Vitamin A Deficiency in children in the North West Frontier Province of Pakistan

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ABSTRACT

BACKGROUND:

Vitamin A deficiency (VAD) is single commonest cause of childhood blindness in developing countries, and contributes significantly (even at sub-clinical levels) to morbidity and mortality from childhood infections. The World Health Organization (WHO) lists Pakistan as having severe sub-clinical VAD, but few reliable population based studies have been undertaken to ascertain the severity and distribution of VAD in children. It was a commonly held belief among health professionals that VAD was not a problem, and prior to 1999 there were no programs of control in Pakistan.

Between July 1992 and January 1996, 154 children aged 0-15 years presented to Lady Reading Hospital, Peshawar, with xerophthalmia. More than 60% had blinding xerophthalmia, and 123 (78%) were 0-6 years of age. We thought that if clinical cases of VAD were presenting to a teaching hospital in Peshawar, that children with blinding xerophthalmia might be presenting in other districts in the Province.

AIMS:

A. To develop a surveillance system for documenting the occurrence and geographical distribution of blinding xerophthalmia in children presenting to eye departments at district level in North West Frontier Province (NWFP)
B. To conduct a population based survey of children aged 0-6 years in the same region to validate the surveillance system, and to determine possible risk factors with a view to developing appropriate control measures.

METHODS:

A: <u>**Surveillance system:**</u>

All district level ophthalmologists in the Province were invited to a one-day workshop where the study was explained. They were asked to complete and return a simple recording form for all children aged 0–72 months who presented with blinding xerophthalmia over a 12 month period. Information recorded included findings of a brief interview with the mothers of affected children.

B: **Selection of study districts for population based survey:**

To validate the surveillance system, two districts in NWFP were selected; one district was selected which had a participating ophthalmologist who did not report any cases (district with "no reported cases, NRC"). The other district was the one with the highest estimated prevalence of blinding xerophthalmia (this was District Swabi – the district with "reported cases, RC"). In each district 4 villages were selected, and 200 children aged 0-6 years who lived in the poorest parts of the village were examined for xerophthalmia according to the WHO criteria. Information was also collected on potential risk factors at village, household and individual level.

RESULTS:

A Surveillance system:

District of residence: Cases of blinding xerophthalmia were reported from 19 districts of the 31 districts in the region. Twenty-one participating ophthalmologists recorded 80 cases of blinding xerophthalmia between 1/11/1996 and 31/10/1997. Four were excluded from the analysis. Fifty-three children (69.7%) were recorded from outpatients, 20 (26.3%) from eye wards, and 3 children (3.9%) had been admitted to children's ward. The highest number of reported cases came from Peshawar District (12 children). District Swabi had the highest estimated prevalence of VAD (80 per million children aged 0-6 years).

Age, sex and seasonality: The commonest age at presentation was 25 - 48 months for boys and girls. Four children were less than 6 months and all were males. Thirty-nine children were male (51%). Fifty children (65%) presented during summer and autumn months.

Findings on interview: The majority of mothers of affected children had received no education, and almost half of households had a monthly income of <1,200Rs (<29 US $). Precipitating illnesses included diarrhoea (63%) and fever with cough (56%). One-third of children aged >9 months had not been immunized against measles, and a quarter of all children had not been adequately breast-fed. Seven children (9%) had never been breastfed.

B Population based study

Study population: A total of 1,680 children aged 0-72 months were examined in the 8 study villages. In the "affected" district 393 households were visited and 861 children were examined. In the "NRC" district 327 households were visited and 819 children examined.

Proportion of children with xerophthalmia: Clinical signs of VAD were present in 53 children (3.2%); 37 (69.8%) had night blindness and 16 (30.2%) had Bitot's spots. In the "RC" district 39 children (4.5%) had VAD, compared with 14 (1.7%) in the "NRC" district (MH Chi sq. = 11, $p=<0.001$). The proportion of children with VAD varied from 1.0% in two "NRC" villages, to 7.1% in a village in the "RC" district.

Factors associated with xerophthalmia (univariate analysis): Out of 53 children with VAD, 29 were males and 24 were females. Children with VAD were significantly older than unaffected children ($p<0.001$), were more likely to have had measles recently ($p<0.013$), and were more likely to live in large households ($p<0.001$).

CONCLUSIONS:

This study shows that the surveillance system employed was a reasonably reliable means of identifying communities of children with clinical VAD, as well as indicating high-risk seasons. The system could also be used to monitor the effectiveness of control programmes in the future. Xerophthalmia seems to be more prevalent in villages identified by the surveillance system. However, even in villages where no child was reported during surveillance, cases of xerophthalmia were detected.

DEDICATION

To my wife and children who have been patient and helpful during my long absence from home and to all those children of Pakistan who suffered needlessly and are still suffering because we could not recognize the source of their tragedy early and because the government, the professionals and the international community have yet to respond in full measure.

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In 1996, I visited the Institute of Ophthalmology, London to attend a course. During my stay there, I discussed my observation of clinical cases of VAD in NWFP Pakistan with Dr Clare Gilbert and Dr Allen Foster. They took a keen interest, and supported me in choosing the topic for my Mphil with University College London. They also helped to negotiate my admission with UCL and to obtain sponsorship from SSI UK and CBM Germany for the study. Dr Clare Gilbert agreed to be the principal supervisor for the study and Dr Allen Foster agreed to be the co-supervisor. They helped a lot in developing the recording forms, and I am extremely thankful to both of them. They have been a great source of inspiration and guidance, both in London and Pakistan. Dr Clare Gilbert also extended great help during the analysis and write up of the dissertation. Without her help and guidance, it would have been very difficult to complete the study. I am extremely thankful to Professor Gordon Johnson, and other members of staff in the department, particularly Dr Murray McGavin, Ms Adrienne Papendorf, Ms Susan Stevens, Ms Ann Naughton, Ms Andrea Foreman and Ms Jyoti Shah.

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CONTENTS

Abbreviations

ANA	Acute Respiratory Infection Needing Assessment
ARI	Acute Respirator Infection
CRS	Convention of the Rights of the child
DGLV	Dark green leafy vegetables
EPI	Expanded Programme of Immunization
FATA	Federally Administered Tribal Areas
GBD	Global Burden of Disease
GDP	Gross Domestic Product
HPLC	High Pressure Liquid Chromatography
LHV	Lady Health Visitor
LHW	Lady Health Worker
MICS	Multiple, Indicator Cluster Survey
NGO	Non Government Organization
NK	Natural Killer cells
NPA	National Programme of Action
NWFP	North West Frontier Province of Pakistan
PEM	Protein Energy Malnutrition
PRS	Poverty Reduction Strategy
SAP	Social Action Plan
VAD	Vitamin A Deficiency
WHO	World Health Organisation

1. INTRODUCTION:

In the introduction section of this thesis, an overview is given of the health situation in Pakistan, particularly in relation to malnutrition and poverty. This is followed by a description of Pakistan (geography, demography, health indicators, and the structure of health services). In the last section, the North West Frontier Province (NWFP) is described in more detail.

Health is one of the most essentials for normal existence. In Pakistan, though the health sector, both in qualitative and quantitative terms has expanded, yet the existing health system is not competent enough to provide adequate services for the growing population. Such a sorry state of affairs can be attributed to some key issues, associated with health sector from the very beginning. Paucity of funds, limited access to health services and their inadequacy, extreme poverty, ignorance and lack of awareness among the masses, and deficient health infrastructure have been identified as fundamental problems in the way of improving public health. These problems still stand and militate against the efforts of the government to make the health sector efficient[1].

The disease pattern is characterised by a high death rate (infant mortality of 90 per thousand live births and mortality rate for under 5 years of 126 per 1000) due to infections, communicable diseases, malnutrition and generalized under nutrition[1]. Over the past forty years life expectancy has improved. Small pox has been eradicated. Vaccines have drastically reduced the occurrence of measles and polio. These successes have come about in part because of growing incomes and increasing education around the globe and in part because of governments' efforts to expand health services, which, moreover, have been enriched by technological progress[2]. Despite these remarkable improvements, enormous health problems remain. Absolute levels of mortality in developing countries remain unacceptably high; child mortality rates are about 10 times higher than those in the established market economies. If death rates among children in poor countries were reduced to those prevailing in rich countries, 11 million fewer children would die each year. Almost half of these preventable deaths are due to diarrhoea and respiratory illness, exacerbated by malnutrition. Although health has improved even in the poorest countries, the pace of progress has been uneven[2].

In addition to premature mortality, a substantial portion of the burden of disease consists of disability, ranging from polio-related paralysis to blindness to the suffering brought about by severe psychosis. To measure the burden of disease, the World Bank report of 1993 uses the disability-adjusted life year (DALY), a measure that combines healthy life years lost because of premature mortality with those lost as a result of disability[2]. There is huge variation in per person loss of DALYs across regions, mainly because of differences in premature mortality. The total loss of DALYs is referred to as the global burden of disease[2].

Good nutrition is necessary for good health. Either directly, or in association with infectious diseases, an inadequate diet accounts for a large share of the word's disease burden, including as much as a quarter of that among young children. Much of this suffering stems from poverty-related under consumption of protein and energy, but equally important are deficiencies of key micronutrients i.e. iodine, vitamin A and iron, from which children and women suffer disproportionately. Increasing the income of the poor is the most effective means of reducing protein energy malnutrition, but governments can play an effective direct role through nutrition education, measures to increase consumption of micronutrients, and reduction in diarrhoea and infections among children. Public action is also essential following crop failure to prevent famines[3].

Malnutrition is not synonymous with hunger, because people become accustomed to a deficient diet. If malnutrition is wide spread in the community, underweight and lethargic children look normal to parents who do not know how well nourished children behave[3].

Vitamin A deficiency is the cause of corneal scarring in 50 - 70% of childhood blindness in most of Asia and Africa[4]. It also increases the severity of and mortality from a variety of infections, especially measles and diarrhoea[5, 6, 7]. It is now estimated that VAD, including clinical and sub-clinical forms of severe and moderate degrees of public health significance, exists 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 more are severely or moderately sub-clinically deficient. At least 254 million children of preschool age are thus “at risk” in terms of their health and survival[8].

Any discussion on health policy starts with a sense of the scale of health problems. These problems are often assessed in terms of mortality, but that indicator fails to account for the losses that occur before death because of handicap, pain or other disability. The World Bank and WHO has jointly conducted a study to measure the global burden of disease (GBD) by combining (a) losses from premature death, which is defined as the difference between the actual age at death and the life expectancy at that age in a low mortality population, and (b) loss of healthy life resulting from disability. The GBD is measured in units of disability-adjusted life years (DALYs). Worldwide. 1.36 billions DALYs were lost in 1990, the equivalent of 42 million deaths of newborn children or 80 million deaths at age 50[9].

Both VAD and iodine deficiency are particularly common in Asia and sub-Saharan Africa. Children under 5 are the principal victims of VAD, iodine deficiency and protein energy malnutrition. The nutritional disease burden for young children is 32 million DALYs, or 6 percent of their total burden of illness. The total impact of malnutrition on health is much larger, however, as mild or moderate protein- energy malnutrition and micronutrient deficiencies are risk factors for illness and death. Studies in Asia and Africa consistently show that mild to moderate stunting or under-weight in children raises the risk of death, contributing to 25 to 50 percent of childhood mortality. The greatest risk occurs for children in their second year, after they are weaned. Malnourished children die principally from measles, diarrhoea and respiratory diseases, tuberculosis, pertussis, and malaria. Child deaths from these diseases cost 231 million DALYs, making the total burden attributable to malnutrition at least one-fourth that amount, or 60 million DALYs[10]. Of the 8 million deaths in children with VAD that occur each year, between 1.3 million and 2.5 million might be prevented by eliminating VAD, for a gain of 39 million to 74 million DALYs. Damage from being under weight and vitamin A deficient cannot be added together because many children suffer from both problems. The total direct and indirect damage from malnutrition is at least 20 to 25 percent of the disease burden in children[10].

Both food consumption and communicable disease affect nutritional status by way of a malnutrition-infection complex. Food consumption depends both on people's capacity to acquire food and on their knowledge of how to choose a nutritious diet. For infants, the chief determinant of nutritional status is whether they are exclusively breastfed for at least the first four to six months of life. After 6 months children need solid food even if they are still breastfed. The composition and hygiene of this food are crucial to continued good health[10]. Chronic malnutrition is mostly a consequence of poverty. High income allows people to buy a more balanced diet, as well as better hygiene and medical care. Chronic food insecurity for poor people is often made worse by seasonal fluctuations in availability and prices. In India and The Philippines temporal variations in children's food intake is greatest among poor households, and severely malnourished children are more likely to die during that part of the year when malnutrition is most prevalent. Small variations in diet can be fatal to children already at risk. Even when refugee populations are protected from starvation, they are often exposed to micronutrient deficiencies because they are dependent on just a few foodstuffs[10].

Because of lack of nutritional knowledge, people may eat more poorly than their incomes allow. This is certainly true for vitamin A; deficiencies persist although almost everywhere in the world foods rich in vitamin A can be grown at low cost in family gardens or commercially. The effect of lack of awareness cannot be quantified, but probably partially explains the gender and age bias of malnutrition. In a number of Asian and African countries, children and women, especially pregnant women, are discouraged from eating eggs and fruit. Lack of knowledge concerning the health benefits of certain foods also interacts with economic factors. For example, when the price of leafy vegetables rich in vitamin A rises in the Philippines, people switch to vegetables containing much less of the vitamin[10].

In Pakistan, attempts have been made to improve the health conditions of the people through training personnel, adequate supply of medicines and establishment of health services. Yet, the health care system as a whole is not what it ought to be and is still deficient in many respects. The main health problems are preventable communicable diseases, severe malnutrition and high infant and maternal mortality rates. There are also clear differences in health indicators, comparing rural with urban areas, and by socio economic group[11]. The Government of Pakistan became a signatory to Alma-Ata declaration of 1978 and responded by including primary health care (PHC) in national health policy and planning process. But like many other countries, achieved less success in the translation of these plans in to actions. Because, central to the concept of PHC is that individual, families and communities take the major responsibility of their own health. The role of health professionals, and health system is to support this process. The implications of this concept are serious for a health system, which has monopolized heath care. PHC asks for a bottom up approach for setting targets and identifying needs. Such a working style calls for a continuing process of dialogue, popular consultation, organizational adaptation and change. PHC must not be confused with first contact care. Eight elements of PHC were identified at Alma-Ata. At the level of the individual, the family and the community, these eight elements come together to constitute PHC. At the level of central bureaucracy, each element may exist in a separate government ministry. One of the key elements for PHC is intersectoral collaboration. Because of rigid compartmentalization in government ministries, there has been more discussion than action with regard to collaboration between sectors.

A great deal of health improvement requires action outside the health sector. Hence flexibility and adaptation in long established bureaucracies are essential[12]. In Pakistan all these factors contributed. There was no real community involvement. Intersectoral collaboration was minimal. There was no established referral system for those referred cases to the supportive secondary health care facilities at district or sub-district levels from the communities, which needed medical or surgical intervention[13]. The influential professors in big hospitals influenced the distribution of the health budget at provincial levels leading to more facilities / budget for tertiary facilities, with very little emphasis on primary health care and secondary health care facilities.

As a result only 18-21 % of people utilise the government health facilities in Pakistan[14, 15]. The reasons include dissatisfaction 60%, unavailability of physician 20%, patients are too ill to be taken to that facility 11 % and 9 % told other reasons[13]. The number of patients with primary problems, seen in Tahsil Headquarter (THQ) was 77 %, District Headquarter (DHQ) hospital 44 % and teaching hospital 44 %. More than 34 % of these patients with primary problems were seen by a physician[13]. This poor planning and poor management of PHC from the government side and lack of education and increased prevalence of poverty in rural areas lead to poor health of the vulnerable population of women, children and elderly in the country.

Science tells us that optimal neural development in a child, leading to physical, mental and cognitive development, depends on good nutrition and loving stimulation during the first months and years of life. Research also clearly illustrates the powerfully positive effects of bonding and interaction between infants and young children and their parents and caregivers on all aspects of child's survival, growth and development. On the negative side, it demonstrates that poor nutrition may trigger a downward spiral for the child, as malnourished infants, lacking energy, appetite and curiosity, may be less able to elicit attention and affection from their caregiver. The long-term benefits of good prenatal care and breast-feeding, and especially the rich effects of talking and playing with infants from their early days, are commonly acknowledged[16].

Malaria, tuberculosis and a variety of childhood diseases, such as diarrhoeas, measles and tetanus still continue to pose potential threat to the health of millions of the people in the country. Unsanitary conditions, polluted water, illiteracy among rural mothers, urban slums, high fertility, small budgetary allocations and inadequate administrative structure have been identified as the main hurdles in the progress of health conditions[11].

Around the world, clinical services are financed through four main channels. Two, out of pocket payments and voluntary insurance are, private. The other two are public, compulsory insurance, that is either publicly managed or heavily regulated by governments and funding from general government revenues. In addition there are three ways of organizing clinical health services: public, private non-profit, and private for profit. In low-income countries private out of pocket payments account for more than half of the mere US $2 to US $ 40, per person spent each year for health care. Most of this money goes for doctor's fee, payments to traditional healer and drugs[17].

1.1 How this study evolved:

The World Health Organization has listed Pakistan as a country with severe sub-clinical VAD[8]. Pakistan has high infant mortality (91/1000 live births), which is greater than India (70), Bangladesh (73), Nepal (77) and Sri Lanka (16) [1]. The under-five mortality rate (U5MR) is a critical indicator of the well being of children in any country[16]. Pakistan has an under 5 mortality of 120/1000 which is more than India (83), Bangladesh (96) and Nepal (107) [1]. The prevalence of under-five year olds suffering from wasting and stunting is almost similar to children in India, Bangladesh and Nepal. Clinical cases of VAD have been reported from these countries and active vitamin A distribution programmes have been in place for a long time. Very little has been reported regarding clinical cases of VAD from Pakistan and there is very little in the way of population-based data. No active programmes were present in the country before November 1999, when for the first time vitamin A, was distributed on National Immunization Days.

We saw two children suffering from corneal ulcers admitted to the eye ward of Lady Reading Hospital, Peshawar, in July 1992, whose ulcers did not respond to routine treatment. Professor Mohammad Daud Khan asked us, "Can we exclude VAD in these children", "difficult to say" was the answer. He advised us to try high dose of vitamin A in these children, but vitamin A capsules were not available in Pakistan at that time. The researcher had brought some vitamin A capsules from Mrs Lakshmi Rahmatullah when he visited Aravind Children hospital, in Tamil Nadu, India during a study tour in March 1992. We gave one capsule (200,000 IU) to each of the children. The next morning the children had improved a lot and were looking different. They could open their eyes, were less irritable and could take feed. All members of the eye care team at Lady Reading Hospital Peshawar and the mothers of the two children noted this dramatic response.

We started registering clinical cases of VAD (xerophthalmia) in one of the teaching hospitals in Peshawar from July 1992. In 1993 we presented our findings at the annual meeting of the Ophthalmological Society of Pakistan[18]. We recorded more cases and presented our observations at the Biannual Congress of the Asia Pacific Academy of Ophthalmology in Hong Kong in 1995[19]. Between July 1992 and January 1996 we had recorded 154 cases of xerophthalmia presenting to one tertiary unit in Peshawar. One hundred and twenty three children (79%) were age 6 years and below, 28 children were between 7 and 15 years of age and in 3 children the age was not recorded. Ninety-four children (61%) had corneal involvement (corneal xerosis, corneal ulcer, keratomalacia), 32 children (21%) had Bitot's spots and 28 children were suffering from night blindness. Out of 94 children with corneal involvement, 73 (78%) of children were less than 3 years of age. Out of 154 children, 99 children (64%) were male and 55 children (36%) were female. Night blindness was present in 21 male children (75%) and 7 female children (25%). Bitot's spots were present in 27 male children (84%) and 5 female children (16%). During the study period more children presented between July and December with only a few presenting in January, March and April[20]. It was this experience that led to the study described in this thesis.

1.2 The Emergence of Pakistan:

The Islamic Republic of Pakistan came into being on August 14, 1947 as a result of partition of the former British India. It comprises four provinces, namely; North West Frontier Province (NWFP), Punjab, Sindh and Baluchistan. The capital, Islamabad, and Federally Administered Tribal Areas (FATA) adjacent to NWFP are administered separately. (See Figure 1.1) Punjab is the most populous province. It is fertile, has a continental climate, and is the most affluent province. Baluchistan has a low population density, as large areas are desert, or mountainous. The climate is very dry, and the majority of the rural population is nomadic pastorals. It is the poorest province. The province of Sindh also has extreme topographically. It was the centre of the Indus civilization, which dates from the third millennium BC[21]. NWFP and FATA will be described later.

1.3 Population:

The population of Pakistan currently (June 2001) is 140.5 million, almost 2.3 % of the world population. It is the 7th most populous country in the world. Each year another 3.2 million people are added to this number[22].

The population of a country is a double-faced phenomenon. It is an asset, a vital factor in the development process on the one hand, but rapid population growth can hamper development, on the other. Population is generally studied on its two aspects: a) quantitative and b) qualitative. The quantitative aspect of population includes; statistics of total population, density of population, birth and death rates, migration etc, while the qualitative aspects refer to the ability and capability of the people. Pakistan has conducted five populations and housing censuses i.e. 1951, 1961, 1972, 1981 and 1998. According to the provisional results of latest census, the overall population has increased by about 55% since 1981, to 130.5 million in 1998. This indicates an average growth rate of 2.6%, compared with 3.1% observed during 1972-81[22].

1.3.1 Rural / urban: The rural / urban population breakup reveals that the rural population has declined from 71.7% in 1981 to 67.5% in 1998 i.e. by 4.2%. According to 1998 census, the capital territory, Islamabad is now the most urbanized area with an urban population of 65.6%. In FATA the share of urban population is only 2.7%. Sindh is the most urbanized province, with 48.9% of people living in urban areas, including Karachi. The urban population of Punjab is 31.3% followed by NWFP 16.9%, and Baluchistan 23.3%. There are 23 big towns / urban centers having population of 0.2 million and above. The biggest city in Pakistan is Karachi, with a population of 9.3 million followed by Lahore 5.1 million[22].

1.3.2 Afghan refugees in Pakistan: The influx of Afghan refugees into Pakistan started in 1979 and peaked at 3.7 million in June 1990. Pakistan is still host to around 2.2 million Afghan Refugees. Apart from exerting pressure on the tight labor market in Pakistan, the refugees have inflicted considerable economic loss and ecological damage. With the end of the cold war the international community has, to a large extent, forgotten the Afghan refugees. International humanitarian assistance has been drastically curtailed and Pakistan has been left to bear the burden of the entire cost. In 1995 the international community discontinued food and other forms of direct assistance to Afghan refugees, which resulted in migration from their camps to urban centers in Pakistan. At present, only limited community based assistance in the field of education, health and water supplies are being provided. Additionally the recent drought, which has hit the region, has further strained Pakistan's ability to meet the needs of the refugees. Inadequate funding has led to the closure of 86 primary schools and 40 basic health units meant for Afghan Refugees. The shortage of clean water is causing epidemics and serious health problems for them. On account of continuous humanitarian crisis in Afghanistan (civil war, non-availability of adequate economic opportunities, drought and other socio-economic conditions) additional Afghan refugees are coming to Pakistan without proper arrangements for shelter, food, clean water and basic sanitation. This has further deteriorated the already fragile health situation of the refugees in general and children in particular[22].

The numbers of unemployed people have increased 6 fold from 0.4 million in 1970-71 to more than 2.4 million in 2000[25]. Although Pakistan's GNP has increased from US$ 2.6 billion in 1950 to US$ 68.8 billion in 2000, yet per capita incomes have not increased substantially. This has the result that, 44 million people are living below the poverty line[22].

1.3.3 Age and Sex distribution: Data on sex and age serve as a basis for estimation and forecasting of population growth and to calculate various demographic indices as a guide to public health and social welfare programs. These data when related to data on other economic characteristics provide insight into the factors and processes of social, economic and demographic changes. They are very important for the formulation of policy / planning and administration of programs for economic and social development.

The quality of age reporting in Pakistan like other developing countries is not good, due to illiteracy, general ignorance about age and hesitation on the part of the respondents to provide accurate information particularly by females, young children and the elderly. There is concentration of reporting of ages at certain digits like 0, 3, and 5. Table 1.1 gives percentage distribution of

Population of Pakistan by sex and 5-year age group[23]. The proportion of the population under 15 years of age is more than 43%[23]. As a result the dependency ratio is quite high in Pakistan. This ratio is defined as the proportion of children under 15 years age plus people aged 65 years in relation to the population aged 15 - 64 years. The economic growth has not been satisfactory and has declined further in the 1990s. Most of the 43% young people below 15 years of age will be entering the job market soon. It is, therefore, essential to attain higher growth rate to absorb the work force entering the job market. Further it is essential to invest in the social sector (education, health and training) so that this 43% children and youth become productive assets for the nation[22].

1.3.4 Household Size: The average household size has declined from 6.7 in 1981 census to 6.6 persons in 1998. The highest household size of 8.8 was observed in FATA, followed by 7.6 in NWFP, 6.8 in Punjab, 6.4 in Baluchistan and 5.8 each in Sindh and Islamabad[24]. (See Table 1.2)

1.4 Employment situation:

According to the Labor Force Survey, the employed labor force is defined as all persons of 10 years and above who worked at least one hour during the reference period, either as "paid employees" or "self employed". The total number of employed persons in urban areas increased to 11.6 million in 2000 from 11.2 million a year ago. Rural employment increased from 25.0 million in 1999 to 25.4 million in 2000. Changes in the growth pattern of the economy over the years have brought corresponding changes in the employment structure. Agriculture, the single largest contributor to GDP, remained the single largest employer of Pakistani work force. This sector used to employ about 58% of the work force in 1960, but its share has gradually declined to 44.1% in 2000. This should have led to increase share of employment in manufacturing. In the case of Pakistan, the share of manufacturing and mining instead of rising has declined over time. The share was 14.8% in 1960s, declined to 13.5% in 1980s and further to 11.2% in year 2000[22].

Interestingly the share of manufacturing in the GDP has increased from 14% in 1960s to 17% in year 2000, but the share of labor employed over time, has declined. The growth and employment in the manufacturing sector clearly reflects the strong bias in favour of capital-intensive technology. The deceleration in manufacturing growth in the 1990s has adversely affected its labor absorptive capacity and placed it at the 4^{th} position, behind the general trade and financial services sector [22].

