, in that diarrhea is significantly ($P < 0.05$) associated with signs of xerophthalmia. This indicates that diarrheal diseases might partly be accountable for vitamin A deficiency in the study area.

The prevalence of respiratory tract infection in the last one month was 4.7%. However, no statistically significant association was observed between the incidence of respiratory tract infection and xerophthalmia. This is consistent with the observation reported earlier from Ethiopia (Yonas et al., 1997). This suggests that respiratory tract infections might not be risk factor for vitamin A deficiency in this area.

Measles is an important risk factor for the development of severe vitamin A deficiency because it depletes vitamin A reserves by markedly increasing the utilization at a time when dietary intake and absorption are reduced. Secondly, measles plays an important role in corneal blindness. In Indonesia, children who had a history of recent measles were eleven times more likely to get corneal lesion than children who had not had measles (Sommer A., 1982). In the present study, however, it was not possible to perform any statistical analysis regarding the association between xerophthalmia and measles due to a very low number of children with measles. The very low prevalence of measles (0.25%) in the study area, however, may suggest that the observed active xerophthalmia might not be linked to measles in the study population.

Evidence mounts that post-measles blindness in Africa is considerable. In Malawi and Tanzania about a half of the number of children in school of the blind had a history of measles immediately preceding the blind episode (UNICEF, 1987). In Ethiopia, measles was reported to be responsible at least for 40% of bilateral blindness cases in schools of the blind (Wolde-Gebreil et al., 1992). Similarly, the data of this study show that a

history of measles preceded the onset of the corneal scarring in both children with corneal scar. Although the numbers of children (2) with corneal scar in this study were so small, the finding seems to support aforementioned observations.

Intestinal helminthiasis: The over all prevalence of intestinal helminthiasis in the present study was 16.6 percent, which shows that intestinal worms does not seems to be a serious problem in the area. Furthermore clinical recored of Dera health center (the nearest health facilities of the study population) also indicates that helminthiasis was not among the ten top disease that had been diagnosed by the health center.

No statistically significant association was found between helmintic infestation and clinical signs of xerophthalmia. This might be explained by the fact that the prevalence of helmenthiasis, especially those parasites known to have an association with VAD, such as ascaris is low in the area. Secondly, the intensity of infection was generally light. The finding indicates that intestinal helminthiasis does not seems to be one of the risk factors of VAD in the area.

To sum up, the study has showed that the consumption of vitamin A rich foods in the area was very low and significantly associated with xerophthalmia. It also demonstrated a significant association between diarrhea and VAD. This suggests that, low consumption of vitamin A rich food and diarrheal diseases were the most important risk factors for vitamin A deficiency in the study area. This was further supported by the lack of any

significant association between the remaining risk factors (PEM, respiratory tract infection, measles and intestinal helminthiasis) and VAD in the area.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

6.1 *Conclusion*

This study has investigated the prevalence of vitamin A deficiency among children aged six months to 15 years and the risk factors of vitamin A deficiency in Arssi zone, central Ethiopia. Both the clinical and biochemical findings indicate that vitamin A deficiency is a public health problem in the area. Furthermore, it was observed that the problem of vitamin A deficiency among preschool children decreased markedly. However, it still continues to be marginally a public health problem in the area (Bitot's spots rate of 0.53%). The findings have also shown that VAD is a very serious public health problem among school age children than preschool children. The difference in the prevalence of xerophthalmia between school age and preschool was significant. This might be due to the on going universal vitamin A capsule distribution program, which targets only preschool children.

Infrequent consumption of vitamin A rich food is the most important risk factor of vitamin A deficiency in the area. The frequency of consumption of foods rich in vitamin A by the children is far below the cut-off point set by HKI. This confirms that vitamin A deficiency, which is presumably due to infrequent consumption of vitamin A rich foods, is a public health problem in the area. Moreover there is strong association between signs of xerophthalmia and frequency of consumption of foods rich in vitamin A.

Diarrheal diseases also appear to be another risk factor to vitamin A deficiency in the area. Although the strength of the association between diarrheal disease and xerophthalmia is not as strong as the association between consumption of vitamin A rich foods and xerophthalmia, it was found to be significant.

The lack of significant relationship between xerophthalmia and respiratory infections or measles or PEM or intestinal helminthiasis also suggest that infrequent consumption of vitamin A rich foods and diarrhea are the most important risk factors of vitamin A deficiency in the area.