Being aware of the growing unemployment in the country, the Government has launched an economic revival plan whereby the economy will be revitalized as a result of which economic activities will generate more job opportunities in the country. The plan focuses on higher investment and promotion of labor-intensive sectors like agriculture, small & medium enterprises, construction, and energy and information technology. Government has established a micro credit bank for promotion of credit facilities for self-employment [22].

In urban areas employment opportunities are available to a substantial number of people, and there is rapid urban migration, which is leading to slum areas. These areas do not have basic living facilities. In rural areas, a large number of people live as landless labourers. They live on daily wages, but work cannot always be found. They tend to have large families and the majority live in very primitive conditions. The women and children of these communities are malnourished and are prone to infectious diseases. A substantial amount of money earned is spent on health care, which is just enough to keep them alive. This cycle of poverty, disease and increased population is playing a major role in the lives of these unfortunate people. About 21% of men and women report that their most recent health-related contact was with government doctor at a public health facility, although a much proportion report seeing a private doctor, particularly among men (56%, compared with 44% of women). Lower-income households seek care more often and use higher quality providers (private doctors) for boys than for girls.

1.5 Social Welfare and Rural Development:

Pakistan economic growth over the last four decades has been satisfactory compared with the developing countries having similar level of per capita income. However, this economic performance has not been translated into improvement in the social sector. At the time of independence in 1947, Pakistan's social infrastructure was extremely poor and underdeveloped. The Government's preoccupation with the objective of GNP maximization through import substitution by industrialization precluded proper development of the social sector. As a result of growing population, the condition of social sector further deteriorated. Consequently, the chain between economic growth and social development became weak and adversely affected growth momentum. The deceleration of growth during the last four years (1996-2000) can partly be attributed to the past neglect of the social sector. Table 1.4 indicates that almost all the social indicators of Pakistan reflect poor performance as compared to other developing countries[25].

The inadequate social sectors have now started exerting severe limits to economic growth. The development of the social sectors has become critical for the country's medium to long-term growth prospects. The main aim of the Social Action Programme (SAP) is to improve access and effectiveness of basic social services like primary education, primary health care, and population welfare services, potable water and sanitation. The provisions of these services are essential for improving the daily lives of the people. These benefits will accrue only if the programmes are well designed and implemented effectively with involvement of the communities they serve[25].

1.6 Transport:

An efficient transport and communication system is not only a prerequisite for the economic development of a nation but it is also essential for meaningful economic cooperation among nations, particularly in the area of trade, tourism and attracting direct foreign investment. Improved transport and communication networks have helped mankind to think and work his way out of the bondage of poverty and despondency. The lack of well-developed well-coordinated transport system with an outmoded communication network in the developing countries has been a major factor in the perpetuation of poverty. The participation of developing countries in the process of globalization thus crucially depends on the efficiency and reliability of their transport and communication services. The transport system in Pakistan consists of road networks (which carry over 90% of freight and passengers), railways (which are under developed), air transport and ports & shipping services[26]. The government has opened the domestic aviation market to private sector competition. The National Carrier, Pakistan International Airline (PIA), serves 32 domestic and 38 international destinations[26].

1.7 Communication:

Communication technology has evolved rapidly over the past decades making it possible to establish faster, cheaper and more reliable lines of communication nationally and internationally. The post office is a Federal government Department, which provide postal facilities through a network of 12,854 post offices across the country. The total number of Internet users in Pakistan as of March 2001 is 1.3 million. There are more than 3.93 million telephone lines including 15,968 PCOs and 51000 Pay Card Phones[26].

1.8 Education:

Education plays an important role in human capital formation. It raises the productivity and efficiency of individuals and produces skilled human resources capable of leading the economy towards the path of sustainable economic development. However, like many developing countries the condition of the education sector in Pakistan is not encouraging[27].

The low enrolment at primary level, wide disparities between regions and genders, lack of trained teachers, deficiency of proper teaching materials and poor physical infrastructure of schools indicate the poor performance of this sector. The literacy rate, estimated in 2000, is 47.1% (male 59% and female 35.4%). Illiteracy among females is still prevalent, particularly in rural areas. High population growth rates are causing unprecedented increase in the absolute number of illiterate adults; which were 43 million in 1981 and gone up to 53 million, according to 1998 population census posing, a big challenge[27].

1.8.1 Educational attainment: Over 39 million persons were found to be either attending educational institutions or had attended earlier according to the 1998 census[23]. The percentage distribution by level of education is shown in Table 1.5. Education is one of most powerful instruments of change. Its importance for achieving national goals through producing young people with knowledge, skills, attitudes and competence to shape the future destiny of the nation is recognized by the Government of Pakistan. Although education is a provincial subject under the constitution, the Federal Government has been given the responsibility for policy, planning and promotion of educational facilities in the federating units to meet the needs and inspirations of the people. Among total graduates and postgraduates 31.1% are females[23].

1.9 Income Distribution and Poverty:

GNP Per Capita[28]	470 US $
Average Annual Growth rate	1.4%
Average Annual Rate of Inflation (2000-01)	5.4%
Public Sector expenditure as % of GNP 2000-2001[27, 1]	
Education	2.3%
Health	0.7%

Does economic growth reduce poverty and income inequality? The relationship between growth, poverty and income distribution has been studied widely in recent years. There is general consensus based on the empirical evidence that absolute poverty can be alleviated if economic growth occurs on a sustained basis and remains neutral to income distribution. Poverty cannot be reduced if economic growth does not occur. It is the most powerful weapon to fight poverty. Poverty can also be reduced by increasing the productivity of the poor, either by investing more in education, especially at the primary level, or by expansion of their access to physical and financial capital. The poor benefit most from basic education. Along with education, improvements in health status and nutrition directly address the worst aspects of poverty. Access of the poor to health services is important both for increasing their income and for raising living standards even if income remains at poverty level.

Traditionally poverty is defined as a lack of resources to reach some (minimum) desired standard of living or attain a set of basic needs. These needs may be a certain minimum daily calorie requirement, or a basket of basic needs that include food, shelter, clothing, education, health care and social participation. Poverty has emerged as the most important issue for Pakistan as it is faced with the twin challenges of reviving economic growth and reducing social inequities. The poverty line is derived in Pakistan on the basis of income, which can provide daily intake of 2250 calories per person. Poverty has increased significantly in the 1990s- rising from 17.3% in 1987-88 to 33.5% in 1999-2000. The incidence of poverty in rural areas has remained higher than the urban areas since 1966-67[29].

1.9.1 Who are the poor? The main reasons for increase in poverty in Pakistan can be attributed to the relatively lower rate of economic growth (a slow increase in per capita income), rising unemployment, stagnant / declining real wages, declining flow of worker remittances, and deterioration of governance. In addition to the above factors, the high population growth also puts pressure on the meager social services thereby causing social distress. An analysis of poverty by socio-economic groups, focusing on key demographic and economic characteristics, reveals the following facts of poverty in Pakistan:

- The incidence of poverty increases with household size in urban areas. Households with a large number of children, and a single earning member, are more likely to be poor in urban areas than in rural areas.
- The incidence of poverty among female-headed household is marginally higher in rural areas than that among male-headed households. However, in urban areas, the incidence of poverty in female-headed households is lower to that in male-headed households.
- Significant proportions of the poor are workers with low incomes. In the majority of cases, workers earn a wage that is less than half of the subsistence level.
- More than one third (36%) of poor households are headed by aged persons who are dependent on transfer incomes, such as pensions and other forms of social support.
- The incidence of poverty is highest (36.5%) where head of the household has no formal education. Poverty falls as the educational attainment of the family head increases.
- Poverty is relatively high when head of the households are unskilled agriculture workers, engaged in services, transport, production and sales occupation.
- Incidence of rural poverty for those households whose heads are

agriculturist, is lower than all other occupations except for those in professional, management, or clerical position[29].

1.10 Poverty Reduction Strategy (PRS) 2001-2004 [29]:

The Government of Pakistan has articulated a multi-pronged poverty reduction strategy to ensure that economic growth is complemented with policies that enhance social development. Pakistan's PRS strategy centers on unleashing growth, improving indicators of social development and reforming formal institutions of governance. For revival of the economic growth the Government of Pakistan has identified four major areas, agriculture, small and medium enterprises, oil and gas sector, and information technology. With relatively low investment, these sectors are likely to generate more growth and more employment opportunities[22].

1.11 Health and Nutrition[1]:

The health indicators (See table 1.6) in Pakistan reflect the poor state of health services in the country. To take care of inadequacy of the health services, the government in 1997 formulated a comprehensive health strategy based on short term and long-term policy measures to rectify the overall situation. The main policy measures and structural changes sought in the strategy are:

- Institution of public private partnership in health sector by transfer of health facilities to NGOs, private sector and local bodies.
- Provision of autonomy to large teaching hospitals and establishment of health boards and village committees.
- Subsidisation of poor segments of the population through Zakat.
- Establishment of properly regulated private sector for quality drugs available at affordable prices.
- Consolidation of the existing primary health care network in the rural areas and functional integration of vertical projects.
- Redefinition of federal and provincial government in health delivery mechanism.
- Promotion of gender equality through adoption of lady health workers programme and women's health project.

Pakistan has an extensive health delivery system, which is a mix of government and private facilities distributed all over the country.

1.12 Multiple Indicator Cluster Survey (MICS) 1995 [30]:

The Multiple Indicator Cluster Survey (MICS) was conducted on a nationally representative sample of approximately 15000 households all over the country. An all-women team of nearly 100 obtained information on 32717 boys and girls under 12 years of age from their mothers. All children under 5 were weighted and measured and the interviewer personally examined whether these children had a scar on their arm indicating vaccination against BCG. Information was also obtained personally from housewives on the source of drinking water and sanitation facilities in their homes.

The multiple cluster indicator survey owes its origin to the Convention of the Rights of the Child (CRC), which was adopted by the United Nations General Assembly in 1989 and came into force in 1990. Pakistan ratified the Convention in September 1990 to become one of those countries, which ratified it at early stages. The Planning Commission of Pakistan, Government of Pakistan, set up an Inter Ministerial task force for adopting the Goals for Children and Development for the 1990s to meet country specific needs. On the basis of these goals the Task Force prepared a National Programme of Action (NPA). This programme formulated indicators to assess progress towards achievements of the Goals. The NPA also envisaged a process of monitoring, which measured changes in the status of indicators. MICS provides the mechanism to monitor progress towards the goals set by National Action Programme[23]. In June 1995, UNICEF (Pakistan), commissioned Gallup to undertake the MICS in Pakistan. The findings of the survey are presented below.

1.12.1 Water and sanitation [30]: The quality of life in rural and urban Pakistan is very different; in urban areas supply of hygienically appropriate water within the dwelling is considered as an important target. On the other hand, for rural areas, where the simple availability of drinking water is sometimes an issue, supply of water at the community level is an important target. As far as sanitation is concerned, disposal of human excreta was chosen as the focus of the study. The urban and rural situation of disposal of human excreta is also very different and cannot be assessed from one common standard. Hence the major results of water and sanitation are being presented and discussed separately for urban and rural areas. Piped supply and hand pump in dwellings is the dominant sources of water in all the provinces of Pakistan. Their ratio in different provinces is shown in table 1.6 – 1.7.

1.12.2 Toilet facilities: MICS finding showed that only 22% of rural and 77% of urban homes have access to basic sanitary facilities by way of latrine, which might be considered hygienically safe[30]. (See Table 1.8 & Table 1.9)

1.12.3 Salt Iodization: MICS finding showed that 19% of rural and urban households are using iodized salt.

1.12.4 Education [30]: According to MICS 70% of children under 12 are currently enrolled in school. Only 47% of the enrolled children however, complete primary school, while the remaining drop out. The enrolment of girls has increased but it is still behind boys.

1.12.5 Breastfeeding[30]: The most crucial period for breastfeeding is the first 0-6 months of life. Breastfeeding rates are very high all over Pakistan: 95% of mothers breast feed their children, and 88% of babies are still receiving breast milk at 1 year, and 56% at 2 years of age. Infants taking mother's milk only during the last 24 hours are classified as exclusively breastfed. Only 16% infants aged 0-4 months are exclusively breastfed in Pakistan, with no significant urban / rural differences. Bottle-feeding has been identified as a possible cause of diarrhea diseases in children. Breastfeeding is sometimes combined with bottle-feeding, which occurs in 18% infants in Pakistan. The most common confounder of breastfeeding is water, which is fed to 69% of infants aged 0-4 months. (See Table 1.10)

The age of six months is considered appropriate for the introduction of complimentary feeding. Complimenting breastfeeding with some semi solid or solid food is an important nutritional issue for children. In MICS survey, the practice of supplementary breastfeeding was assessed at 4-5 months and at 6-9 months. 15% of infants were given semi solid or solid food at 4-5 months of age, increasing to 31% at 6-9 months. Rates are higher in urban areas (36%) than in rural areas (27%). (See Table 1.11)

1.12.6 Acute Respiratory Infections[30]: Mothers knowledge about Acute Respiratory Infections (ARI): The most common symptom, which compels a mother to take her child to a health care provider, is fever, (74% of mothers). After fever, cough appears to be the most bothering symptom to mothers. Fever and cough is followed by a vague and generalized description of child as "not being well and getting sicker" which makes a mother realize the need for professional help. The prevalence of ARI among children of less than 5 years is 37%. It is 35% in NWFP.

Of those mothers who believed that their child suffered from ANA (difficult / fast breathing, chest in drawing), 18% went to a Government hospital, 17% went to a private hospital, 17% went to a qualified (MBBS) private doctor. MICS findings showed that in the judgment of the mothers, 37% of children under 5 suffered from ARI in the two weeks preceding the survey. The study showed that only half (53%) of the mothers who believed their children suffered from ANA sought medical care from appropriate sources. Among mothers who believed their children suffered from ANA, 19% used Government facilities.

1.12.7 Estimates of Diarrhea Diseases in MICS Pakistan 1995[30]: The estimate of diarrhea diseases among children less than 5 years of age during the last two weeks was derived from the response of their mothers, and was therefore based on their perceptions. 26% children under 5 years suffered from diarrhea diseases during the two weeks of summer / late summer preceding the survey. The location and gender differences are not significant. Nevertheless the estimate of diarrhoea is much higher in Sindh (33%) than any other province. Surprisingly it is the lowest in Baluchistan (17%). It is 21% in Punjab and 25% in NWFP. It is advisable that food intake should not be reduced during diarrhoea. Altogether 27% of mothers reduced the food intake during diarrhoea beyond the advisable limit.

1.12.8 Immunization in Children 1995[30]: The Expanded Programme on Immunization aims to give children one dose each of BCG and measles vaccinations and three doses of DPT and OPV vaccinations before the first birthday. The investigation of immunization was limited to children of 12-23 months of age. Immunization cards, mother's recall (history) and evidence of BCG scars were used as sources of information to calculate the proportion of children who had been immunized (See Table 1.12). Only 53% of children had evidence of measles immunization.

1.12.9 Nutritional Status[30]: Anthropometric measurements were used to assess the nutritional status of children under-five years of age. They were weighed on standard Salter type scales and their height was measured with help of wooden boards. According to MICS data, 38.2 percent of the children were found to be severely and moderately underweight. These included 25.4% who were moderately under-weight, 12.8% who were severely underweight. There were significant urban and rural differences in the nutritional status of children: 36% of urban children were moderately underweight compared with 40% in rural areas.

Contrary to the impression that females are more malnourished than boys, the study shows no significant differences in the nutritional status of boys and girls. The PDHS conducted in 1990 had similar findings. (See Table 1.13). The pattern of severe underweight showed that it is lowest in Baluchistan (9%) and highest in Sindh, 11% in Punjab and 12% in NWFP.

Multiple Indicator Cluster Survey (MICS) was conducted in the summer months. MICS might have shown slightly better condition of children if it had been conducted in winter. There is a weight loss among children during summer, especially because 26% of the children weighted in MICS had suffered diarrhoea during two weeks prior to the survey.

1.13 Health services:

The Government has taken many steps to improve the health of the people. Many specific programmes that deal with the major public health problems are under execution. The Expanded Programme of Immunization (EPI) against six diseases to reduce infant and child mortality is under implementation. Health education has become an important component of all health initiatives.

The private sector has been involved in supplementing Government's efforts and financial allocation has steadily been increased[1].

The health concept not only includes freedom from communicable and other diseases but also availability of facilities for maternity and childcare. The infrastructure of health sector therefore covers establishment of hospitals, basic health units, dispensaries, maternity and child health care centers and their staffing with adequate number of doctors, nurses, lady health visitors, dispensers and midwives (see Figure 1.1). The existing national network of health services in public sector consists of the following;

Hospitals	877
Rural Health centers	530
Basic Health Units	5,152
Dispensaries	4,625
Total beds	91,919

1.13.1 Private Sector in Health Delivery: Both the public and private sector provide medical facilities, but the private sector is concentrated in urban areas. The private sector includes two different types of health facilities. These are allopathic and eastern systems of medicine, the latter being Ayurvedic and Homeopathic medicine that the Government recognises. Indigenous midwives still handle the majority of births. The Government has provided many fiscal and monetary incentives to the private sector to expand its role, and recently thousands of new centers have been established all over the country. Reputable medical professionals run the majority of these private medical centers/ clinics. The increasing involvement of the private sector in health facilities is a positive development, as it not only provide health facilities but also a big source of employment for thousands of doctors and other technical and non-technical staff.

1.14 Health Programmes [1]:

Some vertical programmes under implementation are; National Programme for Family Planning and Primary Health Care, Expanded Programme of Immunization (EPI), National Aids Control Programme, Malaria and Tuberculosis control Programmes, and National Hepatitis B control

Programme.

1.14.1 National Programme for Family planning and Primary Health care: This programme aims to extend out reach services to communities at their doorstep through Lady Health Workers (LHWs). These LHWs are a vital link between the community and health facilities. The strategies of the programme include improvement in the quality of services, expansion of services through LHWs, better management and strengthening family planning and reproductive health components. The capacity of LHWs was enhanced to deliver nutrition services to mothers and infants. They also deliver inputs and services for the protection and management of breastfeeding, elimination of micronutrient malnutrition e.g. Iodine Deficiency Disorders and VAD and counseling of mothers and young children.

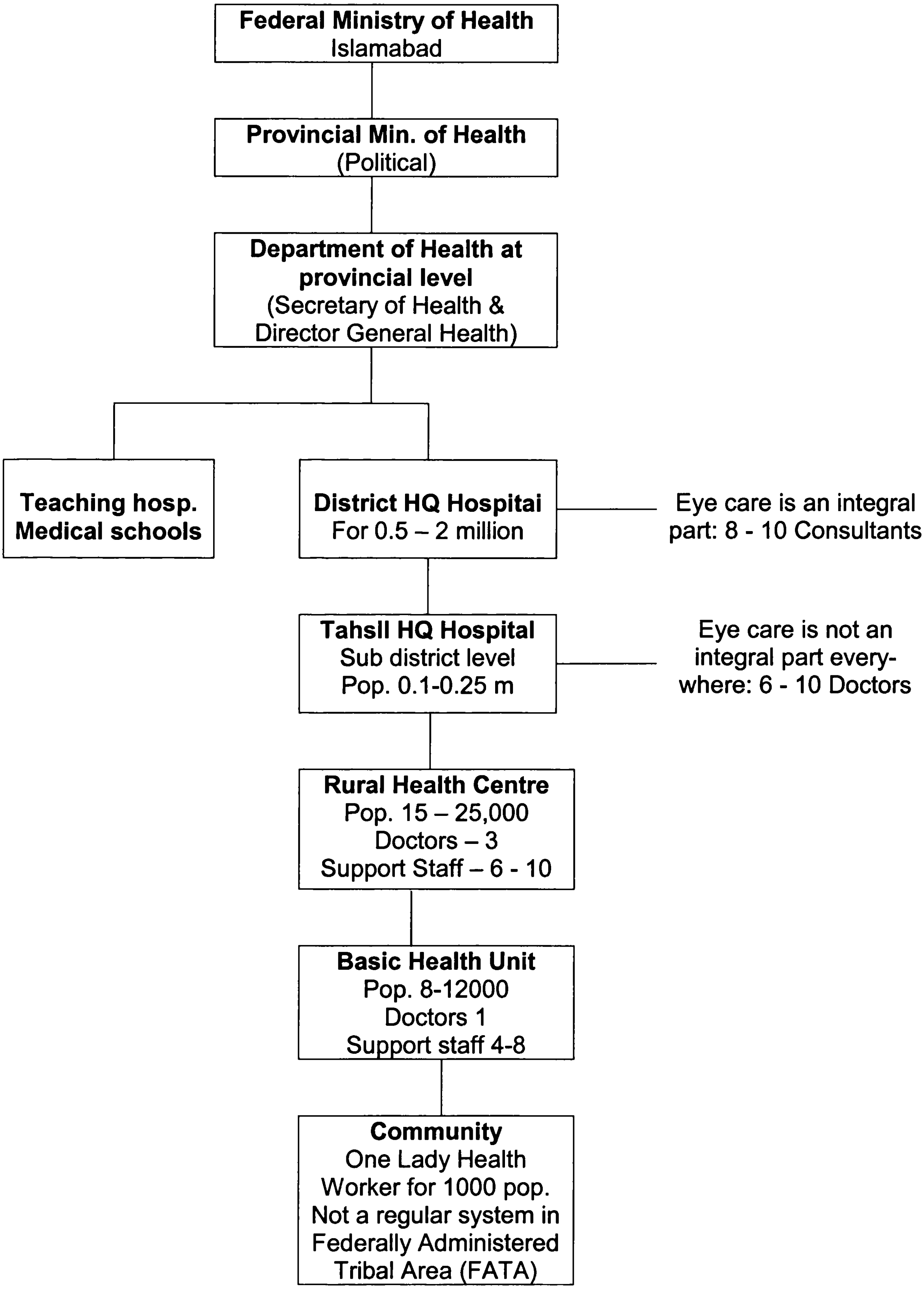
1.14.2 Expanded Programme of Immunization (EPI): Immunization coverage was raised to 70 % during the year 2000. Routine immunization has been expanded through fixed centers, outreach teams and lady health workers. Special immunizations days and campaigns are also conducted.

1.14.3 Food and Nutrition: Malnutrition is a serious health problem in Pakistan. Infants, young children and women are identified as high-risk group. At present, there is no simple solution to this health problem. Strategies have been evolved to deal with specific nutrient deficiency diseases. Government interventions include food fortification, mass media nutrition education programmes, new weaning foods and village level food processing. According to estimates in 1999-2000, the total number of malnourished children in Pakistan was 8 million; with iron deficiency being the most prevalent public health problem. Malnutrition is one of the main reasons behind high mortality rates among mothers and infants in the country. The government is taking a number of steps to overcome malnutrition.

The Micronutrient Deficiency Control Programme has been strengthened, especially its components of breastfeeding, fortification, and provision of vitamin A, iron and iodine[1]. The following micronutrient deficiency control programmes have been undertaken in 1999-2000.

1. *Iodine Deficiency Disorders*
2. *Anemia Control programme*
3. *Vitamin A deficiency Control Programme:* Legislation for the fortification of edible oil/ ghee with vitamin A has been in place since 1965, but manufacturers have not adhered to this. To strengthen the process, an assessment of quality control and technical operations to fortify edible oil / ghee with Vitamin A was conducted. The aim was to provide necessary support to oil / ghee manufacturers and the quality control agencies to maintain the required level of fortification of vitamin A. Integrating the distribution of Vitamin A with National Immunization Days (NIDs), the government has launched a programme for the supplementation of vitamin A to children under-five years in the country.
4. *Promotion of breast-feeding:* A programme to promote breastfeeding throughout the country is in progress. The Baby Friendly Hospitals initiative has been extended to more than 70 hospitals in all the provinces. Promotional activities remained in progress through multi-media campaign.
5. *National Nutritional Survey:* A national nutrition survey has been planned to assess the National Nutrition situation in the country and macro and micro-nutritional status. This study will help in setting up base line information, which will be used for formulating future programmes.
6. *Nutrition programme SAP-II*: A 5 years national programme has been formulated to improve the nutritional status of vulnerable groups on sustainable basis. This project will strengthen Institutions, the concerned line departments and involve NGOs and private sector to improve coordination and delivery of nutrition services. The project will include programmes for combating micronutrient and protein energy malnutrition. It will also improve food security and strengthening information, education and communication, institutional capacity and research.

Health Infrastructures:



1.15 North West Frontier Province (NWFP) and Federally Administered Trlbal Area (FATA):

The North West Frontier Province of Pakistan lies on the way from Central and West Asia to the South Asian subcontinent, through various passes, specially the world famous Khyber Pass. Its borders touch or are close to those of China, and socialist block countries with Afghanistan to the west all along from the Pamirs to the rugged terrain of South Waziristan. Punjab province lies in the southeast and province of Baluchistan to southwest (See Figure 1.1). The North West Frontier Province is richly endowed with natural resources, including prime agricultural land, scenic beauty, abundant forests, vast mineral resources, a network of rivers and streams, a rich cultural heritage and diverse climate. Some of these resources, such as rivers and forests, are of vital national importance.

1.15.1 Climate: The northern zone is cold and snowy in winter with heavy rain fall and pleasant summers, with the exception of the Peshawar basin which is hot in summer and cold in winter, and has moderate rainfall. The southern zone is arid, with hot summers and relatively cold winters and scanty rainfall.

1.15.2 Administration: The province is divided into two areas of separate lego-administrative status - the Federally Administered Tribal Area (FATA) and the "settled" districts. The tribal areas, close to the borders of Afghanistan, lie between the Durand Line and the "settled" districts. During British rule, these areas served as a buffer zone. After independence these areas were granted special lego-administrative status to protect their Islamic and socio-economic values. They are governed by special law, administered by the NWFP Governor as Agent to the President of Pakistan.

Each administrative unit in FATA is similar to a district and is subdivided into tahsil and further into villages. NWFP is subdivided into divisions, districts, sub-districts called "tahsils", and rural areas, called union councils.

The laws of the country govern the settled districts of the province.

Population of NWFP and FATA (census 1998):	21.2 million
Average house hold size	7.8

Urban population	16.9%
Rural population	83.1%(1988 census)
Afghan refugees (January 2001)	2.2 million

1.16 Social Action Program (SAP):

In a bid to give more development to social sectors and to make up past deficiencies, the Provincial Government has initiated a comprehensive Social Action Program (SAP), which aims to accelerate growth in the three sectors of primary education, basic health services, and rural water supply and sanitation.