6.2 Recommendations

1. Although the prevalence of xerophthalmia among preschool children decreased in the area, it still continues to be marginally a public health problem. The observed remarkable result in decreasing the prevalence of xerophthalmia in the study area is mainly attributed to the on-going universal vitamin A capsule distribution. It is, therefore, recommended that the vitamin A capsule distribution should continue to be distributed to preschool children as a short-term intervention until the deficiency decreases below the public health significant level and the long-term prevention program is launched.

2. There is no doubt that VAD is a public health problem among school age children in the area. The seriousness of the problem among these age group children dictates the expansion of the already initiated vitamin A capsule distribution program to school age children. Since the current vitamin A capsule distribution program in the area seems well placed, widening the target age to 15 years would ensure effective distribution of vitamin A capsule to school age children. Moreover, expansion of the target age group of the on-going distribution program does not incur significant additional running costs on the program. It is, therefore, highly recommended to widen the target age group of the current vitamin A capsule distribution program from 6 months to six years, to 6 months to 15 years as a short-term strategy of controlling the problem in the area.
3. Although few recent studies indicate that provitamin A carotenoids may not be an effective strategy for the control of VAD as previously assumed, there is ample epidemiological evidence that suggests adequate intake of dark green leafy vegetable protects individuals from xerophthalmia. For poor communities, such as this community, only plant foods are widely accessible forms of vitamin A. Secondly, for a poor agricultural country like Ethiopia, agriculture-based interventions are more likely to be sustainable than industry-based strategy such as fortification. Hence, increasing the availability and consumption of vitamin A rich food through promotion of horticulture and nutrition education remains the most feasible long-term strategy towards solving the problem.

4. Public health measures such as control of diarrheal diseases should be taken as one of the possible ways of decreasing vitamin A deficiency in the area.
5. Since inadequate intake of vitamin A rich foods and disease conditions are the immediate cause of vitamin A deficiency, further investigations should be carried out in order to determine the basic causes of the problem in this and similar areas. Moreover the current study demonstrated that VAD is public health significance 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 country. Hence, the vitamin A status of school children in other parts of the country should also be studied.