The Frontier Education Foundation has been established with a view to encourage the private sector to participate in the development of education and raise literacy rates. Under SAP the provincial government has commissioned a study to ascertain the factors responsible for deteriorating standards of primary education, and to improve the quality of education at primary level. Sufficient funds have been provided for new primary schools, construction of additional classrooms and teacher's education with special emphasis on female education.

Under the Social Action Plan, a plan is being developed to provide an integrated development program with cross linkages with Basic Health Units and hospitals in rural as well as urban areas. Training programs for nurses and paramedics are being expedited and an incentive package has been proposed to attract female candidates into the nursing profession.

In the sanitation and water supply sector, a number of schemes have been undertaken and some are under implementation. Institutional strengthening of the Public Health Department is under way, and added efforts are being made to provide more facilities, particularly to the remote hilly areas of the province.

1.17 Health Infrastructure and Personnel:

The Federal Ministry of Health in Islamabad is responsible for broad policy and planning for health. The Department of Health does implementation and priority setting at provincial levels. The set up of the health system is as follows:

- Provincial Minister for Health (Politician)
- Secretary to Government of NWFP, Department of Health (Civil Servant)
- Director General Health Services Government of NWFP (Doctor)
- Four Tertiary Health Care Hospitals (2001) attached to medical colleges and the postgraduate medical institute.
- There is one Postgraduate Medical Institute and four Undergraduate Medical Colleges in the province. They have trained an excess of doctors and specialists, who cannot be absorbed into the government sector. This has lead to unemployment of doctors and specialists.
- There is one nursing college and a few nursing schools that have a capacity to train more nurses but few candidates are available because it is only open to females.

1.17.1 District and Agency Head Quarter (DHQ) / AHQ Hospitals: There are 31 District Head Quarter Hospitals in the Province. Each is responsible for a population of 0.4 - 1.5 million. Many of these hospitals are not well developed in terms of appropriate manpower, instruments and equipment, and physical infrastructure. As a result, people go to teaching hospitals, overcrowding them; costs rise and there is under utilization of DHQ hospitals. Eye care is an essential component of DHQ hospital activities, but in May 1997, only 24 districts had an ophthalmologist. Many ophthalmologists cannot work optimally because of lack of separate operating theaters, properly trained ophthalmic paramedics and lack of essential equipment and instruments for eye work.

1.17.2 Tahsil Head Quarter (THQ) hospitals(sub-district level): Each district has 1-3 THQ hospitals for a population of 0.1 –0. 25 million. They are not developed in each district and eye care is not provided at present at this level. In some of the functioning hospitals, in addition to general doctors and paramedics, consultants in gynecology, obstetrics, general medicine, general surgery and children's diseases have been appointed.

1.17.3 Rural health center and civil hospitals: These health facilities provide general health care for a population of 15,000-25,000. The staff includes 3- 4 doctors, including one lady doctor, and 6-12 paramedics, both males and females and other support staff.

1.17.4 Basic health unit (BHU): These primary level facilities provide general health cover to 8,000-12,000 populations. One doctor and few paramedics staff them. For various reasons less than 50% of the target population utilize these health facilities. Lack of medicines, inaccessibility, lack of punctuality, unavailability and attitude of the health providers are some of the important factors.

1.17.5 Community health workers - Lady Health Worker (LHWs): This new cadre has been introduced in some districts over the last 5 years. They work from their homes and provide primary health care and family planning services to a population of 1,000. The services of LHWs are not transferable and they remain part of their communities. They refer patients to the nearest health facility, which is also responsible for their training, continuous medical education and supervision. Primary eye care has been introduced in their curriculum. Very few LHWs are working in FATA at present.

1.17.6 Leprosy Ophthalmic technicians: Leprosy technicians have been working in the community in the province since the mid sixties. With the collaboration of Non-Governmental Organizations (NGOs) and the Government, leprosy has now been controlled. In order not to lose this valuable human resource that have years of field experience, a proposal was put forward to retrain these leprosy technicians in ophthalmology and call them leprosy ophthalmic technicians. The first ophthalmic technician course in Pakistan was started in Peshawar in 1993, at the Pakistan Institute of Community Ophthalmology (PICO), Postgraduate Medical Institute in Peshawar.

1.17.7 Paramedics: Paramedic cadres include Lady Health Visitors (LHVs), trained mainly in midwifery and family planning for 18 months, who work at all levels of health care e.g. BHU, RHC, THQ and DHQ hospital levels. General paramedics are posted in rural hospitals. They are trained for one year after 10 years of schooling. There are also specialized paramedics who work in laboratories, cardiology etc and are called laboratory technicians, and cardiology technicians etc. In 1996 a course was started for ophthalmic nursing in the Post Graduate College of Nursing, in Peshawar.

1.18 Prevalence and causes of blindness in Pakistan and NWFP[31]:

A population-based survey to determine the prevalence and causes of blindness was conducted in the four provinces of Pakistan between 1987 - 90. A total of 29,157 people were examined. (See Table 1.14)

The findings of the survey showed that 1.78% of the people examined were blind in both eyes (visual acuity (VA) less than 3/ 60 in the better eye), 2.44% were blind in one eye, and 4.82% had visual impairment (VA less than 6/18 in the better eye). The major causes of blindness were cataract (66.7%), corneal opacity (12.6%), and uncorrected refractive errors (11.4%), which included uncorrected aphakia.

As the prevalence of blindness was high and the causes were treatable, a national eye care program had been developed stressing the need to develop fully functioning eye departments in all DHQ / AHQ hospitals. Infrastructure for outpatients and operating theaters are required as well as the appointment of appropriately trained paramedics. It has been recommended that primary eye care be made an integral part of primary health care, and that secondary eye care facilities be extended to sub-district level, (Tahsil head-quarter hospital).

In NWFP the prevalence of blindness was 1%[32]. The causes of blindness included cataract (70.1%), corneal opacity in (16.5%) (9% from trachoma and 7.5% due to other causes). Uni-ocular blindness was present in 2.51% of the people examined in NWFP. The causes were cataract (45%), corneal opacity and phthisis in (28.8%), uncorrected aphakia (10%), refractive errors (7.7%) and others (10.4%). It was mentioned that xerophthalmia as a cause could not be excluded and that further research was needed to know about nutritional blindness in NWFP.

1.18.1 Causes of blindness in children in NWFP: Three of the five schools for the blind in the Province were visited, and 57 children examined. There was one child blind from corneal scarring[33].

1.19 Eye Care Services in NWFP:

In all the teaching hospitals, ophthalmology is one of the important specialties taught at undergraduate level. Each ophthalmic department consists of two units and are associated with undergraduate medical college / Postgraduate Medical Institute. The number of consultant Ophthalmologists and trainees' vary between 10-16 in each department. Each department has 60-80 beds for eye patients. These hospitals are involved in human resource development for eye care, diagnosis and management of difficult and complicated cases referred from other ophthalmologist or coming by them selves.

1.19.1 Teaching Hospitals:

- Government Lady Reading Hospital Peshawar
- Hayatabad Medical Complex Peshawar
- Khyber Teaching Hospital Peshawar
- Ayoub Teaching Hospital at Abbotabad

1.19.2 District level facilities:

District / Agency Head-Quarter Hospitals	31
District / Agency Head-Quarter Hospitals with eye specialist (1997)	24
Eye beds	600

1.19.3 Human Resources:

Ophthalmologists (many not working as such)	85
Community ophthalmologists	6
Ophthalmic technicians trained till Sep. 2000	167
Number of cataract operations per year	16000-18000
Cataract Surgical Rate / million pop./ year (CSR)	670

1.20 Pakistan Institute of Community Ophthalmology (PICO):

This tertiary level institution was established in 1989-90, at the Postgraduate Medical Institute, Lady Reading Hospital, Peshawar, as a joint venture between the Health Department of the Government of NWFP, and Sight Savers International, a UK based NGO involved in prevention of blindness. The main aim of PICO is to promote community eye care, which it has done right from its inception. The main areas of activities include:

1. Human resource development i.e. MSc in community eye health, training ophthalmic technicians, orientation courses in community eye health for senior ophthalmologists in the country, micro-surgical training courses for district Ophthalmologists, courses on integration of primary eye care into primary health care for general doctors and paramedics.
2. Out reach programs, particularly to increase cataract surgeries in under-served areas of NWFP and FATA.
3. Monitoring and evaluation of eye care services.
4. Advocacy, and strengthening eye departments in DHQ and AHQ hospitals.
5. Contributing to the national plan for eye care in Pakistan.

The researcher is one of the six Community Ophthalmologists in PICO, which has since moved to the Hyatabad Medical Complex, Peshawar.

1.21 VISION 2020 The Right to Sight, and National Eye Care Programme in Pakistan

Blindness has profound human and socioeconomic consequences in all societies. The cost of lost productivity, and rehabilitation and education of the blind, constitutes a significant economic burden, particularly in many developing countries. Furthermore, blindness is associated with lower life expectancy in these countries. The prevention and cure of blindness can thus provide enormous savings and facilitate development in poor societies.

Worldwide there are nearly 38 million blind people and almost 110 million with low vision. The major cause of blindness is cataract, present in 16 million people[34]. It is estimated that there is a net increase of 1-2 million blind people every year, at current levels of service provision.

To combat blindness WHO, together with the International Agency for the Prevention of Blindness (IAPB), and partnership committee of the international NGOs developed a global plan (VISION 2020) to define priorities and strategies, and use it for advocacy and resource mobilization. It will facilitate coordination and development of work by different partners involved in prevention of blindness. It encourages the development of partnership between the government, private, corporate and voluntary sectors in countries.

VISION 2020 The Right to Sight is a global initiative to eliminate avoidable blindness from the world by year 2020. Avoidable blindness includes all causes of blindness that can either be prevented or treated. The major blinding diseases included in this initiative, are cataract, trachoma, onchocerciasis, childhood blindness, and refractive errors and low vision. VISION 2020 has three elements for the elimination of avoidable blindness[34].

- Strategies / targets for disease control
- Human resource needs and development
- Infrastructure / appropriate technology needs and development

Childhood blindness is the second largest cause of blind-person years, following cataract in the world. Globally, approximately 70 million blind person years are caused by childhood blindness. There are 1.4 million blind children worldwide. Approximately 500,000 children become blind every year. Blindness costs the community billions of dollars in lost productivity, caring for blind people, rehabilitation and special education. About 1/3 of this cost is thought to be incurred by blindness in children[35].

The prevalence of blindness in children is associated with under-5 mortality rates (U5MRs), being higher in poorer countries with high U5MRs. Using estimates based on U5MRs, the prevalence of blindness ranges from 0.3 to 1.5/1000 children. The prevalence is approximately 0.4/1000 in high-income regions, 0.7/1000 in middle-income regions and 0.9/1000 children in low-income regions. The overall prevalence of blindness in children is 0.75 / 1000 children[35].

There is marked regional variation in the major causes of blindness in children in different parts of the world. Corneal scaring due to VAD, measles, ophthalmia neonatorum and use of harmful traditional practices are common. All the above causes of corneal blindness in children are potentially preventable if appropriate human and financial resources are put in appropriate places.

Under VISION 2020 in the field of childhood blindness, it is suggested that the main priorities for action are: elimination of VAD, treatment of congenital cataract, glaucoma, retinopathy of prematurity and serious refractive errors. This will be achieved through: promotion of primary health care; developing specialist children's eye services, for surgery and low vision; school screening.

Corneal blindness related to VAD is probably the single largest cause of childhood blindness. Prevention of corneal blindness in children requires an integrated effort by a large number of people; eye care teams including ophthalmologists, primary health care workers, community and religious leaders and legislators, schoolteachers, traditional healers and nutritionists. Multi-sector collaboration is very important in elimination of corneal blindness[35].

In Pakistan, the National Eye Care Programme started in the late 1980s. It was made more organized in early 1990s. The 1st five-year plan (1994-1998) for the control and cure of blindness was prepared with the approval of the Ministry of Health of the Government of Pakistan. It covered all aspects of blindness prevention, human resource development for comprehensive eye care, and provision of eye care to a defined unit of population (250,000-500,000) e.g. for a district or sub-district. The eye care should be in the form of a package (appropriate human resources, necessary infrastructure, supply of essential diagnostic and surgical equipment and instruments and uninterrupted supply of consumables). There should be an in-built mechanism for monitoring the quality of out put and targets for the programme. The planning should be done at district level with institutional support from a tertiary eye care unit.

The second five-year plan was prepared in 1998 for the years 1999-2003, using VISION 2020 elements as the basis for planning. The Government of Pakistan officially endorsed VISION 2020 in Pakistan on 26th February 2001 in Peshawar. The Government of Pakistan has, thus officially committed itself to eliminate VAD as cause of corneal blindness in children in Pakistan. The programme is in the process of planning for establishing seven centres to deal efficiently and effectively with problem of childhood eye ailments, including refractive errors and low vision.

2 VITAMIN A DEFICIENCY AND XEROPHTHALMIA:

Vitamin A is an essential nutrient for health in man and animals. In the absence of an adequate dietary intake of vitamin A (or its carotenoid precursors) for a significant period, a number of abnormalities appear in experimental animals. These include loss of appetite, loss of weight, increased keratinization of epithelial tissues, reduced frequency of mucous secreting cells, and negative nitrogen balance. As the deficiency becomes progressively more severe, stomach emptying becomes defective, nervous disorders of balance and motor skills appear, and night blindness, eye lesions and then blindness occur. Resistance to infection is much reduced and the reproductive process is disrupted. Death ultimately ensues[36].

2.1 Chemistry and Nomenclature:

Vitamin A considered as a subgroup of the retinoids, compounds consisting of four isoprenoid units joined in a head-to-tail manner and containing five conjugated double bonds. The term "vitamin A" is used as a generic descriptor for retinoids exhibiting qualitatively the biologic activity of retinol. Vitamin A and carotenoids are soluble in most organic solvents, but not in water, and are sensitive to oxidation, isomerisation, and polymerisation. Vitamin A and carotenoids are usually separated by high-pressure liquid chromatography (HPLC) and detected by UV-visible absorption spectrophotometery. Vitamin A shows a characteristic ultraviolet (UV) absorption spectrum with absorption maximum of 325 nm, and a molecular extinction coefficient of 53,000 cm M in hexane[36].

Vitamin A in the human diet is derived from pre-formed vitamin A and from pro-vitamin A carotenoids. Of the latter, beta-carotene has the highest vitamin A activity and is the most plentiful in human foods. Vitamin A activity in food is expressed in international units (IU), 1 IU being equivalent to 0.3 ug of retinol, 0.344 ug of retinyl acetate, 0.55 ug of retinyl palmitate, 0.6 ug of beta carotene[36].

2.2 Dietary sources:

Pre-formed vitamin A is found in animal liver, butter, whole milk, eggs, fish and cod liver oil. These sources are generally expensive. Major plant sources are alpha and beta-carotenes found in dark green leafy vegetables (DGLVs), red palm oil and coloured fruits e.g. mango and papaya. In developing countries, approximately 85% of dietary vitamin A intake comes from carotenoids while in developed countries it is estimated to be 50%[37].

The amount of dark DGLVs consumed in a single meal in preschool age children in Bangladesh was about 40gm (raw weight), when it was prepared in an attractive manner. This amount theoretically meets the daily vitamin A needs of a young child, and when consumed regularly has been shown to reverse mild xerophthalmia[38].

Seasonal food scarcity can be dealt with by drying foods and storing them for use at times when the supply is poor. Drying fruits and vegetables in direct sunlight can lead to 65% or more loss of provitamin A activity. These losses can be reduced by 25-50% through improved solar and shade drying methods that avoid direct ultraviolet light exposure. These measures will work better if they are culturally acceptable.

Even if provitamin A rich foods are available, they may be prepared improperly, reducing their potential nutritional benefit. Carotenoids appear to be fairly resistant to heat. However, excessive cooking of vegetables can markedly reduce provitamin A carotenoid activity through oxidation and isomerization from all – trans to less biologically active cis-configurations. Prolonged boiling for more than 1 hour or boiling followed by frying doubles provitamin A losses (to 20% - 45%). These cooking losses can be partly offset by adding the cooking water or oil used in frying back into foods to be consumed. Modifying traditional dietary / cooking behaviour will require extensive/prolonged efforts in individual communities[38].

A study[39] in West Java, Indonesia has led to some reservations about the role of DGLVs in improving the vitamin A status of communities. In this study vitamin A status was assessed in women after two different dietary interventions – women were randomly allocated to a portion of stir fried DGLVs or to a vitamin A fortified biscuit. The vitamin A status of women given the biscuit improved whereas those given DGLV did not. The authors suggest that the findings may be due to low bioavailability of betacaroteine in DGLVs compared with the simpler matrix in the biscuit. The authors suggest that the approach to combating VAD by increasing the consumption of provitamin A carotenoids from vegetables should be re-examined.

2.3 Daily Requirements:

The recommended daily requirements of retinol vary from 65ug (195 IU) per kg body weight in children aged 4 months to 12ug (36 IU) per kg in adults. The requirements are more in children because of growth. One ug of beta-carotene in plant material is equivalent in biological value to 0.167ug of retinol[38]. The recommended daily requirements of retinal vary from 65ug (195 IU) per kg body weight in children aged 4 months to 12ug (36IU) per kg in adults. The requirements are higher in children because of growth. One ug of beta-carotene in plant material is equivalent in biological value to 0.167ug of retinol[38].

Mothers and other care givers needs to be convinced of the need to provide diets rich in vitamin A and how to prepare them from readily available sources for themselves and for their children. Foods that can provide the daily requirements of vitamin A to different age groups may be as follows[40] :

- Children less than 6 months: exclusive breastfeeding is sufficient.
- Children aged 6-11 months: $1^{1}/_{2}$ tablespoon of carrots, or 1 tablespoon of sweet potatoes or $^{1}/_{3}$ cup of DGLVs or $^{1}/_{2}$ medium size mango
- Children 1-2 years: $1^{1}/_{2}$ tablespoon of carrots, or 1 tablespoon of sweet potatoes or $^{1}/_{2}$ cup of DGLVs or $^{1}/_{2}$ medium size mango
- Children 2-6 years: 2 table spoons or ¼ medium sized carrot, 1½ tablespoon of sweet potatoes or $^{1}/_{2}$ cup of DGLVs, or $^{2}/_{3}$ medium size mango
- For non pregnant females: ¼ cup or ¼ medium size carrot, or 2½ tablespoons of sweet potatoes or 1 cup of DGLVs or 1 medium size mango
- For pregnant females: ¼ cup or ½ medium size carrot, or 2½ tablespoons of sweet potatoes, or 1 cup of DGLVs or 1 medium size mango
- For lactating females: ½ cup or ½ medium size carrot, or ¼ cup of sweet potatoes, or 1½ cup of DGLVs or $^{2}/_{3}$ medium size mango

One or more of these foods are available throughout the year in many countries, although they may be expensive, and the amount required to meet the daily needs can be provided.

2.4 Biochemistry:

2.4.1 Digestion and absorption: Pre-formed vitamin A and carotenoids in the diet are largely released from protein during proteolysis in the stomach. Vitamin A and carotenoids tend to aggregate with lipids into globules, which then pass into the small intestine. Dietary fat, bile salts and pancreatic lipase are important for digestion and absorption. Hydrocarbon carotenoids are not as well absorbed as retinol. In the plasma retinol is transported bound to a protein, retinol-binding protein (RBP). Human RBP is a single polypeptide chain with 182 amino acids with a molecular weight of 21,230. All-trans retinol is bound within the core of the protein. Thus little if any bound retinol is exposed at the surface of the protein. The 1:1 molar complex of all-trans retinol and RBP is called "holo-RBP". In the plasma, holo-RBP is found in large part as a 1-1 complex with transthyretin (prealbumin), which specifically binds one thyroxin molecule per tetramere. In well-nourished adults, the total RBP concentration in plasma is 1.9 - 2.4 umol / litre (40 ug / ml to 50 ug / ml), 80% to 90% of which exists as holo-RBP. In children up to the age of puberty, the total RBP concentration is approximately 60% of the adult level. Protein energy malnutrition, infections and parasitic infestations all lower the steady concentration of holo-RBP. Thus, the vitamin A status of an individual often is not predictable on the basis of holo-RBP concentration alone[41].

By interaction with cell surface receptors, chylomicron remnants are taken into cells by endocytosis. Retinyl esters are hydrolysed, combined with cellular retinol binding protein (CRBP) in the cytosol of hepatocytes. Lipid-rich chylomicra are cleared more slowly from plasma than lipid-poor chylomicra. Bone marrow, and to a lesser degree other peripheral tissues, also take up chylomicra by a similar mechanism. Holo-RBP, derived mainly from the liver but also from other tissues, is taken up from plasma by all tissues of the body. Two mechanisms have been postulated: (1) interaction of holo-RBP with a specific cell surface receptor, followed by internalization of the complex (2) dissociation of the holo-RBP in the plasma into apo-RBP and retinol, followed by incorporation of retinol into the plasma membrane. Thereafter, cytoplasmic RBP (CRBP) may draw retinol out of the membrane into the cytosol. Retinol and its esters are found in significant amounts in adipose tissue, kidney, testis, lung, bone marrow, and the eye, in addition to the liver, and in smaller amounts in other tissues[41].

Retinyl esters in chylomicron remnants are hydrolysed within hepatocytes to retinol. After esterification it is stored in specialized lipid globules. Alternatively, retinol may be transferred to stellate cells or lipocytes. Under normal conditions 80% to 90% of vitamin A is stored in lipocytes or stellate cells, while 10 –20% is stored in hepatocytes. Retinol might be released into the plasma from liver stellate cells by three routes: (1) by transfer back to parenchymal cells, followed by holo-RBP release (2) by direct release into the plasma as an endogenously formed RBP complex (3) by transfer to extra cellular apo-RBP at the cell membrane. Whether all of these routes are active, and if so, which route predominates under given physiological conditions is uncertain. Although vitamin A is primarily stored in the liver, all tissues contain some vitamin A. Non-hepatic tissues may well synthesize and secrete RBP, however, RBP from hepatic and extrahepatic tissues are identical. Thus it has not been possible to ascertain the relative amount derived from each tissue[41].

2.5 Functions of Vitamin A[37]:

Vision: In the outer segment of rod cells in the retina 11-cis retinol combines with membrane bound protein, opsin, to give rhodopsin, involved in vision under conditions of low illuminations.

Cellular differentiation: In VAD keratin-producing cells replace mucous secreting in many epithelial tissues of the body. This is the basis of the pathological process termed xerosis that leads to drying of the conjunctiva and cornea of the eye. The process can be reversed by vitamin A.

Glycoprotein and glycosaminoglycan synthesis: Glycoproteins are polypeptides with short chains of carbohydrates. Glycosaminoglycans are related compounds that are cell surface molecules. Retinoids have been shown to control the expression of enzymes involved in the synthesis of some of these compounds. Impairment of this function by VAD may contribute to lack of mucin secretion and liquefaction of cornea seen in xerophthalmia.

Embryogenesis: Severe VAD on one hand and excessive dosing with Vitamin A and also retinoic acid result in malformations of the embryo affecting most organs of the body in many vertebrate species. It has not been demonstrated conclusively that human VAD causes congenital malformations.

Immune response: Many of the epithelial tissues are important barriers to infections and VAD impairs this function in a non-specific way. In addition vitamin A helps to maintain lymphocyte pool. It also functions in T cell mediated responses. It does seem to stimulate the activation of macrophages.

Haemopoiesis: VAD in man and in experimental animals is consistently associated with an iron deficiency type of anaemia.

Growth: Retinoic acid is known to play its hormone like function in the control of growth and development of tissues in the musculo-skeletal system.

2.6 Vitamin A Deficiency and Child Survival:

Vitamin A deficient animals die much earlier and at a far higher rate than vitamin A sufficient controls. Under experimental conditions of gradual, progressive deficiency, the animal dies before the appearance of xerophthalmia. One of the problems in creating an experimental model to study xerophthalmia has been keeping such animals alive long enough to develop ocular changes. The situation in humans is far more complex. Vitamin A deficiency rarely occurs as an isolated disturbance; when it does, it is rarely recognised in the absence of severe xerophthalmia, a condition long associated with increased mortality[42].

Severe xerophthalmia, particularly keratomalacia, has traditionally been associated with a very high mortality rate. Hirschberg reported mortality rates of 100%, and authors early in this century cited rates of 50% to 80%. Given the lack of understanding and means to treat kwashiorkor and under lying infections at that time, these rates probably approximate the natural, untreated outcome of keratomalacia today. It seems reasonable to suspect that these extraordinarily high mortality rates were determined, at least in part, by concomitant infections and protein energy malnutrition (PEM). Indonesian children presenting with corneal xerophthalmia to the eye hospital in Bandung, received the recommended course of vitamin A therapy (2000,000 IU on two successive days and again one month later, as well as protein rich diets and antibiotics appropriate for systemic infections. Cumulative mortality over the 14 months of follow up was 12.6%, most of the deaths occurring within two months of presentation. Protein energy malnutrition status at admission was the single most important determinant of mortality in this treated group of subjects. Children with severe PEM (i.e. oedema, serum albumin < 2.5 ug/dl, or weight for height < 70% of standard) died at almost seven times the rate of those who were better nourished (25.7% versus 3.8% respectively). Several reports suggest that all else being equal, xerophthalmia (i.e. severe VAD) increases the risk of mortality among malnourished, hospitalized children[42]. In El Salvador, 16% of severely malnourished children with xerophthalmia died compared with 11% without xerophthalmia. In Bangladesh, children hospitalized with severe malnutrition died at 50% higher rate if they were xerophthalmic (10% versus 15%). This difference was not statistically significant, however, and closer examination revealed that the xerophthalmic children were even more undernourished and hypoproteinemic than their non-xerophthalmic counterparts. McLaren long ago argued that xerophthalmia increased mortality among malnourished children. Mortality among hospitalized xerophthalmic children in Jordan was 56-64%, four times the rate among non-xerophthalmic children of similar PEM status[6]. Pereira et al. reported similar, though less dramatic results in Vellore, South India: mortality among children with both keratomalacia and kwashiorkor was 28%, twice the mortality rate among children with kwashiorkor alone[42]. Among girls in El Salvador hospitalized for severe malnutrition, the mortality rate of those children with xerophthalmia was twice that of girls without xerophthalmia; mortality rates among xerophthalmic and non-xerophthalmic boys, however, were similar. This was interpreted as evidence that admission of females with xerophthalmia was delayed, by which time they had become more malnourished[42].

Before 1980, the evidence linking xerophthalmia to mortality was primarily limited to hospitalized children with concomitant, severe malnutrition. The data suggested that PEM was a greater determinant of survival than xerophthalmia, but the studies also indicated that the presence of severe VAD might further exacerbate the underlying risk of death. The contribution of VAD to child mortality, isolated from the confounding effects of severe PEM, was identified in a prospective, longitudinal observational study of generally healthy, free-living rural Indonesian children. Approximately 3,500 pre school age children up to six years of age were followed for 18 months. After baseline examination, the same team reexamined the children every three months, resulting in seven examinations encompassing six intervals. Serum samples were obtained at baseline from children with mild xerophthalmia and from age, sex, neighbourhood matched controls. Any child with advanced xerophthalmia was immediately given 200,000 IU, vitamin A by mouth and immediately hospitalized for treatment. Each child was examined at the start of each interval and was assigned the ocular status present at the interval-initiating examination. Mortality for that interval was ascertained at the follow-up examination three months later. The process was repeated and summed across all six intervals. The data relate solely to children with mild xerophthalmia (XN, X1B) compared with peers with normal eyes (but not necessarily normal vitamin A status). Of the 132 deaths, 24 occurred in children within the three months interval after the examination at which they were diagnosed with xerophthalmia. Age-specific mortality among these mildly xerophthalmic children was four to twelve times the rate among their non-xerophthalmic peers[5]. It is important to note that the association between vitamin A status and mortality was dose dependent: the greater the degree of VAD, the greater the mortality. Wasting (as percent of median weight-for-height) was equally prevalent among children with and without xerophthalmia. Increased mortality was associated with xerophthalmia in the same dose dependent manner whether or not wasting was present. At every age, xerophthalmic children who were not wasted suffered a higher mortality than mildly wasted children who were not xerophthalmic. In this population at least, moderately severe VAD (XN, X1B) was a more important predictor of mortality than was mild PEM, even though weight-for-height was a powerful predictor of mortality[42]. Children with severe deficiency (corneal xerophthalmia X2, X3) were hospitalized, treated, and excluded from the study, removing those xerophthalmic children having highest mortality. Although children were re-examined and their ocular status reclassified at the start of each three-month interval, ocular status could vary within the interval; some xerophthalmic children exhibited improved vitamin A status and developed normal eyes, and vice versa. This dilutes the distinction between non-xerophthalmic and xerophthalmic children, hence the relationship between vitamin status and mortality. Treatment and referral of children with severe systemic disease and malnutrition reduced mortality. Since these conditions were more common among xerophthalmic children, treatment and referral further reduced the apparent risk[42].

It was observed that normal eyes do not mean normal vitamin A status. At least half the "non xerophthalmic " children had serum levels considered " low " (below 20ug /dl); and levels in the other half was not much higher. Eliminating excess mortality associated solely with identifiable xerophthalmia in this population would reduce mortality by at least 16%. The high relative risks, statistical significance, dose dependent relationship, and internal consistency suggest a direct and probably causal relationship between vitamin A status and risk of childhood death, and provide a quantitative estimate of its potential magnitude.

2.6.1 Intervention studies: Data collected in subsequent community intervention trials support these conclusions. Vijayaraghavan and colleagues found that mortality among mildly xerophthalmic children in Hyderabad was more than twice as high as among their less deficient (non-xerophthalmic) peers[43]. In Tamil Nadu, South India, mortality was 50% higher among xerophthalmic compared with non-xerophthalmic children (10.6 versus 7.2 per 1000)[6]. These observational findings have led to community based intervention studies to determine whether improving vitamin A status of deficient populations reduces overall pre-school age mortality. All trials concluded that it would (see table 2.1). Each suggested a similar level of anticipated impact; the actual size of the anticipated impact will vary with local conditions.

Meta-analysis is a descriptive technique that uses formal statistical methods to combine data from several studies in an objective way. This technique was used to arrive at an overall judgment about the effects of vitamin A on child mortality. It is an alternative to narrative summaries that often appears in articles. The technique is useful in that it places studies side by side, examines basic rates, and carefully considers differences in trial design and conduct in order to draw overall conclusions about the outcome effect of the studied intervention.

The first of the meta-analyses, by J Tonascia for the Bellagio meeting, covered the 6 Asian trials using "child-interval at risk". Combining individual estimates, this meta-analysis generated an overall reduction of 34% with very narrow confidence limits (25-42%). The meta-analysis of Beaton et al included all eight major studies, 6 from Asia and 2 from Africa. The estimated overall reduction was 23% (95% CL 12% - 32%). When Beaton and colleagues limited their analysis to the 6 Asian trials, their estimated impact was 30%, similar to Tonascia's 34% using different analytical techniques and a different age range. The other meta-analyses arrived at much the same conclusions.

The meta-analyses confirm that the reduction in pre school age mortality associated with community-based improvement in vitamin A status is unlikely to have been due to chance ($p < 0 .00000002$). These results are remarkably consistent considering the enormous heterogeneity across populations that differed in their culture, ecology, xerophthalmia prevalence and underlying mortality. As well as the wide variations in trial design, mode of supplementation, number and size of clusters, dosing intervals, size of vitamin A dose, duration of supplementation, and type and degree of study supervision and quality control.

The Beaton meta-analysis concluded that the level of impact on child mortality did not predictably vary with either age or anthropometric status. Subsequent data from the NNIPS study and a reassessment of the other trials, suggest this may not, in fact, be entirely the case[42].

In the four trials in which cause-specific mortality was studied (two in Nepal, Ghana and India), vitamin A had more profound and consistent effects on death due to diarrhoea / dysentery and measles[42].

2.6.2 Vitamin A and Mortality: However, not all are convinced of the impact of vitamin A on child mortality. Gopalan[44] argues that the logical way to ensure good vitamin A status is through dietary improvement arguing that countries afflicted with VAD have an abundance of natural food resources to combat it. These countries must be helped to harness their food resources for this purpose and they should not be misled, through exaggerated claims, in to relying perpetually on periodic medication with massive doses of synthetic vitamin A- an approach that was initially adopted purely as a short-term measure. He further argues that there were no miracle drugs, magic bullets and short cuts in war against poverty and nutrition.

Dr Sommer agrees with Gopalan that there are no miracle drugs, magic bullets and short cuts in the war against poverty and nutrition. But he says that now we have more evidence that improving vitamin A status of deficient populations will substantially reduce childhood mortality than we have had before embarking on almost any other major public health initiative. A child dies needlessly from VAD every minute, while we wait the eradication of poverty[45].

2.7 Effects of Vitamin A deficiency on Infectious Morbidity:

The strong impact of vitamin A status on mortality must be mediated, in large part, by its effect on the incidence and / or severity of life threatening infections. Vitamin A prophylaxis and treatment have an impact in reducing mortality associated with diarrhoea and measles. An understanding of the relationship between vitamin A status and infection is important in identifying the mechanisms that account for altered mortality. It is also important in quantifying the burden of infectious morbidity associated with VAD[46].

Vitamin A deficient animals raised in a germ-free environment grow better and live longer than animals raised in conventional facilities. Survival of conventionally reared, deficient animals can be dramatically extended by the use of broad-spectrum antibiotics. Organs particularly susceptible to infection in deficient animals include the respiratory, genitourinary, and gastrointestinal tracks. Massive infection involving the respiratory tract is often a terminal event, though sometimes more apparent on autopsy than during illness[46].

Early clinical reports suggested that relationships existed between vitamin A status and human infection. Thus blinding xerophthalmia has been associated with respiratory tract infections, diarrhoea, tuberculosis, childhood exanthemas, pertussis, scarlet fever, typhoid, malaria, encephalitis, and urinary tract and other infections. The issue is whether VAD per se increases the incidence and / or severity and outcome of infectious episodes. Interpretation of most cross-sectional associations, whether clinical reports or population-based surveys, is complicated by:

(1) The bi-directional relationship between vitamin A status and infection - each appear to increase the risk of the other;
(2) The frequency with which xerophthalmia and diseases with which it has long been associated occur in developing countries, where the risk of infection, malnutrition, and poverty are deeply entwined;
(3) The varying nature of the studies, populations, instruments, and definitions employed;
(4) The differences in the clinical recognition and significance of infectious episodes.

Diarrhoea: Vitamin A supplementation has been shown to reduce diarrhoea specific mortality; thus, vitamin A status must affect the frequency or outcome of clinically significant gastrointestinal disease. A number of cross-sectional studies have found a strong association between impaired vitamin A status (defined by mild xerophthalmia) and the presence, or a recent history, of diarrhoea. Diarrhoea was often the strongest risk factor associated with xerophthalmia in these studies: in Nepal the odds ratio was 20, in Indonesia 23 (diarrhoea during the past month). The associations were often strongest for "persistent", "chronic", or "severe" diarrhoea or dysentery. Despite the consistent association between indices of VAD and evidence of recent or existing diarrhoea, it is not always clear which occurs first.

Measles: Measles bears a striking relationship to vitamin A status. Measles precipitates a large proportion of corneal ulcer / keratomalacia, which partially accounts for the strong association between a history of measles and corneal destruction. Vitamin A status also modifies the severity and outcome of measles and its systemic complications, demonstrated in four measles treatment trials, and by reductions in measles-related deaths in the four community-based vitamin A prophylaxis studies that examined cause-specific mortality. There is strong evidence that vitamin A status influences measles related morbidity and mortality[46].

Vitamin A deficiency increases the severity of measles. Whether vitamin A supplements are administered prophylactically on a community wide basis before children have measles or as treatment for moderately severe, hospitalized cases of measles, mortality is reduced by roughly half. The reduction of measles associated mortality under these two very different conditions strongly suggest that:

- Vitamin A supplementation, even as high dose treatment, influences out come by correcting underlying VAD rather by a non specific, adjuvancy effect;
- It is unlikely that vitamin A status materially affects the incidence of measles, since the entire impact of supplementation can be explained by the reduction in case fatality.

Vitamin A status exerts a power full influence in reducing the severity and complication of measles. There is relatively little evidence to suggest any impact on incidence.

Respiratory Disease: The effect of vitamin A status on respiratory disease is clearly shown in animal models of VAD, clinical and autopsy studies in children and observational incidence data in human populations. However, population based prophylaxis trials, whether for morbidity or mortality, the situation is more complex and uncertain. A meta-analysis of available data from mortality and morbidity intervention trials failed to indicate any consistent impact of vitamin A supplementation on the incidence of acute lower respiratory infection (ALRI), a conclusion supported by a WHO ad hoc review panel. Results of individual studies however, varied. A double blind, placebo controlled trial of the effect of vitamin A supplementation on childhood morbidity was conducted among 11,124 children aged 6-83 months in Haiti[47]. The study reported an increased 2-week prevalence of diarrhoea and the symptoms of respiratory infections after vitamin A supplementation. The Ghana health study involved a subset of 1455 children aged 6 - 59 months, who were monitored weekly for a year. Children were randomly assigned either 200,000IU retinal or placebo every 4 months. Randomization was by individual. There were no significant differences in the Health Study between vitamin A and placebo groups in the prevalence of diarrhoea or acute respiratory infections. Of the symptoms and conditions specifically asked about, only vomiting and anorexia were significantly less frequent in the supplemented children[48] Urinary tract infections are among the most consistently reported clinical accompaniments of VAD. The prevalence of bacteruria increased with the severity of xerophthalmia, from 40% in children with night blindness (XN) to 92% in those with keratomalacia (X3).

There are a variety of mechanisms by which vitamin A status might influence the risk of life threatening infections. Their relative roles and importance are not well explained. Vitamin A deficiency must either lower the body's ability to prevent a pathogen from invading its tissues (establishing "clinical" or "sub-clinical" infection) in the first place, or its ability to cope with such invasion once it occurs. The critical function vitamin A plays in regulating cellular differentiation provide a unique, "core" mechanism that would explain, at least in part, its influence on epithelial barriers, immune competence, and cellular / tissue / organ functioning, healing, resistance and recovery[36].

2.8 Immune competence and Vitamin A status:

It is unlikely that keratinizing metaplasia explains all the infectious phenomena associated with VAD. The severe course of measles in VAD and its rapid response (therapeutic and protective) to vitamin A supplementation suggest more profound and rapidly reversible mechanisms that control resistance and cope with established systemic infections[46].

The immune system is primarily a defensive network that has evolved to make highly specific responses to non-self antigens and pathogens, and to generate long lived protection through antigen specific memory. Immuno-competence requires both structural maintenance in terms of a continual renewal of lymphoid cells, and functional maintenance in terms of cell-cell signaling required to generate appropriate responses to microbial infections or other immunogenic stimuli.

Although the exact role of vitamin A in maintaining immunocompetence has yet to be made clear, a few broad generalizations can be drawn. First, vitamin

A plays an important part in maintaining the lymphocyte pool. Whereas lymphocyte counts are generally low during VAD, administration of retinol to vitamin A deficient animals or humans increases the number and / or proportion of lymphocytes in the blood and spleen. This change, occurring over several days, would be consistent with a likely role of vitamin A in the proliferation and differentiation of progenitor cells of the lymphocytic lineage.

Cell mediated immunity responses presumed to be mediated by T cells, depend on adequate vitamin A status. It has been observed that VAD also reduces the "natural cytotoxicity " expressed by NK cells, mainly by reducing their number in the blood. It has been shown that vitamin A can stimulate non-specific immunity, such as the activation of macrophages and stimulation of phagocytosis with bacterial clearance. The mechanism for this stimulation is unknown.

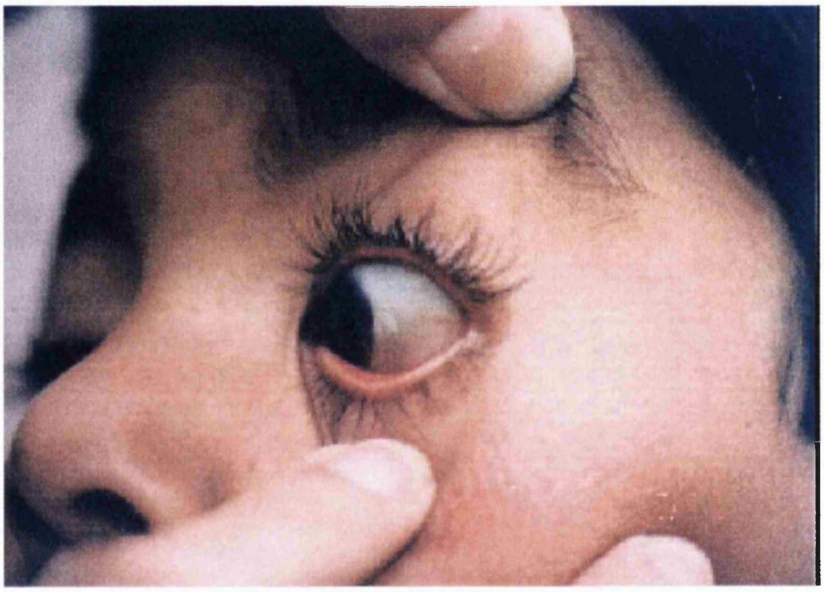
2.9 Eye signs of vitamin A deficiency - xerophthalmia[40]:

Vitamin A deficiency is a systemic disease that affects cells and organs throughout the body; the resultant changes in epithelial architecture are termed "keratinizing metaplasia". Keratinizing metaplasia of respiratory and urinary tracts and related changes in intestinal epithelia probably occur relatively early in the disease, even before the appearance of clinically detectable changes in the eyes. However, since these non-ocular changes are largely hidden from view, they do not provide a ready basis for special clinical diagnosis. Among vitamin A deficient populations, therefore, children with measles, respiratory disease, diarrhoea, or significant PEM should be suspected of being deficient and treated accordingly. Uncomplicated, gradual depletion of vitamin A stores results in xerophthalmia of increasing severity, manifest as night blindness, conjunctival xerosis and Bitot's spots, corneal xerosis, and corneal ulceration / keratomalacia. All these conditions usually respond rapidly to vitamin A therapy, and the milder manifestations generally clear up without significant sequelae. The loss of deep corneal tissue from ulceration / keratomalacia, however, result in scarring and residual opacification. Sudden de-compensation of marginal vitamin A status, as occurs in measles, can result in corneal ulceration that precedes the appearance of milder signs of xerophthalmia[40]. (See Table 2.2).

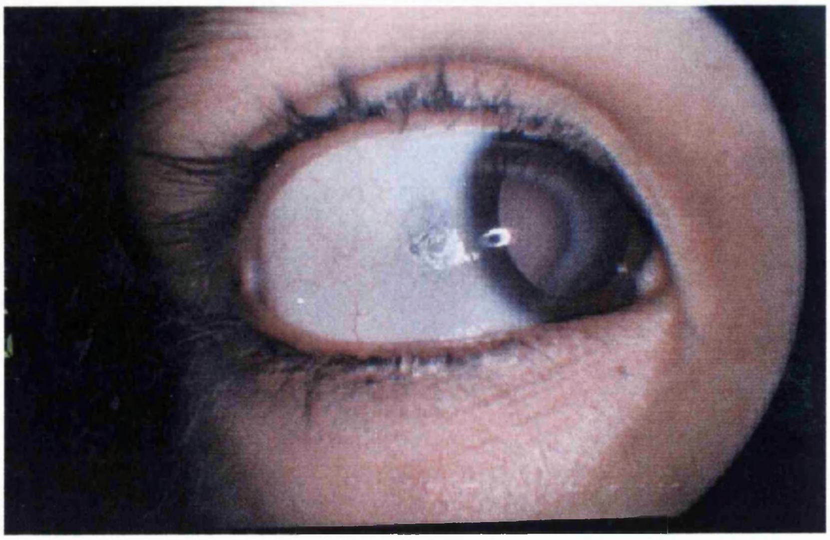
2.9.1 Night blindness (XN): Retinol is essential for the elaboration of rhodopsin (visual purple) by the rods, the sensory receptors of the retina responsible for vision under low levels of illumination. Vitamin A deficiency can therefore interfere with rhodopsin production, impair rod function, and result in night blindness. Night blindness is generally the earliest manifestation of clinical VAD. Affected children no longer move about the house or neighbourhood after dusk, but prefer to sit in a secure corner, often unable to find their food or toys. Night blindness of recent onset in a pre-school child is typical of VAD. Other causes of the condition are relatively rare and almost never present in this age group. Some societies, where VAD is endemic, use specific terms to describe the condition. The presence of night blindness is not always recognized, especially among children who have not yet begun to crawl or toddle. When mothers or other care givers do complain that they have observed the condition, however, they are almost always correct. Night blindness can also affect women of childbearing age, particularly those who are lactating. However, few population-based surveys have been done among adult female populations. Night blindness responds rapidly, usually within 24-48 hours, to vitamin A therapy[40].

2.9.2 Conjunctival xerosis and Bitot's spot (X1A, X1B): The epithelium of the conjunctiva in VAD is transformed from the normal columnar to stratified squamous type, with a resultant loss of goblet cells, formation of granular cell layer, and keratinization of the surface. This is the histopathological picture of conjunctival xerosis. Clinically these changes are expressed as marked dryness or un-wet ability; the affected area appears roughened, with fine droplets or bubbles on the surface, rather than smooth and glistening. The changes are best-detected in oblique illumination; they are often subtle and may be obscured by heavy tearing. As the tears drain of, however, the affected areas emerge like "sandbanks at receding tide". Conjunctival xerosis first appears in the temporal quadrant, as an isolated triangular patch adjacent to the limbus in the inter-palpebral fissure. It is almost always present in both eyes. In some individuals, keratin and saprophytic bacilli accumulate on xerotic surface, giving it a foamy or cheesy appearance. Such lesions are known as Bitot's spots. Bitot's spots are readily recognized and serve as useful clinical criterion for assessing the vitamin A status of populations. Isolated, usually temporal, patches of conjunctival xerosis or Bitot's spots are some times seen in the absence of active VAD. The affected individuals are usually of school age or older, and may have a history of previous bouts of night blindness or xerophthalmia. The only certain means of distinguishing active from inactive lesions is to observe their response to vitamin A therapy. Active conjunctival xerosis and Bitot's spots begin to resolve within 2-5 days after vitamin A treatment, and most will disappear within 2 weeks, although some may persist[40].

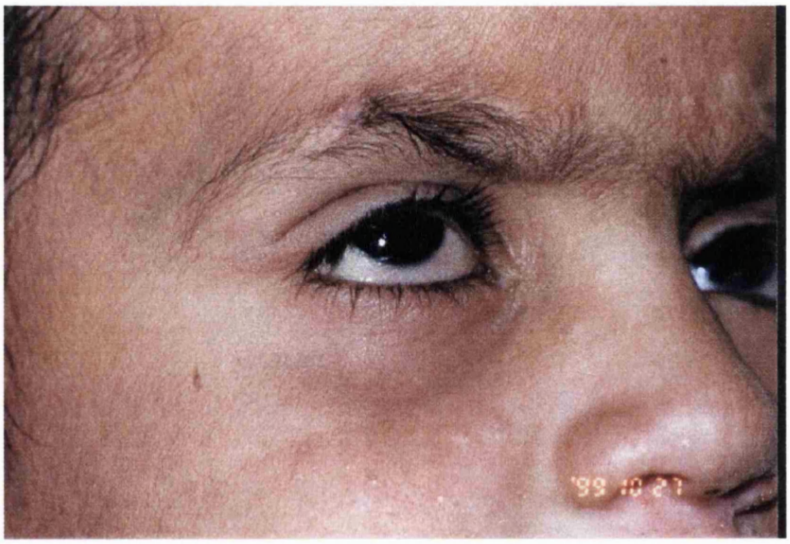
Bitot's spots



Bitot's spots

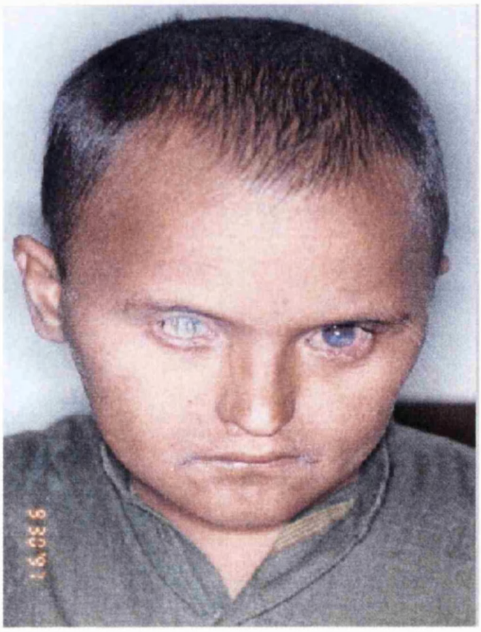


2.9.3 Corneal xerosis (X2): Corneal changes begin early in VAD, long before they can be seen with the naked eye. Many children with night blindness (with out clinically evident conjunctival xerosis) have characteristic superficial punctate lesions of the inferior nasal aspects of cornea, which stain brightly with fluruorescein. Early in the disease the lesions are only visible through a slit-lamp bio-microscope. Clinically, the cornea develops classical xerosis, with a hazy, lusterless, dry appearance, first observable near the inferior limbus. Corneal xerosis responds within 2-5 days to vitamin A therapy, with the cornea regaining its normal appearance in 1-2 weeks[40].



2.9.4 Corneal ulceration / keratomalacia (X3A, X3B): Ulceration / keratomalacia indicates destruction of part or all of the corneal stroma, resulting in permanent structural alteration. Ulcers are classically round or oval "punched-out" defects. The surrounding cornea is generally xerotic but otherwise clear, and typically lacks the grey, infiltrated appearance of ulcers of bacterial origin. There may be more than one ulcer. Small ulcers are almost invariably confined to the periphery of the cornea, specially its inferior and nasal aspects. With therapy, superficial ulcers often heal with little scarring; deeper ulcers, especially perforations, form dense adherent leukomas. Localized keratomalacia is a rapidly progressive condition affecting the full thickness of the cornea. It first appears as an opaque, grey to yellow out-pouching of the corneal surface. In more advanced disease the necrotic stroma sloughs, leaving a large ulcer or descemetocele. Ulceration / keratomalacia involving less than 1/3 of the corneal surface (X3A) generally spares the central pupillary zone, and prompt therapy ordinarily preserves useful vision. More wide spread involvement (X3B), specially generalized liquefactive necrosis, usually results in perforation, extrusion of the intraocular contents, and loss of the globe. Prompt therapy may still save the other eye and the child's life. Sometimes it is difficult to distinguish this condition from bacterial or fungal ulcer. In such circumstances, it is safest to assume that both VAD and infection are present and to treat the children accordingly[40].

2.9.5 Corneal scars (XS): Healed sequelae of corneal disease include scars or opacities of varying density, weakening and out-pouching of the remaining corneal layers (staphyloma and descemetocele) and where loss of intra-ocular contents has occurred, phthisis bulbi (a scarred shrunken globe) [40]. Such end stage lesions are not specific for xerophthalmia and may arise from numerous other conditions, notably trauma and infections.



2.9.6 Xerophthalmic fundus (XF): These are white retinal lesions described in some cases of VAD in adults. They may be accompanied by constriction of the visual fields[40].

2.10 Prevalence of Vitamin A Deficiency:

It is estimated that VAD, including clinical and sub-clinical forms of severe and moderate degrees of public health significance, exists 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, pre school age children are clinically affected, and 251 million more are severely or moderately sub-clinically deficient. At least 254 million children of pre-school age are thus "at risk" in terms of their health and survival[8].

2.11 Epidemiology of Vitamin A deficiency:

The cause of VAD can be quite complex, and depends on the type and amount of vitamin and provitamin (primarily Beta- carotene) ingested, and on the absorptive, transport and storage capacities and metabolic needs of the individual. Seemingly unrelated disease states can dramatically alter each of these factors and, in turn, the individual's vitamin A balance. For example, gastroenteritis will affect both the types and amount of food offered and a child's appetite, while the shortened transit time will decrease absorption of any vitamin A that is ingested. If the child is already protein deficient, transport and storage may be decreased and the fever will increase the metabolic demand[40].