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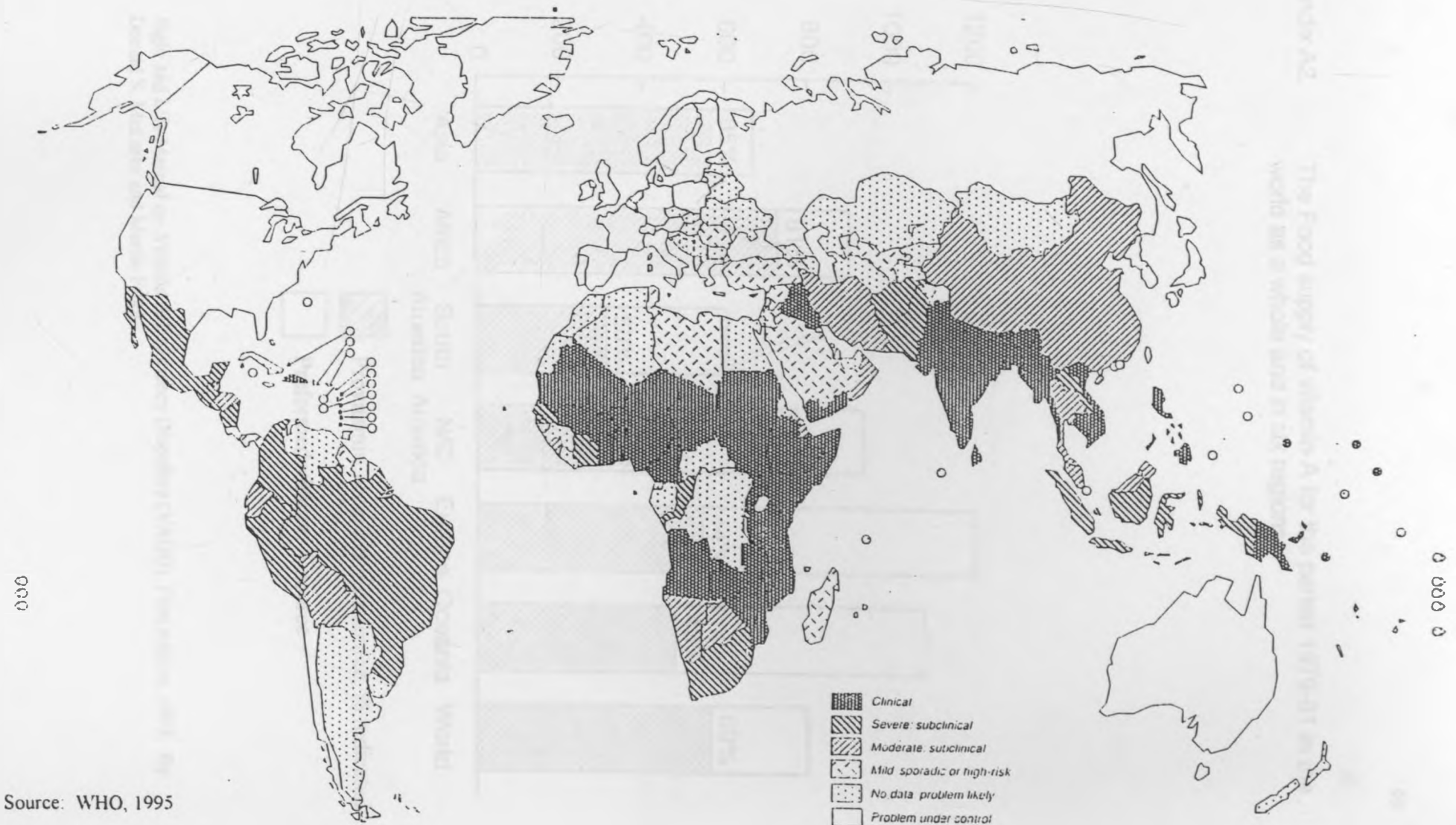
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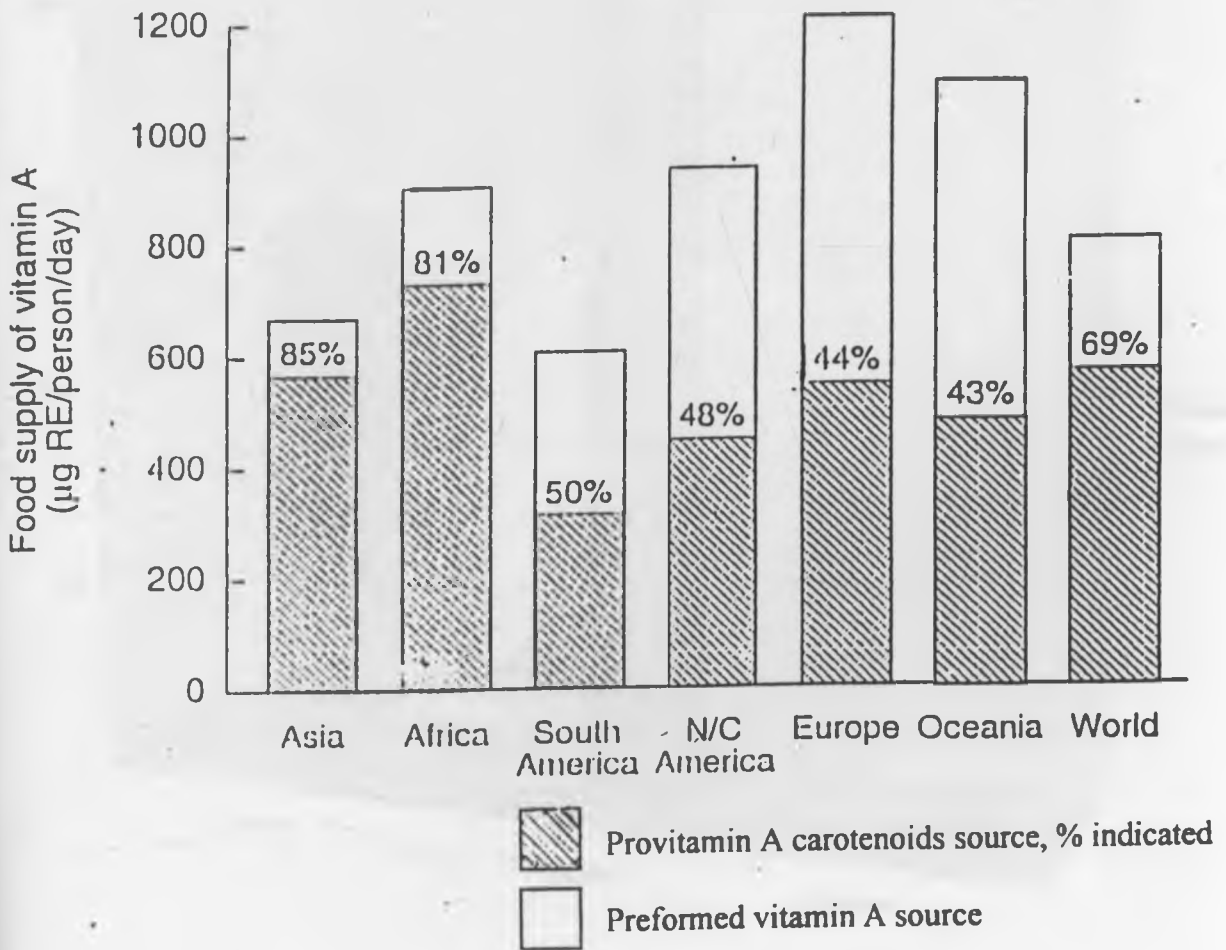
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Source: WHO, 1995