The cause of, and contributions made by, each of these factors may vary from one community to another, resulting in different epidemiological patterns in terms of age, sex, season, number of people affected and relative proportion of cases with and with out xerophthalmia and corneal involvement. In general, however, mortality or blindness is predominantly a disease of young children, most often those from depressed rural communities and urban slums. Older, schoolchildren may suffer milder deficiency and the lesser consequences[40].

2.11.1 Age: Children are born with limited vitamin A reserves, and when a mother is deficient in vitamin A, the newborn child's reserve is even smaller. Colostrums and early breast milk are concentrated sources of vitamin A. For the first 6-12 months of life, many infants depend almost entirely on vitamin A provided by in breast-milk, which is readily absorbable. When a mother is deficient in vitamin A, however, the amount provided in her milk is reduced. Bottle fed children are often at even greater disadvantage, particularly if they receive unfortified skimmed milk already low in vitamin A, or whole milk over diluted with water (and frequently contaminated). After 4-6 months of life a child requires supplementary feedings with foods rich in vitamin A. For a variety of reasons, principally lack of knowledge, preference, cost, or unavailability, these foods may not be consumed in adequate amounts.

Children are also at increased risk of VAD as a result of intestinal infestations and infections, which impair vitamin A absorption; respiratory infections, tuberculosis and measles (and other childhood exanthemas), which increase metabolic deficient in vitamin A, the new born child's reserve are even smaller. Colostrum and demands; and protein energy malnutrition, which interferes with storage, transport and utilisation of vitamin A. As children grow older, they often receive food from a number of relatives and other households, so that they generally consume a more varied, nutritionally balanced diet and suffer fewer infections. As a result, general nutritional status and vitamin A status improve, and the risk of blinding xerophthalmia and other consequences of deficiency declines. While mortality rates for older preschool and early school-age children are low in comparison with rates for the first year or two of life, vitamin A status may have a greater impact on mortality rates of older than of younger children[43-49].

Occasionally, the same or related factors are responsible for VAD among older individuals. This is particularly true of refugees, prisoners, and students who suffer similar privation (e.g. unsanitary conditions, nutritional deprivation), and patients with chronic mal-absorption; all are at risk of blinding xerophthalmia and other serious consequences of deficiency[40].

2.11.2 Sex: Boys are frequently at greater risk of xerophthalmia (night blindness and Bitot's spot) than are girls. In most societies or cultures, however, the risk of severe blinding xerophthalmia (corneal ulceration and keratomalacia) is equal in both sexes; moreover, improvement in vitamin A status generally reduces mortality equally in both sexes[40].

2.11.3 Season: Xerophthalmia may be more prevalent at certain times of the year, the pattern being determined by the severity and concurrence of the various factors that impair vitamin A status. In many areas of the world, for instance, sources of vitamin A (and of food in general) are in short supply during the hot, dry season, and measles and diarrhoea are common. Measles is a particularly important seasonal factor, precipitating as much as 25-50% of cases of blinding xerophthalmia in Asia, and perhaps even more in Africa. In many parts of Africa, measles is said to be the commonest cause of childhood blindness, a large proportion of which is secondary to measles-induced de-compensation of vitamin A status. Measles is also a major cause of all childhood deaths; mortality can be reduced significantly by vitamin A prophylaxis and therapy[40].

2.11.4 Clustering: Since most members of the same community share the dietary and health practices responsible for VAD, VAD and xerophthalmia tend to cluster within specific families and neighbourhoods. Children living in the immediate vicinity 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 living in a different neighbourhood of the same village or town.
It is important, therefore to identify populations with sub-clinical VAD, as well as those with xerophthalmia, to quantify the at risk populations and to implement intervention programs that reflect the true magnitude and severity of the problem[8].

2.11.5 Ecological Factors: At the macro-level, hostile environments e.g. arid, infertile land, or the periodicity of excessive rain and humidity, in part determine the variety and amount of foods rich in vitamin A -activity that can be grown, and the duration of their availability. This applies particularly to vegetables (e.g. green vegetables), and fruits that require abundant water supplies and / or moderate temperature to grow. From a national perspective, vegetable and fruit crops are of less importance and thus do not compete for land use. Crops rich in vitamin A-activity for local consumption, therefore, are more often provided through horticultural activities at the micro-level. Thus countries or parts of countries with long periods of water shortage and relatively constant hot temperatures are more likely to have a VAD problem than those are with stable water supplies. The seasonality of VAD is only partially related to ecological factors that influence food availability. The pattern of disease frequency is also important. Vitamin A deficiency tends to reach its apex following the peak prevalence of diarrhoeal and respiratory diseases. Overcrowded housing and contaminated environments associated with poor living conditions contribute to the problem. Measles epidemics that occur under these conditions are especially devastating and often precipitate acute VAD, frequently resulting in blindness and death for many children[8].

In Pakistan the monsoon starts at the end of June or early July, and diarrhoeal diseases are more common in that season. Measles epidemics also tend to start in early summer, and continue till November and December. Many families have single rooms for sleeping; these overcrowded conditions lead to repeated and severe attacks of chest infections. Any child with borderline vitamin A status may go into hypo-vitaminosis threatening both his / her eye health and general health.

2.11.6 Social Factors: Social under-development within a country limits accessibility to health and social services, including education. Under-educated, impoverished women tend to follow traditional ideas and practices, and are less confident in engaging social interactions where more modern concepts and practices are promoted. Due to under-education, they are less likely to learn from educational materials typically displayed at health centers and used in health-related community educational activities, including those concerned with appropriate child care and feeding practices. Under educated males are also less likely to adopt new ideas and practices related to family care and feeding. A socially backward, impoverished environment also favours large families with consequent overcrowding that is associated with poor environmental sanitation and personal hygiene, which are prime conditioning factors for VAD and malnutrition[8].

2.11.7 Cultural factors: Although colostrum and early breast milk are good sources of vitamin A, in many communities, including NWFP, Pakistan, mothers and grand mothers give "guti", a type of herbal water to new born children, which is thought to be good for digestion and cleaning the gut. Breast feeding can be delayed for a few days and this may lead to cessation of milk production because the reflex of suckling and milk ejection is not established. Other cultural practices in Pakistan include not giving children eggs in the summer because mothers think they are "hot".

In VAD deficient communities systemic diseases (e.g. diarrhoea and respiratory infections) are common in children. At a time when demand for vitamin A is high intake can be low, not only because of loss of appetite, but also because of traditional practices and taboos. For example, mothers and grand mothers reduce or stop feeding the child so that he can recover soon from the disease. Foods like egg and meat are not given because of the belief that it will exacerbate the diarrhoea. The child may only be given water, which may be contaminated, and if diarrhoea and vomiting continue, even this is stopped. These practices further worsens the situation of the already under nourished child (personal observations). Increasing literacy rates in women and reaching them through health education material may be one of the ways to improve the nutritional status of young children.

2.11.8 Economic Factors: Poverty is a root, though not an invariable, cause of VAD in public health terms. Because only foods of animal origin contain pre-formed sources of vitamin A, which are generally relatively expensive, VAD is confined largely to impoverished countries, neighborhoods and families which rely on less expensive pro-vitamin A from plants sources to meet their requirements. Pro-vitamin A sources must be converted to retinol, and the series of events between consumption of pro-vitamin A and its conversion to retinol include several steps that are dependent on normal physiological functions. Poverty also contributes in some other ways. Unemployment and low wage jobs are major obstacles to overcoming VAD in depressed environments[8].

2.11.9 General pattern of xerophthalmia: Varying levels of VAD can occur at any age, from sub-clinical affects that increase risk of morbidity and mortality, to blinding malnutrition (keratomalacia). Vitamin A deficiency affects children of pre-school age because of their great susceptibility to infections, and due to an increased demand for the micronutrient by the body to support their rapid growth. The potentially blinding corneal disease is most prevalent among children under 3 years of age and is usually associated with PEM. The prevalence of mild xerophthalmia, notably Bitot's spots, may be highest in school-age group though this may reflect of past rather than current vitamin A status (see Table 2.4). Either form of the disease can occur at any age. Most cases, however, fall within the indicated range of peak incidence

2.12 Indicators of vitamin A deficiency:

There are several different indicators, which can be used to assess the vitamin A status of communities, and to identify communities at risk. The vitamin A status of communities can be assessed by (1) clinical indicators (i.e. signs of xerophthalmia) (2) biochemical indicators (serum retinol levels, breast milk vitamin A, Relative dose response (RDR), and the modified dose response (MRDR)) (3). Histological indicators (i.e. conjunctival impression cytology, CIC). The communities at risk can also be identified by (1) ecological and related indicators associated with risk of VAD (2) nutritional status and diet related indicators (3) illness related indicators (4) socio-economic indicators.

2.12.1 <u>Clinical indicators – xerophthalmia</u>: Clinical signs are rare events. Therefore, when examinations are performed to determine the prevalence of severe, potentially blinding VAD, large representative samples are required. Eye signs are, however, the most specific and sensitive of the VAD indicators. Biological indicators of sub-clinical VAD below selected cut-off points are more common, thus requiring a smaller sample size. However, all the sub-clinical indicators available to date lack specificity and / or sensitivity. Clinically obvious signs of VAD, i.e. Bitot's spots, corneal xerosis, keratomalacia, and corneal scars, are well-established indicators of VAD. There is a standard classification system for ocular indicators of VAD, and minimum prevalence criteria for interpretation to identify a public health problem. (See Table 2.5)

2.12.2 <u>Sub-clinical indicators:</u>

a) Functional indicators:

<u>Night blindness</u>: Although night blindness is part of the traditional classification of xerophthalmia, it is not readily apparent. Taking a history from mothers can assess night blindness in children aged 24 - 71 months but this may not be a reliable indicator below 24 months of age, since very young children are not particularly mobile after dark, with the result that their night blindness may go unnoticed. Several objective assessment procedures are presently being developed to measure pupillary and visual thresholds and vision restoration time. However, until these procedures are standardized and reference data are available, night blindness can only be assessed by history.

Acceptability: It is generally an acceptable question, using an interview technique.

Technical feasibility: Reliable assessment by interview requires that there should be a specific local word for this condition. There is a risk of high number of false positive responses, if the respondents believe that this may result in some benefit. It is important to field test the reliability of local words prior to a survey.

Uses and application: The prevalence of night blindness can be used to map areas where an intervention should be targeted, and in surveillance of an intervention to monitor the program's effectiveness.

Confounders: A significant age trend is observed in the prevalence of night blindness. Little night blindness is observed in very young children, while the prevalence increases in children from 2- 6 years of age and older. Therefore, to use this indicator of VAD the age group for which the indicators is applicable should be standardized to a representative sample of pre-school children between 24-71 months of age, school age 6-14 years of age, and adults 15 years of age and above.

To establish more firmly the sensitivity and specificity of night blindness, there is a need for further research to clarify the relationship between night blindness as assessed through interview, and different objective measures i.e. delayed dark adaptation (DA), vision restoration time (VRT), pupillary thresholds, and other indicators of vitamin A status. There are instruments for measuring dark adaptation objectively in institutional settings but no instrument is yet available for measuring delayed dark adaptation in children below 4 years of age[50].

b) Biological indicators:

Serum retinol: The level of retinol in the blood is under homeostatic control over a broad range of body stores, and serum levels only reflect body stores when these are very low or very high. Thus serum concentration is not a reliable indicator to use for diagnosing VAD in individuals. Among populations, however, a frequency distribution of serum retinol concentrations can be very informative. A disadvantage in using serum retinol concentration as an indicator of vitamin A status is that retinol concentrations are decreased by acute and chronic infections. However, changes over time in serum retinol distributions within a population can be interpreted with great confidence.

Acceptability: Being an invasive procedure in very young children it is accepted with difficulty by parents. In areas of HIV infection, necessary precautions are required.

Technical feasibility: Collection of blood, separation of serum and its storage and analysis needs careful monitoring and quality control, which may be difficult in many circumstances. Currently the reliability of techniques using filter paper as the collection, storage, and transport vehicle is under investigation.

Cost: The cost depends on the analytic method used (HPLC, fluorescence and UV spectrophotometery). The HPLC system should have at least a manual injector, a pump, a single wavelength detector, and a chart recorder. The column used for HPLC can be any type C-18 reversed-phased column. A guard column is highly recommended because serum extracts contain considerable concentrated lipid.

Confounders: The specificity of serum values can be confounded because RBP is an acute phase protein. It can be profoundly affected by febrile and afebrile infections, even in individuals with relatively normal body stores of vitamin A. Further, RBP has a short half-life that may limit synthesis in the presence of PEM, and hence hinder the mobilization of retinol from the stores. In addition, normal serum retinol values change with age, increasing from lower levels at birth to adult levels after puberty. This age relationship should be considered when evaluating serum retinol data from infants and young children.

Interpretation: In the past, serum levels of vitamin A of < 0.5 μmol/l and < 0.70 μmol/l were used to describe populations with deficient and low vitamin A status. The cut off value of < 0.70 μmol/l has been retained to indicate a low vitamin A status. However, the prevalence level designating an important public health problem has been lowered to 10% from the previously used 15%. (See Table 2.6)

These prevalence criteria need further verification under field conditions using other indicators of VAD. Several factors common to deprived populations can lower serum values of vitamin A or status independently of intake e.g. acute and chronic infections.

c) Other biological indicators:

Breast milk vitamin A concentration: Breast milk vitamin A concentration is a unique indicator of vitamin A status because it provides information on the mother and beast fed infant. The mother's secretion of vitamin A in milk is directly related to her vitamin A status. The concentration of vitamin A in breast milk is in the form of vitamin A in the milk fat. During a feed the fat content of milk is variable for an individual mother; the first milk expressed from a full breast has the lowest vitamin A, while the last milk expressed has the highest. This variation in milk vitamin A concentration is unrelated to the mother's vitamin A status. And must be accounted for when using breast milk as an indicator to assess vitamin A status of **individuals**. However, for the purpose of assessing vitamin A status of **population**, assuming that samples are collected through the day and at varied periods following the last feed, it is not necessary to account for the sampling variation in milk fat because this variation will be randomly distributed among all samples provided that the collection period is randomly distributed. Where random sampling through the day is not possible, milk vitamin A values should be expressed relative to fat concentration.

Acceptability: Collection of breast milk samples by female health workers is generally acceptable. For an infant who is exclusively or almost exclusively breast-fed from 0-6 months of age, and partially breast fed from 6-12 months of age, a milk concentration of 1.05 umol/l provides enough vitamin A to meet metabolic needs but allows for little or no liver storage of vitamin A. This cut-off represents the minimum concentration required to prevent sub-clinical deficiency in the first 6 months of life. Milk concentrations after the first postpartum month are the most useful for estimating the vitamin A status of the mother and infant.

d) Relative dose response test (RDR) and modified dose response test (MRDR):

Even if the synthesis of retinol binding protein (apo-RBP) in the liver is not controlled by vitamin A status, its release still depends on availability of vitamin

A from dietary sources or endogenous body stores. Therefore during periods of fasting or depletion of body stores, apo-RBP accumulates in the liver. The basis of the RDR and the MRDR tests are that after a suitable dose of vitamin A, the "R" or the "DR" only appears in the plasma in significant amounts above baseline levels if endogenous liver retinol concentrations are low. The RDR and the MRDR both depend on measuring serum levels, after giving a loading dose of vitamin A. In the RDR two serum samples are required (at baseline and 5 hours later) while the MRDR requires only the follow up serum sample.

RDR test: After obtaining a fasting blood sample, a dose of 450-1000 ug retinyl ("R") ester (palmitate or acetate) in an oily solution is given. A simple breakfast is given which should contain some fat to aid absorption, but little vitamin A. Five hours after dosing; a second blood sample is obtained. Retinol in the fasting pre-dosing (A0) and post-dosing (A5) samples is determined. The RDR = A5-A0/ A5 x 100 (%).

MRDR test: The child is given a single oral dose of 3,4-didehydroretinyl acetate ("DR") (100 ug/kg body weight or 1.5 mg standard dose) dissolved in oil, and a single blood sample is taken 4-6 hours later, and R and DR measured. A molar ratio of DR to R can be calculated to give a value for the MRDR = Serum DR concentration / Serum R concentration.

Acceptability: Blood taking has to be culturally acceptable, and as the RDR test requires two blood samples this test is generally less acceptable than the MRDR test. For the MRDR the dose can be given at home, requiring the subject to come only once for blood collection 4-6 hours after later.

Technical aspects: Free DR is not stable once extracted from serum, must be protected from light and analysed immediately by HPLC. Currently DR is not available commercially. The RDR can be done using any of the procedures for serum retinol analysis but MRDR requires HPLC.

Interpretation: RDR: A response of more than 20% is indicative of inadequate liver reserves (<0.07 umol/g liver). MRDR: It has been suggested that that a moderate public health problem exists when ≥20 - 30% of the population have ratios of ≥0.06, and severe when >30% of a population's pre-school children are classified as deficient.

e) Serum 30-day response test (+S30DR):

The basic principles behind +S30DR are similar to that of the RDR and MRDR.

The assumption is that, on a population basis, a significant number of individuals have vitamin A levels below what their homeostatic level would be if their vitamin A status were adequate. This indicator is most appropriate for monitoring the effectiveness of intervention programmes for improving vitamin A status.

The test: Pre- and post dosing blood samples are taken around 30 days apart. The +S30DR is calculated as follows: T1- T0 / T1 x 100 (%), where T1 is the serum vitamin A value 30-35 days after an intervention and T0 is the base line level before.

Acceptability. It is more likely to be acceptable, as samples are taken 30 days apart.

Feasible: If laboratory facilities are available. (See Table 2.7)

Additional supporting evidence is needed because no single biological indicator of sub-clinical VAD by itself is of sufficient specificity and sensitivity to identify a public health problem[50].

f) Histological indicators - Conjunctival Impression cytology (CIC)

In VAD the integrity of epithelial cells is compromised; stem cells do not transform to mucin-secreting goblet cells, and the normal morphology of columnar epithelial cells is lost. By examining epithelial cells obtained from the conjunctival surface on a piece of filter paper, it is possible to assess whether changes have occurred that are associated with VAD.

The test: Samples are obtained by applying a small strip of filter paper of standard pore size to the lower temporal surface of the conjunctiva of one eye, followed by a separate strip to other eye. The cells, which have become attached to the filter paper, can be processed in two ways before being examined by light microscopy 1) impression cytology with transfer (ICT) 2) conjunctival impression cytology (CIC). In ICT a single, inexpensive staining solution is used, and the procedure is not very difficult. CIC requires more reagents, which are expensive and may be difficult to obtain, and more processing steps for fixing, staining and mounting specimens.

Interpretation: A normal impression of conjunctival cells shows sheets of small epithelial cells and an abundance of mucin-secreting goblet cells. In VAD, the epithelial cells are flattened and enlarged, and there is a marked reduction or absence of goblet cells. Currently three interpretation schemes are in use, and it is recommended that an abnormal classification be made only when both eyes are abnormal.

Acceptability: Impression cytology is generally well accepted in the field among children above three years of age.

Limitations: Abnormalities can occur in non-VAD conditions such as trachoma and conjunctivitis, and the technique cannot be used alone to determine the prevalence of VAD in populations with a high prevalence of inflammatory eye diseases. It is difficult to obtain good quality impressions in children under 24 months of age[50].

h) Ecological and related indicators associated with risk of Vitamin A Deficiency:

Biological indicators, both clinical (xerophthalmia) and biochemical are widely used to assess the prevalence and severity of VAD, and to evaluate the effectiveness of VAD control programmes. Ecological and related indicators help to identify areas / populations where VAD is likely to be prevalent by focusing on factors that are responsible for, or contribute to, the problem's occurrence. Assessment of these risk indicators provides crucial information for planning and targeting VAD interventions, thus increasing the likelihood of effectiveness. They do not replace other biological indicators and cannot be used alone for determining the vitamin A status of populations, or to define whether there is a problem of public health significance.

The objectives for gathering information on indirect indicators are as follows:

1. Identifying areas / populations likely to be at high risk for VAD and where more specific biological investigations are needed.
2. Planning VAD control programmes where there is a problem.
3. Monitoring progress of vitamin A control programmes.
4. Engaging in advocacy to ensure that vitamin A health is given appropriate consideration within programmes to improve health, social and economic development.

i) Nutritional status and diet related indicators:

These include breast feeding patterns, anthropometric indicators of PEM, prevalence of low birth weight (LBW), market and household food availability, dietary patterns of vulnerable groups, semi-quantitative and qualitative measures of food consumption, beliefs and attitudes concerning food.

j) Illness related indicators:

These include immunisation coverage rates; measles case fatality rates, disease prevalence rates (e.g. diarrhoea episodes rates, incidence and prevalence), and fever and helminth infection rates.

k) Socio-economic indicators:

They include maternal education and literacy, income / employment, water supply and sanitation, access to health and social services, access to land and agriculture services and inputs.

2.13 Control of vitamin A deficiency:

2.13.1 Treatment of xerophthalmia[40]: Immediate, substantial improvement in vitamin A status is required in all instances in which deficiency poses an imminent threat to vision, health, and survival. The most clinically urgent conditions are xerophthalmia, severe infectious episodes (i.e. measles, dysentery or persistent diarrhoea), and severe PEM. The frequency of vitamin A dosing is dependent on the condition being treated. (See Table 2.8)

Xerophthalmia is a medical emergency carrying a high risk of corneal destruction and blindness, and / or sepsis and death. Effective therapy requires prompt recognition of children with active disease; immediate administration of massive doses of vitamin A, with concomitant treatment of underlying systemic illness and PEM; and prevention of any recurrence[40]. Prompt administration of massive amounts of vitamin A is essential. Oral administration is preferred because it is safe, cheap, and highly effective. A dose of 200,000 IU of vitamin A is administered by mouth immediately upon diagnosis and the dose is repeated the following day. An additional dose is given 1-4 weeks later with the hope of boosting liver reserves. Because children with severe PEM handle a massive dose poorly, it is essential that they are carefully monitored and given additional doses as needed, commonly every 4 weeks, until their protein status improves.

In the rare instance in which children are unable to swallow (e.g. in stomatitis accompanying severe measles), in cases of persistent vomiting or in mal-absorption syndrome (e.g. cystic fibrosis), which prevent adequate absorption of vitamin A, an intramuscular injection of 100,00 IU of water miscible retinyl palmitate should be substituted for the first oral dose. Needles and syringes must be sterile. Oil-miscible preparations should never be given by injection because they are poorly absorbed from the injection site[40]. For children age 6-11 months, intramuscular and oral doses should be reduced by half; infants under 6 months of age should receive one quarter of the normal dose. Very large doses of vitamin A may be teratogenic, particularly early in pregnancy, and treatment of xerophthalmia in women of reproductive age therefore requires modification of the standard regimen. For night blindness or Bitot's spots, 5.5 mg retinyl palmitate (10,000 IU vitamin A) should be administered daily for at least 2 weeks. This dose can be safely administered throughout pregnancy. Where corneal lesions are present, the risk of blindness outweighs the risk of congenital defects, and administration of the full therapeutic schedule is probably warranted.

Where vitamin A preparations are not available, treatment should be instituted with foods rich in vitamin A (fish and animal livers, fish-liver oil, egg yolk, dairy products, etc) or B-carotene (lightly cooked green leafy vegetables, including leaves of the "drumstick" or " horseradish " tree (Moringa oleifera), the various amaranths, cassava leaves, etc., red palm oil, and red-, yellow-, and orange-coloured fruits, such as papaya and mango). Adding a small amount of edible oil will enhance the absorption of the B-carotene. Even where high-dose supplements are used, a vitamin-A-rich diet should be initiated as well[40].

Children with xerophthalmia, particularly its blinding forms, are often severely ill, malnourished, and dehydrated. Proper treatment will help save their vision as well as their lives, and includes general supportive care, re-hydration, and frequent feeding (by nasogastric tube if necessary) with easily digestible energy-and protein-rich foods. Concurrent illnesses, such as respiratory and gastrointestinal infections, tuberculosis, worm infestations, and amoebiasis, should be treated with appropriate agents (antibiotics, anthelminthics, etc.).

Eye Care[40]: In the presence of corneal involvement, broad-spectrum antibiotic eye ointment should be applied every 8 hours to reduce the risk of secondary bacterial infection. Established infections require immediate, vigorous local and systemic therapy. Until the causative agents are identified, antibiotics that cover a wide range of organisms, especially Staphylococcus and Pseudomonas, should be chosen (e.g. topical bacitracin and gentamicin, plus sub-conjunctival and systemic gentamicin and methicillin).

Every effort should be made to preserve the structural integrity of the eye. Where the cornea is weakened (by active keratomalacia, ulceration, or thinning), the eye must be protected from undue pressure: examinations, application of drugs, and dressing changes should be performed with the utmost care, and the eye should be covered, at all other times, by a firm plastic or metal shield (a simple plastic shield can easily be fashioned from discarded X-ray film). When necessary, a child's hands can be restrained.

Preventing recurrence[40]: Vulnerable children have already demonstrated that their home environment is deficient in vitamin A. Mothers and other care-givers need to be convinced of the need to provide diets rich in vitamin A and shown how to prepare them from inexpensive, readily available sources (primarily mango, papaya, carrots, yellow pumpkin and squash or sweet potato, and dark-green leafy vegetables. As a rough guide, a handful of fresh green or red varieties of amaranth (40g) or drumstick leaves (35g), or a medium-sized mango (100g) will provide the daily requirement for toddlers and preschool children.

Large, simple wall posters in clinic and hospital waiting rooms will alert mothers to the problem of VAD and means of preventing it. Nutritionists, dietitians, and other specially trained personnel can provide more detailed instruction for those whose children are already affected. Periodic follow-ups are important to check whether xerophthalmia has recurred and, if it has, to provide prompt treatment. Administration of a large dose of vitamin A (appropriate for age) at intervals of 4-6 months will ensure that a child maintains adequate vitamin A stores.

Measles and other high-risk infections[40]: Severe infection episodes, particularly measles but also malaria and chickenpox, can cause acute de-compensation in vitamin A status. If vitamin A status is marginal to begin with, the resultant deficiency greatly increases the risk of blindness, systemic complications (e.g. laryngotracheobronchitis), and death. All cases off measles in populations in which VAD is known to occur, or where measles case-fatality rates exceed 1%, should receive the same initial treatment as if they had xerophthalmia: a large dose off vitamin A (appropriate to age) on two successive days. These children are presumed to be deficient in vitamin A, regardless of their appearance. Children with severe, complicated, life-threatening measles and all children with measles who are under 2 years of age should be considered for vitamin A therapy even if they do not come from a "high-risk" population.

2.13.2 Programmes Controlling Vitamin A deficiency[51]: A meeting of the consultative group of ACC/SCN of the United Nations took place in Ottawa, Canada between 28-30 July 1993. This meeting brought together individuals from 11 countries that were directly involved in VAD control activities along with representatives of Subcommittee on Nutrition member agencies and academics. The future potential of different control activities was considered from the dual perspective of past experience and the findings of the meta-analysis. The overall objective of the meeting was to provide guidance to policy makers on when vitamin A interventions are warranted, on choices of alternative methods of controlling VAD under different circumstances (usually expected to be a mix of interventions with appropriate sequencing), and the likely benefits. Programmes types were defined as : Supplementation; dietary modification; fortification; public health and breast feeding promotion.

Supplementation[51]: A distinction needs to be made between universal and targeted supplementation. Universal delivery is defined here, following West and Sommer, as single-purpose distribution of large doses of vitamin A to all children of defined age (and other designated groups) within communities in specified regions according to a pre-established time schedule. Targeted delivery refers to distribution of large doses of vitamin A through contacts between high-risk individuals and the existing health service infrastructure (including periodic mass immunization campaigns) and / or existing community-based health / nutrition programmes. There are three types of targeted supplementation:

i) Targeting specific age groups through existing infrastructure

ii) Targeting to specific diseases in individuals through existing health services (may be called medical-targeting or disease-targeting or therapeutic). A further distinction may be made between therapeutic targeting solely to xerophthalmic cases on the one hand, and targeting to all individuals presenting with diseases such as chronic diarrhoea, measles, ARI and severe PEM, on the other;

iii) Targeting to specific age groups and / or sick children through community-based health / nutrition interventions.

Supplementation generally was found to be low-cost, acceptable and clinically effective within the relatively short-term, providing coverage of the population is good. There was observed, on average, a 75-80% reduction in mild xerophthalmia prevalence among 1-4 year olds with at least 65% coverage (West and Sommer 1987) – a minimum target population coverage level suggested for universal supplementation programmes.

With over 85% coverage, effectiveness with respect to severe corneal xerophthalmia may be as high as 90%, while there is unlikely to be an impact where coverage is less than 25 %. A strong inverse association was found between coverage and subsequent night blindness prevalence in Bangladesh. The following are some guiding principles regarding the role of supplementation in VAD control.

a. Supplementation with vitamin A should not inhibit attention / investment in other strategies. There is a need to push at least as hard for the underlying preventive approaches, as for supplementation. To date, there has been a relatively larger flow of resources into supplementation than to fortification or dietary approaches.

b. New vertical infrastructures should not be established as "single-purpose" delivery channels for vitamin A supplementation. Single-purpose machinery can be cost-effective where there is the possibility for eradication (which is not the case for VAD). There is thus a need to think in terms of integration within existing delivery systems including health and nutrition services e.g. well-baby clinics / services, etc.

Supplementation possibilities have tended to be bounded by the traditionally used delivery systems, which has limited opportunities. A full assessment of all available options including novel delivery systems needs to be explored. Hitherto unexploited possibilities may include Child-to-Child programmes, the formal school system, and low dose supplements sold over-the-counter in a plastic pouch of 12 one-monthly doses. Contacts where supplements are given (e.g. during immunisation) can also be used as an educational opportunity. Childbirth presents an opportunity of maternal supplementation that may be used. Other means to improve women's vitamin A status during pregnancy and post-delivery should also be considered. A continuing issue of concern is how to reach those children who do not come into contact with the services.

c. An important consideration must be to minimize the risk of multiple dosing, which necessitates adequate record keeping of the use of high dose supplements. Where record keeping is inadequate, reducing the frequency of supplementation contacts may be advisable.

d. There are situations when a pharmacological dose is needed to reach a goal and a dietary approach would not be appropriate e.g. case management of disease (measles, protein-energy malnutrition, xerophthalmia). Supplements may also be indicated when food is just not adequately available, for example in refugee and emergency situation. Vitamin A supplementation should be further explored for the management of diarrhoeal disease, e.g. with diarrhoeal disease, more frequent and lower doses may be considered. For example, in Tanzania capsule of 50,000 IU were available, making it easier to prescribe at different dose levels.

<u>Supplementation with immunisation</u>: Initial recommendations by WHO and UNICEF to combine vitamin A supplementation with measles immunisation were thrown into doubt by an early study by Semba in Indonesia[52]. This study showed that vitamin A supplementation was associated with a lower likelihood of seroconversion following measles immunisation at 6 months, and that girls were less likely to seroconvert than boys. He suggested that the immune enhancement by vitamin A may limit the ability of live vaccine virus to establish a subclinical infection, thus rendering the measles vaccine less effective

and contributing to primary vaccine failure. Ross[53] commented on the findings of Semba's study that the wisdom of giving vitamin A supplements with measles vaccine in programmes that vaccinate from 6 months of age was questionable. He suggested that further trials be undertaken in different populations and at older ages (e.g. 9 months and 12 months).

In another randomised, double blind, placebo-controlled clinical trial Semba[54] showed that sero-conversion rates were similar in vitamin A and placebo treatment groups in 9 month old infants. In another trial in Guinea-Bissau, West Africa[55] the findings were similar i.e. simultaneous administration of measles vaccine and vitamin A supplements did not have a negative effect on acquired measles immunity. Indeed in children only receiving one dose of measles vaccine at age 9 months, 100,000 I.U vitamin A increased antibody concentrations, especially in boys.

As a result of these studies it was recommended that the strategy of combining vitamin A supplements with immunisation be adopted in situations where VAD is a public health problem. This recommendation has been taken up by many countries, and in 1998, 94 million doses of vitamin A were administered simultaneously during routine immunisation, national immunisation days, health days and measles campaigns in 41 countries. This programme is thought to have averted 169,000 deaths. In 2000, 56 countries distributed almost 100 million doses of vitamin A – 40 countries including vitamin A supplementation with their routine immunisation services[56]. The challenge is set for governments and donors to maintain and improve coverage.

<u>Dietary Modification</u>[54]: While dietary modification defines a goal not a strategy, programmes to reach this goal have employed strategies made up of four specific activities to improve the vitamin A (and sometimes fat) content of the diet of at-risk population groups:

a. Nutrition education or communications, often using a social marketing approach, to improve practices related to the consumption of available vitamin A-rich food sources;
b. Horticultural interventions (or home food provisioning) e.g. home-gardening, that aim to increase availability of vitamin A-rich foods;

c. Economic / food policies affecting availability, price and effective demand for vitamin A-rich foods;

d. Technological advances concerning food preservation, plant breeding, etc.

The scope off 'dietary modification' interventions is thus broad. A division can be made between those that aim to improve the availability of vitamin A-rich foods (that is (ii) – (iv)), and those that aim to improve the consumption of vitamin A-rich foods (including (i)).

Improving Consumption of Vitamin A-Rich Foods[51]: Improving the consumption of vitamin A-rich foods, one of which is breast milk, assumes that such foods are available or could be made available but are not being consumed in adequate amounts by vulnerable groups. This implies the need for behavioral change. Behavioral change can be accomplished by a variety of mechanisms, which involve appropriate message and their presentation within a receptive environment. There are a number of general principles of directed behavioral change, and one of these is the need to adapt to the local context and resources. Effective communication is only one part of the total task required to successfully change vitamin A-related behaviors. In general, what is needed for vitamin A-related dietary modification is a conceptual system for thinking through the problems of bringing about changes in the ideas or practices of the target populations as they relate to vitamin A. This system should aim at behavioral change through culturally appropriate information and the creation of an environment suitable for change. Social marketing is one example of such a behavioral change strategy. For sustainability, modified dietary habits need to become embedded in the culture; thus the process is one not only of behavioral but also of cultural change.

Breastfeeding Promotion[51]: Breastfeeding protects infants against VAD, although breastfed infants of mothers with marginal vitamin A status may become vitamin A-deficient. In Indonesia, Stoltzfus et al. (1993) demonstrated that high-dose supplementation of lactating mothers was an efficacious way of improving the vitamin A status of breastfeeding infants (the probability of low liver vitamin A stores at 6 months of age were reduced by two-thirds). Mother's breast milk vitamin A levels were still elevated at 8 months post partum, at a time when complementary feeding is becoming increasingly important. As complementary foods may be low in vitamin A, the infant will still be dependent on vitamin A that is either available from accumulated liver stores, or still being ingested through breastfeeding.

Improving Availability of Vitamin A-Rich Foods[51]: In general, preconditions for successful home gardening interventions were found to be the following: land and water, relevant technologies, fences, fertilizer, high quality inexpensive seeds, labour time, investment capital, knowledge of optimum means of production in local conditions, including pest and disease control, and adequate marketing, storage and preservation.

These preconditions are likely to be most difficult to achieve for those population groups with the highest risks of VAD. However, while one pre-requisite is land, vitamin A does have an advantage over most nutrients in that even landless households may cultivate vines that grow on roof-tops or papaya plants that grow alongside the walls of house. For seasonally available vitamin A-rich vegetables and fruits, improved methods of preservation across seasons may be another important consideration (sun-drying of mangoes is one example); although sun drying may destroy most of the vitamin A in the case of leaves.

Fortification[51]: While fortification seems to be an attractive medium to long-team option, its sustained implementation has in the past been bedeviled by industrial and political constraints. Even before the industrial stage, appropriate food vehicles need to be sought that are affordable, accessible, widely consumed among at-risk groups, and unaffected organoleptically by the fortification process. In practice, fortification may be easier to achieve (at least initially) if the vehicle is centrally processed, although as long as the food vehicles are accessible to the at-risk groups, decentralized small-scale fortification be suitable. Fortification is generally of two types:

- Universal i.e. consumed throughout the population with little variation in intake (e.g. sugar, margarine, and potentially oil, cereals and flour, monosodium glutamate).

- Targeted e.g. supplementary feeding programmes for pregnant women or welfare recipients, school feeding, complementary foods. Targeted fortification can reach target groups more readily than supplementation and indeed could replace supplementation. Fortification of food aid is an important issue.

Preconditions for successful fortification interventions were found to be the following, and the presence of these should be sought in deciding on whether fortification is promising[51].

- Vitamin A deficiency is a public health problem in sectors of the population;
- At least one (usually centrally-processed) food vehicle which is accessible, affordable, widely consumed by the at-risk group, stable over time and unaffected organoleptically by fortificant (which should retain its potency);
- A concentration of fortificant that is based on dietary consumption data from different age and socio-economic groups in different regions. The range of fortifcant intake within a population should be narrow to avoid any risk of toxicity;
- A fortification process that is economically viable (costs not excessive relative to the value of the commodity), technically feasible and regularly monitored;
- Population monitoring and evaluation to convince government of benefits, as well as to indicate the need for reducing the fortificant level as the diet improves;
- Political commitment, reflected in initial government commitment to bear the marginal costs of the fortification process before gradual phasing in consumer cost-sharing;
- Policy to ensure sustained financial support;
- A good public image of the fortified food; promoting nutritionally 'bad' food should be avoided;
- Prospects of raising population awareness (particularly consumers) and heightening confidence in the benefits of fortification;
- Legislation or regulations that favour collaborating producers, and which protect them against unfair competition.

The advantage of fortification includes the fact that in the long run it may be one of the least costly interventions for a government. It has been found to be cost effective and sociably acceptable, being one of the most natural means of supplementing intake; and a delivery system (the market chain) is already in place. Disadvantages include the initial need for foreign exchange, the recurrent costs, the fact that it will reach untargeted as well as targeted population, frequent dependence on centrally processed food vehicle, and the need to know consumption patterns of as well as food purchasing behaviour i.e. price elasticities etc[51].

Prevention and management of disease: Many public health interventions have direct implications for vitamin A status. Infectious diseases exacerbate VAD by a variety of mechanisms, including reduced food intake (due to both anorexia and withdrawal of solid food), reduced intestinal absorption, and urinary loss of vitamin A. infections that cause diarrhoea and giardiasis reduce absorption of the vitamin. All infections reduce appetite and most induce a catabolic response that leads to vitamin A loss. Measles has a particularly severe effect on vitamin A status through these mechanisms.

It follows that measures that will reduce the burden of infection will help to prevent or reduce VAD. These include immunizations, particularly against measles, pertussis, and tuberculosis; environment sanitation, food safety and personal hygiene for reducing incidence of diarrhoea; and malaria prevention. Prevention of other nutritional deficiencies, particularly those of protein-energy and iron, will reduce the incidence and severity of many of the infectious diseases that adversely affect vitamin A status[51].

Preschool-age child mortality is reduced by vitamin A administration after the onset of measles; for this reason it is recommended that vitamin A supplements be given as soon as measles is diagnosed, in areas where VAD occurs. If a supplementation programme is under way in the area, careful records must be kept so as to avoid giving too closely spaced supplements. Vitamin A supplementation of deficient preschool-age children will reduce overall infection disease mortality in most circumstances. Specific vitamin A-related measures are not alternatives or substitutes for the basic services that will benefit health as well as vitamin A status. Public health measures and specific vitamin A interventions will usually be complementary, and both are to be recommended.

Vitamin A control programme in the health sector should be integrated into other public health measures. This will also result in more effective utilization of limited health resources. When priorities for interventions must compete for limited resources, cost-effective choices should take into account the relative benefits of various strategies. For example, high measles vaccine coverage may be a better choice than full immunization for a smaller proportion of the population at risk[51].

A common contributory cause of blindness associated with VAD is severe protein-energy deficiency. Xerophthalmia and keratomalacia may occur in children with adequate liver stores and even sufficient intake, when serum levels of retinol-binding protein are deficient. Under these circumstances improving nutritional status may be sufficient to promote mobilization of liver stores of vitamin A and alleviate the deficiency. Thus, measures to prevent severe malnutrition in young children will help to prevent VAD-associated blindness. These measures include growth monitoring and surveillance, nutrition education and rehabilitation, and food supplementation.

General public health-type interventions that included oral rehydration therapy, de-worming, immunization and treatment of acute respiratory infections were compared with other approaches in two of the three comparative evaluations (in Nepal and the Philippines). In Nepal, the relatively limited impact on vitamin A status was ascribed to underlying food insecurity, while in the Philippines the public health component was combined with home-gardening promotion, which cumulatively had a positive effect on reducing xerophthalmia.

<u>Consideration in the choice of strategy</u>[51]: One early and difficult set of considerations concerns the balance between interventions that are quick acting, to save lives now, versus longer term attacks on underlying causes. This is particularly difficult if, as seems to be the case, quick acting solutions such as distribution of supplements tend to be less sustainable than the longer-term interventions, such as behavioural change. It seems undeniable that if there is a quick acting solution available, in other words that if lives could be saved sooner rather than later, then this has to form part of the attack on

the problem[51].

Sequencing of interventions: A likely common approach would be to introduce (or strengthen) quick acting solutions, and at the same time bring in interventions to increase the dietary intake, in this case of mothers and weaning and older children. Long term approaches, such as dietary modification, fortification need to be initiated concurrently with short-term approaches, not after. This is because the very existence of an ongoing intervention (despite it only being intended as a short term measure) in practice can often detract from consideration of other longer-term approaches, which are necessary to sustainably attack the problem[51].

Periodic evaluation and situation analysis will provide the basis for adjusting strategies e.g. increased targeting or phasing out certain interventions. Evidence showing the existence of VAD problem is required for advocacy and for policy formulation programmes decisions. When clinical or biological evidence from surveys is not available, an initial rapid assessment can provide information about the presence of xerophthalmia, night blindness or low dietary vitamin A intake, which may be enough for decision-making regarding early interventions. Innovative approaches, like the use of information about the use of information obtained from school children and their families may be considered. When no clinical signs are present, pilot projects to assess VAD as measured by serum retinol levels can be under taken. In addition, assessment of evidence of precarious health and socioeconomic conditions should be considered for deciding about the need of interventions. Research should be linked to interventions and policy, requiring strong relationships and communication mechanisms[51].

Causal factors of VAD (See Table 2.3[51]) have been found to be commonly associated with VAD. These have been categorized by level, as immediate, underlying and basic. At the immediate level of causation, dietary intake and disease factors may co-exist and interact in their influence on the outcomes. At the underlying level the three problem clusters of food, health and care are relevant. Finally, the basic causes will include such broad factors as poverty, national level resources, culture, ecology and the political system[51].

2.14 Surveillance for vitamin A deficiency:

Surveillance, from the French "*surveiller* ", means to watch over with great attention, authority and often with suspicion[57]. The term "surveillance" was originally confined to certain restrictions placed on the actions of individuals under observations after being in contact with a serious communicable disease. From about 1950, it was applied to measures taken in relation to disease, as distinct from individual patients or contacts[58].

Surveillance is also defined as "the continuous scrutiny of the factors that determine the occurrence, and distribution of disease and other condition of ill health". Surveillance programmes can assume any character and dimension- thus we have epidemiological surveillance, demographic surveillance and nutritional surveillance[59]. The main objectives of surveillance are: (a) to provide information about new and changing trends in the health status of a population e.g. morbidity, mortality, nutritional status or other indicators and environmental hazards, health practices and other factors that may affect health; (b) to provide back which may be expected to modify the policy and the system itself and lead to redefinition of objectives, and (c) provide timely warning of public health disasters so that intervention can be mobilized[59].

2.14.1 General Objectives of the Surveillance[57]: Surveillance should provide ongoing information about the nutritional condition of the population and factors that influence them. This information will provide a basis for decisions to be made by those responsible for policy, planning, and the management of the programmes relating to improvement of food consumption patterns and nutritional status.

2.14.2 Specific Objectives[57]: Nutritional surveillance is a continuous process that should have the following objectives;

1. To describe the nutritional status of the population, with particular reference to defined subgroups that are identified at being at risk. This will permit description of the character and magnitude of the nutrition problem and changes in this feature.
2. To provide information that will contribute to the analysis of causes

and associated factors and so permit a selection of preventive measures, which may or may not be nutritional.

3. To promote decisions by governments concerning priorities and the disposal of resources to meet the needs of both normal development and emergencies.
4. To enable predictions to be made on the basis of current trends in order to indicate the probable evolution of nutritional problems. Considered in conjunction with existing and potential measures and resources, these will assist in the formulation of policy.
5. To monitor nutritional programmes and to evaluate their effectiveness.

2.14.3 Sources of data for surveillance[57]: Before a system of nutritional surveillance can be designed for a country there must be an initial assessment of the situation in that country. This assessment should include as far as possible information of four types:

- Type, extent and timing of the nutritional problems,
- Identification and description of the groups particularly at risk,
- Reasons for the existence of malnutrition,
- Existing sources of data on which a surveillance system could draw.

Where no information is available, the first step in setting up surveillance will have to be based on analogy with countries in which there are similar socioeconomic and ecological conditions. A preliminary assessment should attempt to pinpoint the deficiency states that are most prevalent and more serious. The second step is the process of identification and description of the groups to be considered. The third aspect of preliminary description relates to cause, and should address the question " why is a particular group at risk?"
In the initial assessment, the sources of data must be identified and evaluated in order to define the nutritional problems, the groups at risk, and the possible causes.

At the same time, the available resources of data for surveillance must be identified and the requirements for additional sources determined. Data sources can be classified as:

- Data currently recorded or potentially obtainable with in the present system of collection.
- Additional (new) data that should be obtained either through the existing services (e.g. agricultural, health, education etc.) or by recruitment of personnel specifically for the purpose.

Surveillance may be by two methods:

(1) When all data regarding a condition is collected as routine in the normal health system e.g. recording of births, deaths, registration of blind, notifying a particular condition or

(2) To set up a special system to record the occurrence of the condition of interest.

It can be done for a defined population or through sentinel sites.

Surveillance of VAD may be done to assess the magnitude, severity and distribution of the problem; to identify and characterize high risk areas / populations where control programmes are needed; to track progress towards attainment of long term goals; and or to monitor progress and evaluate impact of control programmes[50].

Therefore, the key to VAD surveillance are the selection of indicators which measure vitamin A status, the conditions that contribute to VAD, and how vitamin A status changes over time in response to changing conditions. The appropriate composite indicators depend in part of the purpose(s) of VAD surveillance. The feasibility of obtaining reliable data for specific purposes should be considered not only within the constraints of available technical and financial resources, but also in the light of the specific demographic and cultural context. These considerations will determine the selection of appropriate indicators[50].

2.15 Vitamin A Deficiency in Pakistan and the North West Frontier Province:

The paediatricians and ophthalmologists at undergraduate and post-graduate level teach that VAD disorders do not exist in Pakistan. As a result, VAD is not considered as a possible cause of corneal ulcers in poor malnourished, young children who are treated routinely with antibiotics and mydriatics, generally, with no response. The WHO, however, considers that Pakistan is having severe problem of sub-clinical VAD[8]. Few studies have been done on clinical, or sub clinical VAD in Pakistan, and the findings are summarized in table 2.9.

In 1990, The UNICEF Pakistan asked the Department of Pathology and the Department Paediatrics of the Aga Khan University Hospital Karachi and King Edward Medical College Lahore to collect information on the existing knowledge in the country on VAD related, community based research, clinical research and studies on the availability of vitamin A from dietary sources or from manufactured pharmaceutical preparations. The collected data would form basis to a possible large-scale vitamin A intervention programme in Pakistan. This was important because so far the extent of VAD in Pakistan had not been evaluated[60].

The data was collected from all over Pakistan. The Aga Khan University Hospital collected data from Sind and Baluchistan. The team from King Edward Medical College Lahore collected data from Punjab and NWFP respectively. A total of 71 specialized professionals mainly concerned with child health from 56 different institutions were contacted and information collected through a previously structured questionnaire form. At least 12 other institutes of different provinces declined to participate in the study as they thought they did not have any relevant information at this stage to the cause. In total there were 71 respondents; 36 from the province of Sind, 11 from NWFP, 19 from Punjab and 5 from Baluchistan respectively. All the respondents were highly specialized professionals e.g. paediatricians, ophthalmologists, social scientists, project in charge and basic health scientists holding offices in different government and private organizations of the country.

Awareness of the different grades of eye changes among professionals varied between different provinces. Overall 66.2% of the respondents were aware of the grades of eye changes due to VAD. However only 5.6% of the total 71 respondents could give correct classification of different grades of eye changes. About 59% provided their own classification and 32.2% could not give any classification. These results suggested that a limited number of professionals were aware of the correct classification of eye changes due to VAD in Pakistan. About 59.2% of the overall respondents had seen eye changes and 36.6% did not see at all, the eye changes during their practices in different provinces. However only 11.3% respondents found night blindness common in their areas. Maximum number of respondents (70.4%) said that night blindness was not common in their areas. The investigation team made an opinion on these results, that signs of VAD were relatively uncommon in Pakistan[60]. However the report said that there were several terms of night blindness, used through out Pakistan. These were called as "Chanjar", ("shabkor", "shamkor", "andrhatha", "Rotanda" and "Narata " in different provinces.

In this report for UNICEF, 81.1% of participants from NWFP said that a local term existed for night blindness[60]. The report mentioned, that 36 respondents from all the provinces provided their written opinions on VAD in the country. Diarrhoea, measles and respiratory infections associated with protein calories malnutrition were attributed as the causative factors for precipitation of eye changes due to VAD. The report mentioned that vitamin A containing food was mostly available in the province of Sind and poorly available in Baluchistan. However, some of the respondents commented that in spite of the availability of vitamin A containing food sources in their area, people would not buy and use them because of high cost and inappropriate food habits.

According to this report, suggestions were made by most of the respondents for prospective studies to find out the significance of VAD in morbidity, mortality of children due to diarrhoea, acute respiratory infections and measles[67]. The report concluded that from this limited survey, it was clear that on the whole, there was a lack of knowledge on status of VAD and its effects on child health in Pakistan. It recommended the need for prospective studies to find out the extent of damage among the under-privileged children who suffered a high morbidity due to various diseases. The report recommended that vitamin A supplementation programme in Pakistan was highly desirable to find out if reduction of child morbidity and mortality could be effectively achieved[60].

Most of the communities especially in rural areas of NWFP also seem to be aware of night blindness shabkor", "shamkor", "andrhatha", as parents of children are aware of the condition. They described that these children cannot walk or play after the evening, when the light becomes low. They told that the children recovered after being given cooked animal liver for a few days. However, parents often were too poor to give this diet for long, and the disease returned after some time[61]. There are few religious leaders in some of the towns and villages in NWFP who are known to treat all sorts of night blindness in the people coming to them. They advise these patients to recite holly versus (from Quran) on cooked animal liver and to take it for 7-10 days. It is said that many patients suffering from night blindness respond to this type of treatment[61]. It was these experiences that became the basis of this study to collect more information on VAD in NWFP Pakistan.

3 AIMS:

To determine whether clinical VAD occurs in children aged 0-6 years in NWFP and FATA, and to ascertain underlying causes in order to develop appropriate control measures.

OBJECTIVES:

1. To set and run up surveillance system to document blinding xerophthalmia (stage X2 and X3) in children aged 0-72 months at district level hospitals in NWFP and FATA over one year period.

2. To validate the surveillance system as a means of identifying districts with a clinical problem of VAD, by undertaking population based surveys in districts with and with out reported cases.

3. To identify risk factors for VAD at village, household and individual level in order to make recommendations for appropriate interventions for the control of VAD in children in Pakistan.

4. METHODS

All aspects of the study were planned in collaboration with staff in the Department of Preventive Ophthalmology, Institute of Ophthalmology, London.

4.1 Surveillance system:

The first objective of the study was to determine whether cases of blinding xerophthalmia were presenting to other eye units in other districts in NWFP. As a first step it was decided to set up and run a surveillance system in all districts in NWFP where there was an ophthalmologist for a one-year period. A list of all the Districts in NWFP was made, and districts with an ophthalmologist working in the district head quarter hospital identified. The names and addresses of ophthalmologists were recorded.

4.1.1 Development of a surveillance form: A form for ophthalmologists to document cases of blinding xerophthalmia in children age 0-72 months was designed in London. It was field tested by the researcher and one other ophthalmologist colleague in a tertiary eye care department at Peshawar, and modified (Appendix 1). A manual was written to accompany the form, which gave instructions on which cases to document, how to complete the form, and who to return it to (Appendix 2). The surveillance form and manual were written in English, as all medical personnel in Pakistan are fluent in English.