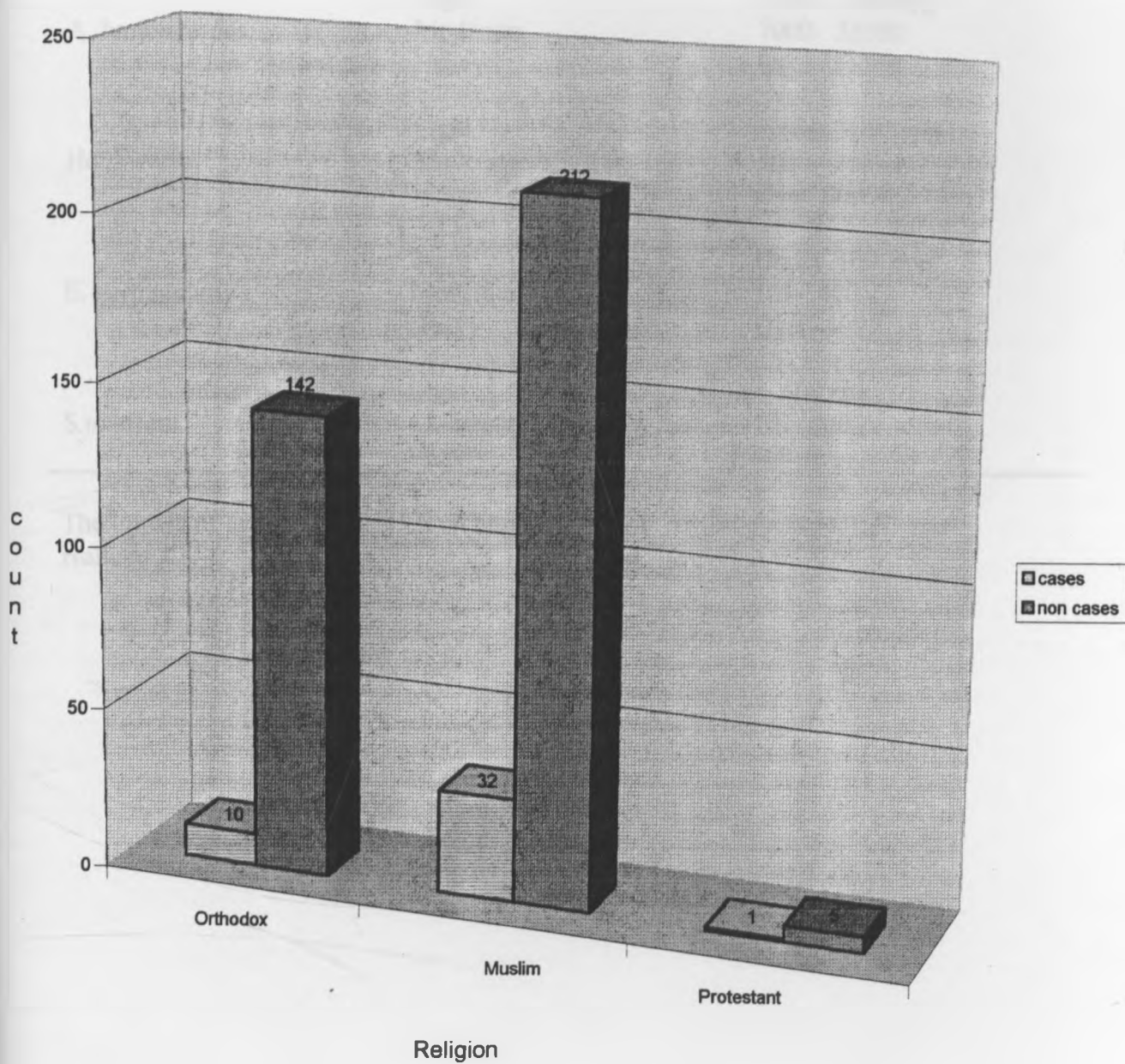
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area, or its authorities, or the delimitation of its frontiers or boundaries. Dotted lines are shown where there is no agreement on the boundaries.

Appendix A2: The Food supply of vitamin A for the period 1979-81 in the world as a whole and in six regions



Source: Sight and Life Manual on Vitamin A Deficiency Disorders (VADD). First edition, 1997. By Donald S. McLaren and Martin Frigg.

Appendix A3 Distribution of xerophthalmia by religion



Appendix A4 Definitions of intensity of infections used in this study

Parasite	Intensity of infection	Egg count
A. lumbricoides	Light	Under 7000 epg
	Moderate	7000- 35000
	Heavy	Over 35000
Hookworm	Light	Under 5000 epg
	Moderate	5000- 20000
	Heavy	Over 20000
E. vermicularis	Light	Under 100 epg
	Moderate	101- 400
	Heavy	Over- 400
S.mansoni	Light	1- 400 epg
	Moderate	101- 400
	Heavy	400

The impact of helminth infection on human nutrition. by Stephenson, L.S. and Holland ,C.

SECTION B

HKI FOOD FREQUENCY QUESTIONNAIRE

Note to interviewer: Proceed to interview the mother/caretaker about the selected child only.

1. Zone _____ 2. Woreda _____ 3. Village _____
 4. H.H No. _____ 3. ID No. _____ 4. Date of interview _____
 6. Name of selected child _____ 7. Sex _____ 8. Age _____ 9. Name of mother/
 caretaker of the selected child _____ 10. Name of interviewer _____

Note to interviewer : For each food listed in the table below, ask the following question in the order that the food items are listed.

11. How many days, in the past seven days, did _____ (name of selected child)
 eat _____ (Specific food item)?

Name of food item	Number of days eaten per week
Main staple (such as wheat, millet, maize, tef, etc: select only one)	
Spicy, hot peppers	
Dark green leafy vegetables (DGLVs as a food group)	<input type="checkbox"/>
Milk	
Carrots	<input type="checkbox"/>
Ripe mango	<input type="checkbox"/>
Dark yellow or orange squash (includes pumpkin)	<input type="checkbox"/>
Spinach	
Ripe papaya	<input type="checkbox"/>
Pasta and macaroni (or other staple food)	
Eggs with yolk	<input type="radio"/>
Small fish (liver intact)	<input type="radio"/>
Peanuts (or other legume)	
Yellow or orange sweet potato or yam	<input type="checkbox"/>
Chicken or other fowl (or other meat)	
Amaranth leaves (or other DGLV)	
Any kind of liver	<input type="radio"/>
Sweet potato leaves (or other DGLV)	
Beef (or cow, sheep or goat meat)	
Butter	<input type="radio"/>
Lentils (or other legume)	
Red palm oil	<input type="checkbox"/>
Cod liver oil	<input type="radio"/>
Food cooked in oil	
Apricot (other plant source rich in vitamin A)	<input type="checkbox"/>
Coconuts (other fat oil)	
Weaning food fortified with vitamin A (or other food fortified with vitamin A) such as, FAFA, Berta, Famix, Donation food, etc	<input type="radio"/>
Margarine fortified with vitamin A (or other food fortified with vitamin A)	<input type="radio"/>

Animal source of vitamin A

Plant source vitamin A

SECTION C: BREAST FEEDING AND WEANING

Date of survey ____ : ____ : ____ : Name of interviewer _____
 Name of respondent _____ ID No. _____

Question to be answered by mothers of the child under 3 years of age.