4.1.2 Workshop: Permission to hold a workshop on "Vitamin A deficiency and its consequences" was obtained from the Director General of Health Services for NWFP, and the administrator of the Government Lady Reading Hospital Peshawar, the venue of the workshop. Letters of invitation were written through the office of Director General Health Services NWFP. The researcher also contacted and requested many of the participants to attend the workshop.

4.1.3 Venue of workshop: The workshop was held in the department of ophthalmology, Lady Reading Hospital Peshawar, which has a well-equipped lecture theatre. A hospital setting was chosen; as it would be easier to demonstrate clinical cases, should any attend the hospital during the workshop.

4.1.4 Participants: The following people attended the workshop:

District Ophthalmologists	10
Ophthalmologists from Teaching Hospitals	
Lady Reading Hospital	6
Khyber Teaching Hospital	1
Ayub Teaching Hospital Abbotabad	1
Pediatricians (from two teaching hospitals)	6
Doctors from the office of the Director General Health	2
UNICEF office Peshawar	1

4.1.5 Aims and objectives of the workshop: The purpose of the workshop was as follows:

1. To familiarize the participants with the causes, clinical signs, consequences and treatment of VAD in children.
2. To improve the diagnostic skills of ophthalmologist for blinding xerophthalmia.
3. To inform the ophthalmologists of the purpose of the surveillance system.
4. To instruct ophthalmologists in completing the surveillance form using the manual, and when and how to return the forms to the researcher.
5. To give district level ophthalmologist literature on VAD, a supply of vitamin A capsules, surveillance forms, manuals and stamped addressed envelops (12 for each ophthalmologist) for returning forms.

4.1.6 Duration and timetable: The workshop lasted one day. There was an introduction given by the researcher followed by a description of the different stages of xerophthalmia. Slides were used to demonstrate the eye signs, and four cases of xerophthalmia were shown to participants, including cases coming for follow up. All the participants took active part in the discussion. Many commented that had seen cases like this before.

4.1.7 Surveillance: Ophthalmologists both at district level and working in other tertiary eye units were asked to complete the surveillance form for each case of blinding xerophthalmia presenting to their unit over a one year period (i.e. corneal xerosis X2, ulcers and keratomalacia X3A and X3B, and corneal scars related to VAD, XS). Ophthalmologists were asked to document unilateral as well as bilateral cases and to document the hometown / village and district of affected children. Paediatricians were requested to refer high-risk cases to the local ophthalmologist for examination (i.e. those with persistent diarrhoea, chest infections, measles and malnourished children) as well as any child whose eyes were suspected to be involved. They were asked to refer the children even if they were admitted in their units. Pediatricians did not complete the forms. Each ophthalmologist was asked to return a completed form each month to the researcher. They were given 12 stamped addressed envelopes, which also had the study months written on them. If they had not seen a case during any particular month they were asked to return a blank envelope. To document returns a table was made listing the names of the district ophthalmologists involved in the study, and the 12 months of the study. When forms were returned the information was added to the table. However, this practice was only maintained for few months.

4.1.8 <u>Visit to ophthalmologists who could not attend the workshop</u>: Seven district ophthalmologists who could not attend the workshop were visited in person by the researcher, and two were contacted by telephone. Surveillance forms and a book on "vitamin A deficiency and its consequences" were given / sent to them.

4.1.9 <u>Data management</u>: A database was created in Epi-Info 6.04, and all data from the surveillance forms were double entered. After cleaning, the data were analysed by district. A total of 80 cases were reported during the 12-month period (from 1.11.96 to 31.10.97). Four cases were excluded; three were aged over 72 months and in the fourth child two forms had been completed. This left 76 cases for analysis. Preliminary analysis showed that cases of blinding xerophthalmia were reported from 19 districts and agencies of NWFP and FATA. This information was used to identify districts for the population surveys (see below).

4.2 Validation of surveillance system - sampling:

In order to determine whether the surveillance system correctly identified districts with VAD, a total of 8 villages in two districts were selected for population-based surveys. The sampling strategy adopted, reflected the research question. The sample size and the method of sampling used were not intended to provide a precise estimate of the prevalence of VAD, but purely to determine whether or not there were cases of VAD in the selected villages. The sample selected was not intended to be representative of the child population of NWFP.

4.2.1 Sampling strategy: In order to validate the surveillance system, one "RC" district was selected (i.e. a district with a case or cases reported during surveillance), and one "NRC" district (i.e. a district without a reported case). The sampling method is summarized in Table 4.1.

4.2.2 Selection of "NRC" district: The names of all districts with a practicing ophthalmologist, but where no case was reported over the year of surveillance, were identified. One of these districts was excluded from the sampling frame, as it was a district with an intensive eye care programme, which was not thought to be representative. The names of the remaining four districts were written on pieces of paper of the same size, which were folded so as to obscure the writing. A colleague was asked to select one piece of paper. This district, Batkhela, Malakand Agency, was included in the study.

4.2.3 Selection of "RC" district: An attempt was made to identify the "most RC" district in the following manner. A spreadsheet was created in Excel, which contained the names of all the districts in NWFP and FATA. The total estimated population of each district was added, and the number of children 0-6 years estimated, assuming this to be15% of the total population (42% are aged 0-14 years)[19]. The number of cases of blinding xerophthalmia reported during the surveillance period was added, and an estimate made of the prevalence of blinding xerophthalmia per million children aged 0-6 years. The district with the highest estimated prevalence of blinding xerophthalmia was District Swabi (80 per million children) (See Table 5.4).

4.2.4 Selection of villages in "NRC" district: The administrator of Malakand Agency was requested to provide a list of the administrative units in the Agency with defined boundaries, which were included in a sampling frame, irrespective of size. Four of these units were selected randomly by writing the names of the units on pieces of paper. The pieces were folded to obscure the writing and a colleague was asked to select 4 pieces of papers. In each of the selected units, a list of villages was obtained from the office of the administrator. The villages were numbered sequentially, and one village was selected from each administrative unit by asking the administrative officer to select a number from the list of villages. In one administrative unit there were many villages with small populations, and so two nearby villages were selected from that administrative unit. Sampling was, therefore, irrespective of size.

4.2.5 Selection of villages in "RC" district: A list was made of all 11 villages with a reported case in the most "RC" district (Swabi). The list was numbered, and four villages were selected as above. Sampling was, therefore, irrespective of size.

4.2.6 Selection of households: The Lady Health Worker (LHW) of each village and their supervisor were identified with the help of the DHO office, and the purpose of the study explained. The LHWs identified the poorest part of each village, and in each village sufficient households were visited to generate approximately 200 children aged 0-6 years. In this study a household was defined as "the family unit where food is cooked for all family members".

4.2.7 Sample size:

The purpose of the community-based study was not to estimate the precise prevalence of VAD in children, but to validate the findings of the surveillance system, by comparing the proportion of children with VAD in districts with and without reported cases. A sample size of 800 children / district would have 80% power to detect a relative risk of 5.0 at the 95% confidence level (i.e. 0.5% compared with 2.5%).

4.3 Population based surveys:

4.3.1 Development of Proforma: Proforma for recording village level data, household data and child data were developed in London. These Proforma were field tested during the pilot study and were modified thereafter. The Proforma were all written in English. For each Proforma instructions were written, which gave definitions, and details on how to complete the Proforma. (See Appendices 3-7)

4.3.2 Permission: In each district the DHO was visited 6 weeks in advance of the proposed fieldwork to obtain permission, and to set a preliminary date for the fieldwork. In Swabi District one of the four selected villages was an Afghan refugee settlement, which was established more than 15 years ago. Permission was required first from Director of Health Services for Afghan Refugees, then the office of health services of UNHCR in Peshawar, with a letter to the Medical Officer of the health facility in the settlement. The DHO contacted the Supervisors of the LHWs for each village and requested their participation in the study.

4.3.3 Recruitment of the field staff: As the target population was children aged 0-6 years, and as interviews were to be held primarily with mothers, it was decided for cultural reasons to have female field workers. The field workers were all known to the researcher and were selected on the basis that they were trained / trainees at PICO. They had all seen, examined and diagnosed cases of xerophthalmia while working in the department. The researcher is a senior faculty member on the teaching course and has been teaching the subject of VAD during the courses. The field workers selected were: Trainee ophthalmic technicians (2), qualified ophthalmic technician (1), qualified nurse (1). The team that undertook the fieldwork included the four female staff, the researcher, a driver, and the LHWs and their Supervisors in each village.

4.3.4 Training of field workers: The field workers were trained in interviewing mothers and grand mothers, and were taught how to measure anthropometrics indices with the assistance of staff at the tertiary nutrition unit in Peshawar. Bathroom scales were used to measure weight, and children were weighed in their ordinary light clothes. Children less than 24 months were weighed as follows: another person held the child, and both were weighed; the adult was weighed alone, and the difference calculated. The length of babies 0-24 months was measured with a tape measure, with the child lying down and knees straight. The height of children over 24 months was measured with a ruler placed horizontally on the top of their head, and a tape measure. Mid-upper arm circumference was also measured with a tape measure. The researcher trained the field staff to examine the eyes of children for signs of xerophthalmia using a torch and x2 magnifier.

4.3.5 Pilot study: We visited twenty houses in Hayatabad Township, which were not included in the study with all the team members. Record forms were filled for children and households, to pilot test the methods and Proforma. We made no changes in the Proforma for the child or the household.

4.3.6 Implementation of population based survey: Four teams were made, comprising one ophthalmic technician with one local LHW. The researcher played a supervisory role. In the "NRC" district, LHWs were asked to identify households in the poorest part of the village, which the teams then visited. In the "RC" district the LHW Supervisors were contacted two days before the expected visit by the team, and they were asked to identify the household of the child with blinding xerophthalmia identified through the surveillance system. The teams met at this household. All the four teams visited other households in the immediate neighbourhood. In each household every child aged 0-6 years who was normally resident was examined and the findings were recorded according to WHO criteria[65], (normally resident was defined as living in the house for at least 6 months, or since birth if less than 6 months of age). The childhood Proforma was completed after interviewing the mother, or other carer. The interview included asking for night blindness in the local language (shabkor or shamkor). The household Proforma was also completed for each household visited.

4.3.7 Quality control: The researcher always remained with the teams. All the teams used to work in the one cluster of households. Teams were asked to send any child seen with Bitot's spots or other signs of xerophthalmia to the researcher for confirmation. The researcher also examined 10% of children randomly who were not referred for the presence of xerophthalmia.

4.4 Data management:

All the record forms were double entered in a database made in Epi6 6.04 in Peshawar by data entry operators. We did frequency analysis to clean the data. We validated the two files. In case of any deviation we referred to the original record forms and revalidated the entry.

5. RESULTS

The findings of the surveillance system will be described first. Then observations of the villages included in the population based surveys, followed by a description of the study population. The proportion of children with xerophthalmia will be described by district and village, followed by analysis of possible village, household and childhood risk factors. The data analyzed by village size will be presented, demonstrating how this may be a confounding variable. The findings stratified by age and village size will be presented. Finally, a comparison of demographic details of children identified in the surveillance system, and the VAD positive children in the population-based study will be reported.

5.1 Surveillance system:

5.1.1 Place of identification: Ophthalmologists at districts and teaching hospitals in NWFP recorded a total of 80 cases of blinding xerophthalmia over a period of one year, from 1st November 1996 to 31st October 1997. Four children were excluded from the analysis for the reasons given in the methods section. Fifty-three patients (69.7%) were recruited in the study from outpatients, 20 (26.3%) had been admitted to eye wards, and 3 children (3.9%) had been admitted to children's ward (Table 5.1).

5.1.2 Ocular findings: The findings in right eyes were corneal xerosis in 25 eyes (33%), corneal ulcer in 17 (22%), keratomalacia less than 1/3 of cornea in 11 (14%), keratomalacia more than 1/3 in 9 eyes (12%) and corneal scar / phthisis in 9 eyes (12%). Findings in left eyes were similar (Table 5.2). Bilateral symmetrical signs were present in 52 children, 21 of these had corneal xerosis (28%), 8 had corneal ulcer (11%), 17 had keratomalacia of any degree (22%), and 6 had bilateral corneal scar/ phthisis (8%) (Table 5.3). Eleven children had asymmetrical signs, 6 of who had keratomalacia or corneal ulcers in one eye with other signs in the other eye.

5.1.3 District of residence: Cases were reported from 19 districts of NWFP and FATA. One child came from the Punjab and 2 came from Afghanistan. The highest number of reported cases came from District Peshawar (12 children) (Table 5.4). The population varies in different districts. We estimated the prevalence of blinding xerophthalmia in children age 0-6 years per million population. We calculated this by using the number of children with blinding xerophthalmia identified as numerator, and the estimated population of children 0-6 years as denominator and multiplied by one million. District Swabi district had the highest estimated prevalence of blinding xerophthalmia (80 cases of blinding xerophthalmia per million population of children aged 0-6 years). No cases were reported from only five districts, which had an ophthalmologist working at the DHQ hospitals.

5.1.4 Age and sex: The age and sex distribution of reported cases is shown in Table 5.5. There was no significant difference in the number of boys and girls. The commonest age at presentation was 25-48 months for boys and girls (Figure 5.1). The youngest child reported was a three months old baby boy. A total of four children were aged 6 months of age or less, and all were males. There was no statistically significant difference in the age of affected boys and girls.

Study child with xerophthalmia and protein energy malnutrition

Study child with xerophthalmia

5.1.5 Nationality, and estimated prevalence of blinding xerophthalmia by nationality: Fifty-five children (72.4%) were Pakistani (54 from NWFP, 1 from Punjab), 19 children (25%) were Afghan refugees living in Pakistan, and 2 children were from Afghanistan (Table 5.6). If one assumes the population of children aged 0-6 years in NWFP to be 3.1 million, the estimated prevalence of blinding xerophthalmia in Pakistani children is 17/ million. There are an estimated 1.5 million Afghan refugees, approximately 225,000 of whom are children aged 0-6 years. The estimated prevalence of blinding xerophthalmia in Afghani children is approximately 84 / million.

5.1.6 Seasonality of presentation: Twenty six children (34.2%) presented during summer months, 24 (31.5%) presented in autumn, 17 cases (22.3%) presented in winter, and 9 cases (11.8%) presented in spring (Figure 5.2).

5.1.7 Findings on interview: Mothers were interviewed in 24 cases (31.6%), grandmothers in 12 cases (15.8%), fathers in 30 cases (39.5%) and others in 10 cases (13.2%). The results of the interviews are shown in Tables 5.7 to 5.14. Almost half of the affected children lived in households with 3-5 children aged 0-6 years. Almost 50% lived in households with 5-9 persons living in the house. A total 93.4% of mothers had received no education, and almost half of households had a total family income of less than 1,500 Rs. / month (i.e. <29 US$ / month). Over 2 / 3 of the families was landless, and in children aged over 9 months of age 1/3 had not been immunised against measles. Almost 2 / 3 of children had had a diarrhea disease, 56.4% of children had fever with cough in the 4 weeks prior to presentation, and 1/4 had not been adequately breast-fed (defined as breast-fed for at least 12 months). Seven children (9%) had not been breast-fed at all.

5.2 Population based study - study population:

5.2.1 Numbers examined, age and sex: The population- based surveys were undertaken during the spring months of 1999. A total of 1,680 children, aged 0-72 months were examined in 8 villages in two districts. Observations from the villages are shown in Table 5.15. Almost equal numbers were examined in the "RC" and the "NRC" districts (861 vs 819 respectively) (Table 5.16). The number of children examined in each village ranged from 199 to 233. The number of boys examined was almost equal to the number of girls (827 boys (49.2%), and 835 girls (50.8%)). There was no significant difference in the gender of children examined by district ("RC" district; 420 boys, 48.8%; "NRC" district; 407 boys, 49.7%).

The proportion of children examined was almost equal for each age (17.6 - 19.9% for each yearly age group), except children aged 6 who were only 6.4% of the study population (Table 5.17). There was no statistically significant difference in the mean ages between the districts (Table 5.18) (Kruskal-Wallis test p = 0.22), and comparing the eight villages (Kruskal-Wallis p=0.19).

5.2.2 Number of households included in the study: In the "RC" district 393 (54%) households were visited, and 327 (45.4%) households were visited in "NRC" district. (See Table 5.19)

5.2.3 Proportion of children with xerophthalmia: The overall proportion of children examined who had clinical VAD was 3.2% (Table 5.20). Clinical signs of VAD were present in 53 children, of whom 37 (69.8%) had night blindness, and 16 (30.2%) had Bitot's spots. No child was identified with active corneal changes, or corneal scarring. In the "RC" district 39 children (4.5%) had clinical VAD, compared with 14 (1.7%) in the "NRC" district (MH Chi sq = 10.9, p=<0.001). If the two children identified from the surveillance system and who were traced to their villages are excluded, there is still a statistically significant difference in the proportion of children with VAD in the two districts (4.3% compared with 1.7%, MH Chi sq = 9.6, p=0.001).

The proportion of children examined whom had VAD varied from 1.0% in two of the "NRC" villages, to 7.1% in village number 4, an Afghan refugee settlement in the "RC" district.

Night blindness was seen more frequently in the "RC" district than Bitot's spots (30 /37, 81%), whereas night blindness and Bitot's spots occurred with roughly equal frequency in the "NRC" district (Table 5.21). Night blindness was present in 37 out of 1680 children (2.2%) and Bitot's spots were present in 16 (0.95 %) of children.

5.2.4 Sex, age and ethnic group of children with xerophthalmia: Males were slightly more affected than females, but this was not statistically significant (RR 1.25, 95% CI 0.7 - 2.1; MH Chi sq = 0.66, p=0.41) (Table 5.22). No child with xerophthalmia was identified in the age group 0-12 months. The proportion of children with clinical VAD increased with increasing age (Table 5.23), with the highest proportion being in children aged 6 years (6.5% of those examined). There was a highly statistically significant trend of increasing VAD with increasing age (Chi sq test for linear trend p = 0.0001). The mean age was 50 months (SD +/- 14 months) in children with VAD and 35 months (SD +/- 20) in children with out VAD (Kruskal-Wallis Chi sq = 29.9, p = <0.001). Excluding children less than 6 months the mean age of children with VAD was 50 (SD +/- 14 months), compared to a mean age of 38 months (SD+/- 19 months) in children with out VAD (Kruskal-Wallis Chi sq=23;p=<0.001) Table 5.29).

Vitamin A deficiency was noted in 40 of the 1460 children examined who were Pakistani or of unknown ethnic origin (2.7%), compared with 13 of 220 Afghan refugee children (5.9%)(RR 2.2, 95% CI 1.2-4.0, MH Chi square = 6.3, p=0.01) (Table 5.24).

5.3 Population-based survey - village, household and childhood risk factors:

5.3.1 Village variables: Village information in the "RC" district was compared with village information collected from villages in the "NRC" district (Tables 5.25 and 5.26). There did not seem to be much difference between the villages in the two districts; for example all had a mosque and a primary school. It would seem that villages in the "RC" district had slightly better levels of socio-economic development than villages in the "NRC" district.

5.3.2 Household variables: Possible risk factors at the household level were analysed, comparing households in the "RC" district with households in the "NRC" district (Tables 5.27a and 5.27b). Households in the "RC" district were significantly more likely to have good quality houses, to own a television, to have an electricity supply, to have clean houses, to have good water supply and sanitation, and to own their own homes. Conversely they were less likely to own their own land, to be Pakistani, to own any type of domestic animal. Households in "RC" villages had significantly higher levels of female literacy. Other variables analysed were not significant, in particular there was no difference in the average monthly income or in the occupation of the head of the household.

5.3.3 Childhood variables: Children with xerophthalmia were significantly older than those without, even after excluding children below the age of 6 months who are at low risk (Table 5.29) (Kruskal-Wallis p=<0.001). The only other significant association between children with xerophthalmia and those without was that children with xerophthalmia were more likely to have had a recent history of measles infection (RR 2.6, 95% CI 1.-5.1 p=0.01) (Table 5.30). Data on height and weight was not included in the analysis as the data were of questionable quality. While cleaning the data the frequency distribution curves for these anthropometric measures showed extreme outliers which were not due to data entry errors.

5.4 Proportion of child population examined in each village and district:

As sampling was not done using probability in proportion to size methods, the proportion of the estimated population of children aged 0-6 years, who were examined in each village, was calculated (Table 5.31). In the "RC" district approximately 12% of the child population were examined, compared with 27% in the "NRC" district (MH chi sq p=<0.001). In the larger villages (i.e. those with a total population of >1,500) the proportion of children with VAD was higher than in smaller villages (32 / 642, 5% compared with 21 / 1038, 2%, MH Chi sq p=<0.001). As village size may have confounded the association of certain household variables, the analysis was repeated comparing household variables in large villages compared with small villages (Tables 5.33a and 5.33b).

5.4.1 Clinical vitamin A deficiency by village size: Vitamin A deficiency was present in 32 children out of 642 examined in big villages (5%), compared with 21 children out of 1,038 examined in small villages (2%) (RR 2.5, 95% CI 1.4-4.2, Chi sq=11.4 p= <0.001) (Table 5.32).

5.4.2 Comparison of household variables in small and big villages: Households in big villages were more significantly likely to have good sanitation, an electricity supply, to own a television, and to have a good quality house. They were significantly less likely to be Pakistani, and to own any type of domestic animal or land. The head of the household was less likely to be educated, and the father less likely to have a job with a regular income (Table 5.33a and 5.33b). Other variables were not significant.

5.5 Stratified analysis:

5.5.1 Stratifying by village size: Household variables were reanalysed after adjusting for village size. Ethnic group, maternal education and use of oil could not be analysed, as some cells contained no values. After adjusting for village size the occupation of the father remains significant, with those with a regular income being less likely to come from a household of a child with VAD (adjusted RR 0.43 95% CI 0.23 - 0.8). Ownership of a television is protective against VAD (adjusted OD 0.53 95% CI 0.26-0.99 p=0.05). Variables that remained non-significant after adjusting for village size were electricity supply, land ownership, cleanliness of the house, total income, number of sleeping rooms, sanitation, water supply, ownership of the house. In big villages there was no association between owning domestic animals and having a child with VAD, but in small villages ownership of animals was protective. It is not therefore possible to make a summary odd ratio for this variable.

5.5.2 Stratifying by age: Children were grouped into those at low risk of VAD (0-24 months) and those at higher risk (25-72 months). After stratifying by age measles remained significantly associated with VAD (OR 2.1 95% CI 1.1-4.34). All other variables were either not significant after adjusting for age, or the analysis could not be done due to absent values in cells.

5.6 Comparison of children with blinding xerophthalmia identified in surveillance system with VAD children in population-based study:

The age of children with blinding xerophthalmia identified in surveillance system ranged from 3-72 months with a mean age of 38 +/-19.6 months, while the age of children with VAD in the population based surveys ranged from 18-72 months with a mean age of 50.3 +/- 14 months. In children with blinding xerophthalmia there were 39 boys (51.3%), while in population based study there were 29 boys (54.7%). The mean income in the families of children with blinding xerophthalmia was Pak. Rupees 2,760, while in the population based surveys it was Pakistani Rupees 3,440.

6. DISCUSSION:

6.1 Surveillance system for blinding xerophthalmia

The study was aimed to determine the occurrence of clinical cases of VAD in NWFP and FATA of Pakistan. The first part of the study included development of a surveillance system, for recording the occurrence of blinding xerophthalmia in children aged 0-6 years over a period of one year in the eye departments of District Head Quarter hospitals. The second part of the study was to conduct a population-based study to validate the findings of the surveillance system and to identify risk factors.

During one year 76 cases of blinding xerophthalmia were reported from 19 districts. Twenty-one ophthalmologists filled the record forms for 76 children reported to be suffering from blinding xerophthalmia (corneal xerosis, corneal ulcer, keratomalacia and corneal scars due to VAD). The highest number of reported cases came from Peshawar district (12 children). The population varies in different districts. We estimated the prevalence of blinding xerophthalmia in children age 0-6 years per million population. We calculated this by using the number of children with blinding xerophthalmia identified as numerator, and the estimated population of children 0-6 years as denominator multiplied by million. District Swabi had the highest estimated prevalence of blinding xerophthalmia (80 cases of blinding xerophthalmia per million population of children aged 0-6 years). Malakand Agency was one of five "NRC" districts with no reported case of blinding xerophthalmia.

Out of 76 children, 39 children were male (51%) and the commonest age at presentation was 38 months (SD + / -19.6). Four children were less than 6 months of age and all were male. Fifty children (65%) presented during the summer and autumn months of the year. Sixty three percent children reported diarrhoea and (56%) children reported, fever with cough, 4 weeks prior to presentation to hospital. One third of the children aged more than 9 months had not been immunised against measles and a quarter of all children had not been adequately breastfed. Seven children (9%) had not been breastfed at all. More than 93 % of mothers of children with blinding xerophthalmia were illiterate. More than 68 % of the families of children with blinding xerophthalmia were landless. In 46.1% of the families with blinding xerophthalmia the monthly average income was less than 1500 Pakistani rupees (29 US $). In 36.8%, the average family income was 1500- 3400 Pakistani Rupees (30-68 US$) per month.

A population-based study to validate the findings of surveillance system was conducted in March, a spring month of 1999. A total of 1680 children, aged, 0-6 months were examined in 8 villages. Xerophthalmia was present in 53 children (3.2%). The prevalence of xerophthalmia was 4.5% (39 out of 861 children) in the "RC" district and 1.7 % in the "NRC" district. The proportion of children with xerophthalmia varied from 1.0 % in two villages to 7.1 % in one village in the "RC" district. Male children were 29 (54 %). The mean age was 50 +/- 14 months in children with VAD and 35 + / - 20 months with out VAD (p=<0.001).

This study examined the effectiveness of surveillance system of the eye departments of DHQ / AHQ hospitals for documenting the occurrence and geographical distribution of children aged 0-6 years with blinding xerophthalmia in NWFP of Pakistan. The findings have indicated that the surveillance system employed was a reasonably reliable means of identifying communities with clinical VAD, as well as indicating high-risk seasons. It has also helped in identifying the possible risk factors associated with blinding xerophthalmia in NWFP and FATA of Pakistan.

The population-based study has helped in validating the findings of the surveillance system. This study has shown that the proportion of children with xerophthalmia is more in the communities from where a child with blinding xerophthalmia was recruited in the surveillance system, as compared to communities from where no case of xerophthalmia was recruited during one-year surveillance study period. However, even in the "NRC" district the proportion of children with xerophthalmia is more (1.7%) than the prevalence determining VAD as a public health problem according to WHO standard[40].