1. Name of the child _____ 2. Sex M__F__ 3. Age(mos) ____
4. Are you still breastfeeding your child?
 1. Yes 2. No if no, go to question 6.
5. If yes, when did you start breast-feeding?
 1. Immediately after birth 3. Later, specify _____
 2. One to three days after birth
6. When did you stop breast feeding ____ (mos)?
7. Why did you stop breast-feeding?
 1. Pregnancy
 2. Birth of next-in-line child
 3. Illness of mother/child
 4. Insufficient breast milk
 5. Child too old
 6. Other specify _____
8. Is your child exclusively breastfed?
 1. yes 2. no
9. For how long will babies feed breast milk only?
 1. Less than four months
 2. greater than 4 months and less than 6 months
 3. Other, specify.
10. For how long should mothers' breast-feed their babies?
 1. 4 months 2. 4 to 6 months
 3. 6 to 12 months 4. 1 to 2 years
 5. Above 2 years
11. Are you giving to your child any food or drink other than breast milk? 1.yes 2.no
12. If yes, what and at what age did you start?

<u>Types of food</u>	<u>Age</u>
_____	_____
_____	_____
_____	_____
_____	_____

SECTION D: MORBIDITY, SANITATION AND HYGIENE*Question to be answered by mothers or caretaker of the child*

Date of survey ____ : ____ : ____ : Name of interviewer _____

Name of respondent _____ ID No. _____

1. Name of the child _____ 2. Sex M _ F _ 3. Age(mos) ____

4. Has the child had diarrhea in the last four weeks?

1. Yes 2. No

5. If yes, for how long did the child has diarrhea (in days)

6. Has the child had cough in the last four weeks?

1. Yes 2. No

7. If yes, for how long did the child has cough (in days)

8. Has the child had fever in the last four weeks?

1. Yes 2. No

9. If yes, for how long did the child has fever (in days)

10. Has the child had measles in the last four weeks?

1. Yes 2. No

11. If yes, for how long did the child has measles (in days)

12. What is the source(s) of water used in the household?

1. Piped water in the house
2. Piped water outside the house
3. River
4. Bore-hole
5. Protected wells
6. Others: specify _____

13. Distance from the house to the water source (in Km).

14. Do you use a latrine?

1. Yes 2. No

15. Type of latrine used?

- | | |
|----------------|-------------------------|
| 1. Pit latrine | 3. Septic |
| 2. VIP latrine | 4. Other, specify _____ |

SECTION F: OPHTHALMOLOGICAL EXAMINATION.

Date of Survey _____ ID No. _____

Name of child _____ Sex M_ F_ Age (months) ____

1. Do you observe symptoms of night blindness in your child?

1. Yes 2. No

2. If yes, at what age?
_____3. If the answer for Q no. 1 is yes, how?
_____4. What is a local name for night blindness?

5. Does the child have the following signs of xerophthalmia?

Signs	Right eye		Left eye	
	Yes	No	Yes	No
Conjunctival xerosis				
Bitot's spot				
Corneal xerosis				
Corneal ulceration < 1/3 corneal surface				
Corneal ulceration ≥ 1/3 corneal surface				
Corneal scar				

6. Explain the cause of xerophthalmia?

7. How do you control or prevent the problem?

1. Home treatment

2. Traditional healer

3. Hospital/Health center

4. Did nothing

5. Other/ Specify _____

8. Mention if there is any traditional treatment?

9. How long does it takes to reach to the nearest health service?
1. Less than 15 minute
 2. Greater than 15 minute and less than one hour.
 3. An hour or two hours.
 4. More than two hours.
10. Has the child revived vitamin A capsule in the last six months?

SECTION G: LABORATORY EXAMINATION

I. BLOOD

Date _____

1. Zone _____ 2. Woreda (district) _____
3. Village _____
4. Name of child _____
5. ID No. _____
6. Sex M _____ F _____
7. Age (months) _____
8. Serum retinol level _____

II. STOOL

Date _____

1. Zone _____ 2. Woreda(district) _____
3. Village _____
4. Name of child _____
5. ID No. _____
6. Sex M _____ F _____
7. Age (months) _____
8. Ova or parasite _____
9. Wormload _____