6.2 Limitations of the study:

Before starting discussion of the findings, I would like to mention some of the limitations of this study.

6.2.1 Limitations of surveillance system: One of the limitation of the surveillance system was that twenty-one ophthalmologists working in different eye departments of teaching / district / agency headquarters hospitals in NWFP and FATA examined and filled record forms for children suffering from blinding xerophthalmia. The enthusiasm of all the participating ophthalmologist was not equal. Many might have forgotten to fill the record forms for each child examined with blinding xerophthalmia. Some of the ophthalmologists might have forgotten to send the forms for some of the cases, which they diagnosed and treated. It is less likely that all the cases occurring in NWFP and FATA were reported, leading to under reporting of total number of children with blinding xerophthalmia in one year. It is unfortunate that we did not maintain a complete record of all the monthly returns from district ophthalmologists, which makes it difficult to assess bias due to under reporting.

We requested the ophthalmologists to have close liaison with the paediatricians at district level. Most of the children with blinding xerophthalmia have some form of systemic disease like diarrhoea / respiratory infections and measles etc. Paediatricians therefore treat them in the first instance. As many of the paediatricians were not aware of the association of systemic illness and VAD, it was likely that they would not have referred all suspected cases of VAD to ophthalmologist for recording in that district leading to under reporting of cases. The surveillance system by the district ophthalmologists recorded only advanced cases of blinding xerophthalmia. Many cases of mild corneal xerosis might have been missed leading to under reporting of the actual number.

Siddiqi S et al[13] have reported the deficiencies in the referral system of the public sector in Pakistan. The study has reported a referral rate of 0.2 % from first level care facility to next higher level i.e. THQ / DHQ hospitals. People tend to refer themselves directly to secondary and tertiary care institutions. This has overburdened the out patient departments of major hospitals. In the absence of an established referral system in health care in Pakistan, people who are aware and are having appropriate resources would reach the eye departments of DHQ hospitals. Thus a substantial number of children from poor, illiterate and far away communities with the problem of blinding xerophthalmia would have not reported to these hospitals leading to under reporting of the cases.

Another limitation of the study was that there were 21observers (district ophthalmologists). Thus multiple observers made the diagnosis of blinding xerophthalmia and sent the record forms to the researcher. We could not confirm the diagnosis of blinding xerophthalmia in each child examined. It might have lead to observer bias as diagnosis of blinding xerophthalmia may have different between different observers (inter-observer variation).

We included measurements of age, height and weight in the record form, but the quality of height and weight was not satisfactory so we did not analyse it.

6.2.2 Limitations of population based study: The sample size and the methods of sampling used were not intended to provide a precise estimate of the prevalence of VAD in NWFP but purely to determine whether or not there were cases in the selected villages. The sample selected was deliberately biased, and was not intended to be representative. This means the findings of this study cannot be generalised to the child population of NWFP. The selection of households in the villages was also intentionally biased because we visited the poor households.

The population-based survey was undertaken during the month of March 1999. This is the season of the year where few cases of blinding xerophthalmia presented to different hospitals during surveillance. This is likely to be due to some protective factors working in the community at this time of the year (supply of free / cheap sources of vitamin A, dark green leafy vegetables, *Saag).* It may be due to less frequent and less severe associated risk factors (diarrhoea and or respiratory diseases / measles) in spring season. It is likely that the prevalence of the clinical signs of xerophthalmia in this study will be on the lower side. If the population based study had been undertaken in the summer months this would have given a more realistic position of VAD in the villages surveyed.

In this study it was not possible to explore the association between VAD and nutritional status, as the quality of the data was so poor. One of the reasons was because the researcher was male he was not allowed into homes to supervise the measurement of height and weight. Better quality weighing scales and height measuring boards should ideally have been used, such as those recommended by UNICEF, but these were not available in NWFP. Collecting detailed and reliable dietary intake data is complex and resource intensive, and was not undertaken as it was beyond the scope of this study.

6.3 Findings of surveillance system:

6.3.1 Numbers reported: According to MICS of Pakistan, the most common symptom which compels a mother to take her child to a health care provider is fever, described by 74% of mothers. Of those mothers who believed that their child suffered from difficult / fast breathing only 18% went to a Government hospital for some help[30]. The National Health Survey of Pakistan of 1990-9, had also mentioned that only 21% of people utilise health care facilities in government sector[15]. This might have an impact on the number of cases in our study. It is more likely that about 80% of the children suffering from severe form of VAD associated with systemic diseases like diarrhoea and respiratory infections / measles would have not availed the health at district level hospitals in government sector and were left out, resulting in under reporting of blinding cases of VAD.

The number of blinding xerophthalmia cases reported may also not be indicative of the burden of disease in the community because the mortality rate in children with blinding xerophthalmia is very high, and children with blinding xerophthalmia, particularly those in association with systemic diseases, would probably have died before presenting to health facilities.

6.3.2 Ethnicity: Fifty-five children (72.4%) were Pakistani (54 from NWFP and 1 from Punjab), 19 children (25 %) were Afghan refugees, and two children were from Afghanistan. The estimated prevalence would be 17 per million population aged 0-6 years for Pakistani children while 84 per million for Afghan refugee children. There could be two possible explanations for this: one is that blinding xerophthalmia genuinely is more prevalent in Afghan refugees. The second reason is that the Afghan refugee population access health care services more readily than the local population. Probably both factors are relevant. Pakistan was hosting around 2.2 million Afghan refugees during January 2001 with many more residing as unofficial refugees. According to information from the office of the Commissioner for Afghan Refugees NWFP at Peshawar, 80% of Afghan refugees are settled in different districts of NWFP, with 20% in FATA. Immediately after the influx of Afghan refugees during the 1980s a lot of international help was available, and effective health, nutrition and water and sanitation programmes were established in many settlements. Many of these settlements were established near district headquarters, making health and other services readily accessible. During the early 1990s, after withdrawal of Russian troops from Afghanistan, much of this international support was withdrawn, and many of the aid-supported facilities have closed. This had led to severe health and nutritional problems for Afghan refugees who still, however, have access to the government district level facilities which they readily make use of.

6.3.3 Age and sex: The commonest age of presentation in our study (25-48 months) is comparable to the commonest presenting age of 2-4 years reported by Hennig et al[65] from Nepal, by Cohen et al[64] from Bangladesh, and by Sommer in Indonesia. In our study the youngest child reported was a 3 month old baby boy, and 4 children were less than 6 months old. The study from Nepal reported 21 children aged less than one year, and Sommer has also reported corneal xerophthalmia during infancy. In our study, 51.3% of the 76 children were male. The slight preponderance of boys over girls has been reported by many other authors.

6.3.4 Predisposing factors: In this study diarrhoea was reported in 48 children (63.2%) and fever with cough was reported in 43 children (56.6%). There are no other reported studies from Pakistan, which address the association of VAD with systemic diseases in children. However, Ahmad et all[69] have reported in a study from NWFP that diarrhoea and Acute Respiratory Infections accounted for 75% of all child deaths. Most of the rural poor and illiterate population lack the knowledge regarding health care and healthy life. They take the malnutrition, morbidity and eye problems of their children as a normal phenomenon. Even death of a young child in some communities, is not taken as “unusual”. Many of the families of these 76 children reported deaths of children in their families.

6.3.5 Seasonality: In our study 34% of children with blinding xerophthalmia presented during the months of June, July and August (summer), which is similar to the seasonal pattern reported by Hennig et al[65] in Nepal, and Foster in Tanzania. In Pakistan summer starts from the end of May, and the monsoon starts from June-July. There are more flies in the summer due to poor sanitation in rural areas, and as a result more people suffer from diarrhoea in the summer, especially young children. With the onset of the dry, hot season the availability of vitamin A rich foods decline and they become more expensive. The risk of other febrile illness also increases (e.g. malaria and enteric fever).

6.4 Population based study:

6.4.1 Proportion of children with xerophthalmia: The results showed that clinical signs of VAD were present in 3.2% of children examined (n=1,680), which is comparable to many studies where children with no apparent morbidity have been examined in surveys[64]. The prevalence of xerophthalmia has been reported to be much higher in children with systemic diseases (i.e. diarrhoea, PEM, ARI and worm infestation). This has been significantly shown in Indian studies. Night blindness was reported in 33.3 % children out of a total of 24 suffering from ARI[64].

In all reported studies there is a wide variation in prevalence of the different categories of VAD between regions and countries, as well as within countries. The World Health Organization has pooled data from different regions and countries, and has categorised countries into 6 levels of severity: clinical VAD; severe sub-clinical VAD; moderate sub-clinical VAD; mild sub-clinical VAD; VAD under control, and no data available. Pakistan was classified in 1995 as having severe sub-clinical VAD (72). However, this decision was based on only a few, small studies some of which were conducted 30-40 years ago. Findings of an unpublished study undertaken in Thar District (a desert area of Pakistan) night blindness was reported to be 7% in individuals aged 5 years and above. Night blindness has been reported be to 1.9% in children aged 5-14 years (73). In another population-based study from NWFP, Paracha et al determined plasma retinol levels in 2,756 children[63]. Serum retinol levels <0.70 umol/l were reported in 32.4% in boys and 31% in girls, and <0.35 umol/l was reported in 3.2% and 3.3% of girls and boys respectively. Night blindness was present in 0.1% of 3,061 children examined, while Bitot's spots were reported in 0.6%. The prevalence of xerophthalmia was lower than in our study which might be explained by the sampling method as well as variation in the nature and prevalence of risk factors.

In another study from Pakistan 110 children (M= 53, F=57) aged 0-3 years were examined for signs of xerophthalmia[70]. Thickened bulbar conjunctiva was reported in 3 children (2.7%) but Bitot's spots were not reported. In the same study 385 children age 4-15 years were examined (M=173 and F=212), 26.2% of whom were reported to have signs of xerophthalmia and thicker bulbar conjunctiva. Seven children (1.8%), 4 male and 3 female children were reported to have Bitot's spots. The prevalence of Bitot's spots is more than reported in our study, but the age group is different.

Molla et al[62] reported findings from a study undertaken in the slums of Karachi. They reported deficient retinol (<10 ug / dl) in 12 children (2%) aged 6-60 months in three slums areas of Karachi. Marginal deficiency (<20 ug / dl) was found in 46% of children, but they did not see any signs of clinical xerophthalmia.

6.4.2 Clinical signs: Night blindness alone was reported in 37 children (2.20%) and Bitot's spots were reported in 16 children (0.95%). No child was identified with active corneal xerosis, ulceration or scarring.

6.4.3 Comparison of findings in the two districts: The proportion of children with xerophthalmia was 4.5% in the "RC" district identified by the surveillance system, and 1.7% in the "NRC" district. This study has shown that the surveillance system employed was a reasonably reliable means of identifying communities of children with clinical VAD. The system can also be used to monitor the effectiveness of any control programme in future.

The signs of xerophthalmia differed between districts: night blindness accounted for 81% of cases in the "RC" district and for 56% in the "NRC" district, but this difference is not statistically significant.

6.4.4 Village findings and risk factors: The villages included in the study were not homogeneous with respect to size and materials used for building, but were similar in many other respects. In our study the proportion of children with xerophthalmia was significantly higher in the 3 big villages compared with small villages (5% versus 2%). This finding may seem surprising as two of the big villages had houses built out of better materials, and had better education facilities. The other big village was an Afghan refugee settlement. In one of the two large non-Afghan villages occupants had been given compensation in the 1970s as a dam had been built, flooding their land. They used this money to construct good quality houses. In the other big village male members of the household had been remitting money from the Gulf in the 1970s and 1980s, which again was used for construction. When recession hit the Middle East during the oil crisis these men returned home. Interestingly there is now very little difference in the incomes between households of big and small villages.

In big villages even if the proportion of very poor is the same as in small villages, the number of poor children will be more, which may be why the proportion of children with xerophthalmia is more in big villages. Size of the village is, therefore, a confounder.

6.4.5 Household findings and risk factors: Household variables were reanalyzed after adjusting for village size. Ethnic group, maternal education and regular use of oil in cooking could not be analyzed, as some cells contained no values. After adjusting for village size the occupation of the father remained significant, with a child with VAD being less likely to come from a household with a regular income. Ownership of a television was also protective against VAD. In Molla's study in the Karachi slums[62], one of the possible reasons why they did not see cases of xerophthalmia might be that the average monthly family income varied from 72 to 94 US dollar. Families living in slum areas had migrated from other parts of the country, and had a regular monthly income, which has been shown to be protective from VAD. In our study of surveillance the average income in almost half of the households was less than 29 US dollar per month, almost one third of the family income in the Karachi slum study. In our study there is an association with income, which shows that xerophthalmia is likely to be more common in families without a regular income. In the study by Paracha et al[63] parents who had a low level of education and inadequate earnings were at about 20 to 50% greater risk of having a child with VAD.

Variables that remained non-significant after adjusting for village size were electricity supply, land ownership, cleanliness of the house, total income, number of sleeping rooms, sanitation, water supply, ownership of the house. Other studies have shown some of these factors to be important. For example, Cohen N et al[64] had reported from Bangladesh that 80% of blind children (the majority being blind from corneal scarring) came from landless households: the Nepalese survey in 1981 also showed that land ownership was a risk factor for VAD, with families with small plots or no land being at increased risk.

In big villages there was no association between owning domestic animals and having a child with VAD, but in small villages ownership of animals was protective. It is not therefore possible to make a summary relative risk for this variable. In our study ownership of fruit trees (such as mango and papaya) was not looked into.

6.4.6 Childhood risk factors: The only statistically significant individual risk factors for VAD were age and a recent history of measles. However, the sample size was not very large, and the confidence intervals are wide, so the study does not have much power to detect differences.

Children with signs of VAD were older than children without VAD even after removing children at very low risk (i.e. those <5 months). There was a highly statistically significant trend of increasing VAD with increasing age. Similar trends have been reported by many studies that night blindness and Bitot's spots are more in older children. Cohen et al reported that rates of night blindness rose steeply with age in rural areas, from 5.3 per 1000 at 1 year to 66.6 per 1000 at age 5 years[64]. Hennig et al have reported that the peak age for non-corneal xerophthalmia was 5 years while the peak age for corneal xerophthalmia was 3 years[65]. Muhilal et al have also reported that rates for xerophthalmia were higher in older than younger children[66].

In our study children with signs of VAD were 2.57 times more likely to have had a recent attack of measles. Many other studies have shown measles to be a risk factor for developing signs of VAD[67]. Measles causes VAD through multiple mechanisms, including loss of appetite, increased demand, reduced transport, reduced absorption, and increased loss in the faeces and urine[68] .

In the communities studied measles immunisation coverage was only 60%, and has decreased from more than 80% in the 1980s. Some of the reasons for this decrease are less emphasis from the government, repeated transfer of EPI workers because of political intervention, and poor supervision. This may be partly due to political instability in the country, as over the last 14 years 7 Governments have been in power, every one with their own policies, affecting all aspects of life including health.

7. CONCLUSIONS AND RECOMMENDATIONS

The aim of the study was to document cases of clinical VAD in children in NWFP and FATA. The first part of the study included the development and implementation of a surveillance system for recording the occurrence of blinding xerophthalmia in children aged 0-6 years in eye departments of district headquarter hospitals over a period of one year. The second part of the study was to conduct a population-based study to validate the surveillance system, and to identify risk factors for VAD at village, household and individual level.

7.1 Surveillance:

7.1.1 Conclusion:

The study shows that blinding xerophthalmia occurs in many districts of NWFP. The surveillance system was able to identify high risk communities, children, seasons and systemic diseases in the affected communities.

7.1.2 Recommendations

The surveillance system should continue. A control programme for VAD has been in place since November 1999, and on-going surveillance of new cases of blinding xerophthalmia can be used to monitor the effectiveness of the interventions. One approach would be to continue with district ophthalmologists after further training, with improved feedback. The merit of this will be that district ophthalmologists have been doing it for some time. They have seen the benefit of treating children with vitamin A and are now convinced that VAD occurs in young children and can be managed easily. The disadvantage will be that it will pick only cases presenting to ophthalmologists. Some additional resources will be needed to run the system. Paediatricians could also be involved in the surveillance system, as they identify / diagnose high-risk children, and the system may pick more cases if they are included. However, involving them will need advocacy and permission from the Government, and it will be cost and labour intensive. Another benefit of involving them is that they will become more aware of the problem of VAD in NWFP.

Another approach would be to use sentinel sites, using the five districts with the greatest number of reported cases. In these districts all sectors could be involved i.e. district ophthalmologists, paediatricians and doctors in the government, non-government and private sectors. It may prove more successful, because it will be focussed and manageable. It may pick high proportion of cases of blinding xerophthalmia. The demerit is that it will cover only limited geographical areas.

7.2 Measles immunisation:

7.2.1 Conclusion:

In the population based study children with a recent history of measles were much more likely to have VAD, and in the surveillance system 1/3 of eligible children had not been immunised against measles.

7.2.2 Recommendation

There is a need to improve measles immunisation coverage, to control epidemics of measles. The problems of coverage of vaccination depend on many factors i.e. those in relation to the providers (e.g. training, record keeping, mobility and supervision of staff), recipients (e.g. awareness and co-operation of parents), or the process itself (e.g. supply of vaccine to far flung rural areas, effects of storage etc). Further exploration of the reasons for the low coverage is recommended, so that specific measures can be adopted to improve coverage. The lady health workers, school teachers, Imams and local government Counsellors can influence the communities positively by encouraging immunization, and by providing help in mobility, accommodation and food for the immunization staff. Local Counsellors and Imams can advocate on behalf of their communities so that teams are sent.

7.3 Improving control measures:

7.3.1 Conclusion:

Vitamin A deficiency was found in poor communities throughout the Province. Precipitating illness like diarrhoea and respiratory infections were common.

7.3.2 Recommendations

More studies are needed to determine risk factors for VAD including nutritional and breast-feeding habits, health practices, water supplies and sanitation, and personal hygiene. It will be of great help to identify possible protective factors within high risk communities and how they can be practised by families with affected children. The most important will be the involvement of the communities themselves to bring about healthy change in their behaviour. One of the important messages will be the promotion of breastfeeding, which should start as soon as possible after the birth. The role of lady health workers is important here, as they are part of the community. Lady health workers look after pregnant women throughout pregnancy, and she can advise them in eating a balanced diet, including foods rich in provitamin A. She is supposed to be present at the time of delivery conducted by a traditional birth attendant. Her presence at this time can establish a very personal relationship with the family, and she can advise them about appropriate complimentary and weaning foods at 6 months of age. She can remind / help the family in vaccinating the children acting as bridge between EPI programme and the communities, and the importance of taking vitamin A with immunization. She can monitor the growth of child and health for the initial years of life. If there is any serious systemic illness in the children, they can be referred to the nearest health facility. Lady health workers can explain to families that the cost of prevention is less than cost of treatment. More training, including counselling skills, will help LHWs in imparting health education to their fellow communities.

Imams in village mosques can be used to influence the behaviour of communities, particularly as they have reservations about NGOs entering their communities, as they believe they spread other religions. They can involve men through Friday prayer sermons, as according to Islamic teachings, breast feeding should continue for two years. Health education regarding personal hygiene can reduce morbidity due to diarrhoea e.g. washing hands with soap and water before eating food and after using toilet, which is also part of Islamic teaching. At the community level Imams provide a mechanism to co-ordinate the otherwise vertical programmes for promotion and maintenance of child health.

Safe drinking water and good sanitation in the rural communities and urban slums is also important, and will compliment the above efforts. Here the role of the local government becomes very important. A lot of advocacy will be needed from district and provincial health authorities as health of the communities cannot be improved in isolation without clean water supply and basic sanitation.

Supplies of high dose of vitamin A have to be ensured in the health facilities for high-risk children and for treating children with xerophthalmia.

7.4 Fortification:

7.4.1 Conclusion:

Although studies of fortification were not part of our research, it has an established place in improving the intake and vitamin A status in affected communities.

7.4.2 Recommendation:

The pure food act of 1965 regarding fortification of edible oil/ghee needs to be implemented. This act makes it mandatory to add vitamin A during manufacture of edible oil. However, studies have shown that more than 50% of manufacturing units are not complying at all and the rest are not doing it according to the prescribed standards. The Government has to be firm so that all the manufacturers stick to the standards of the law regarding vitamin A fortification. The government should also offer technical and/or financial assistance to set up the process, as was the case with iodination of salt. The Nutrition Section of the Planning Commission of Pakistan has to be convinced of the need for fortification so that they can put pressure on the manufacturers.

7.5 Seasonality:

7.5.1 Conclusion:

In Pakistan vitamin A is being administered with polio vaccination, and this programme has been in place since November 1999. The study has identified summer, autumn and to a lesser extent winter, as the highest risk seasons for blinding xerophthalmia.

7.5.2 Recommendations

Administration of vitamin A supplements should take place in March / April and November to reduce the peaks of xerophthalmia in the high risk seasons.

7.6 Afghan refugees:

7.6.1 Conclusions:

Afghan refugee children seem to be more at risk of xerophthalmia than Pakistani children.

7.6.2 Recommendations

It is important to advocate with the international organisations and agencies (e.g. UNHCR, UNICEF, INGOs) to keep their international and humanitarian obligations and continue to provide support in health and education for Afghans. Healthy, educated, skilled Afghans are essential for reconstruction of their country.

7.7 Poverty:

7.7.1 Conclusions:

The study has shown that blinding and non-blinding VAD affect poor households.

7.7.2 Recommendation:

It is important to adopt medium and long-term strategies to reduce poverty especially in rural areas. One of the most important steps will be to invest in health and education. This will provide opportunities for the common people to improve their skills and compete in open market for jobs. This may lead to awareness and generalised prosperity. Communicating health messages to literate communities becomes easier, as they may become more health conscious and even more receptive to messages.

7.8 Political and professional will and commitment:

7.8.1 Conclusions:

It is the experience and observation of the research that community health is not a priority for politicians and professionals.

7.8 2 Recommendations:

It is important that health becomes one of the top priorities for politicians and policy makers so that more resources are allocated to health. This can only be done if the professionals play their role effectively. They have to present statistics regarding health problems and its economic losses to politicians and policy makers in such way that they are convinced about the central role health can play in the development of the nation. The professionals have to do their homework very carefully and present the case in a very professional, persuasive way to minimise the chances of refusals/ delaying allocations. Presently the government spends less than 0.7% of GDP on health and less than 2.5% on education. The government needs to be convinced that the allocation for health and education has to be increased to 3% and 5% respectively over the next few years. This may lead to a visible improvement if good governance is observed in the use of all resources.

Figure 1.1 Map of Pakistan

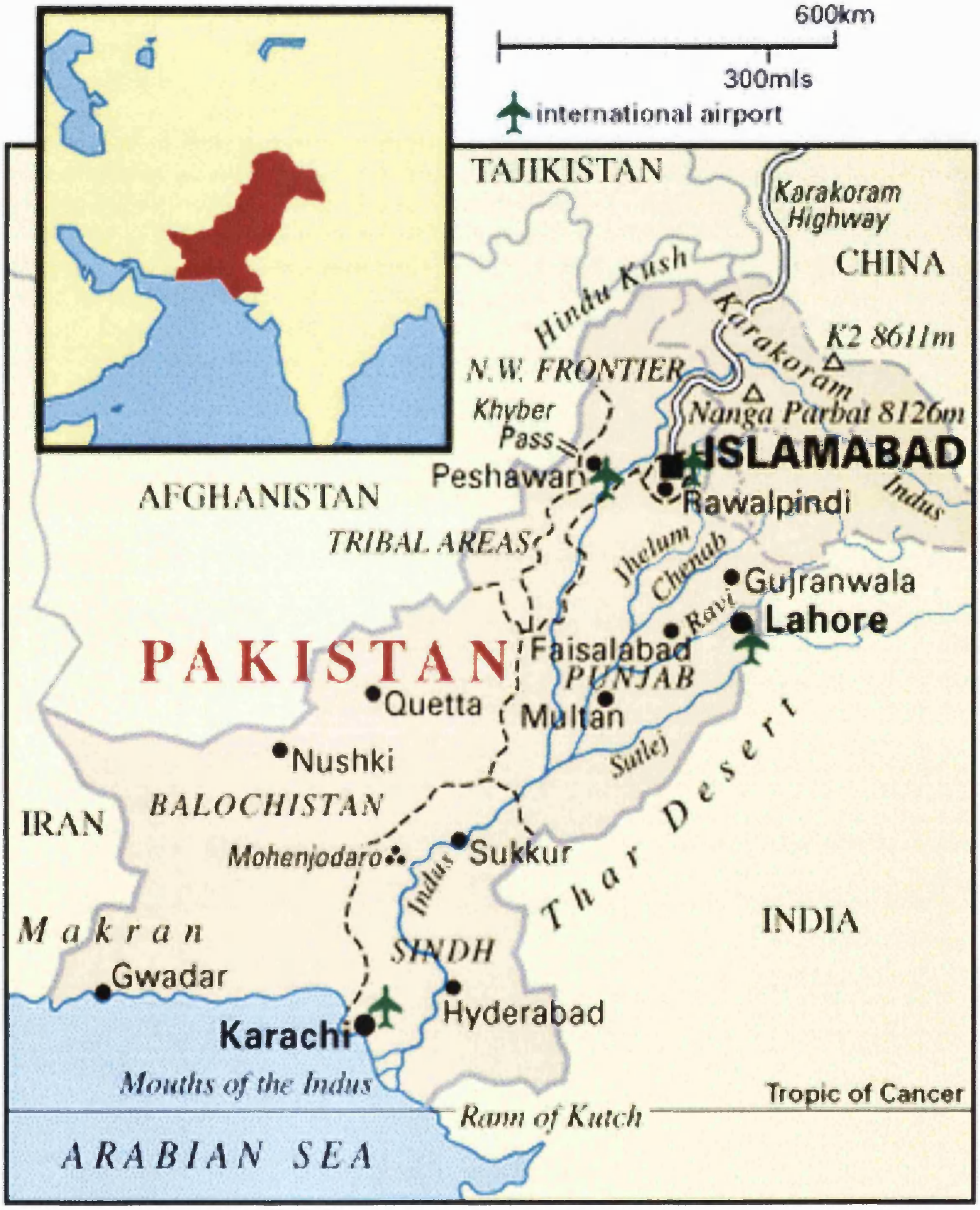


Figure 1.2 Map of NWFP

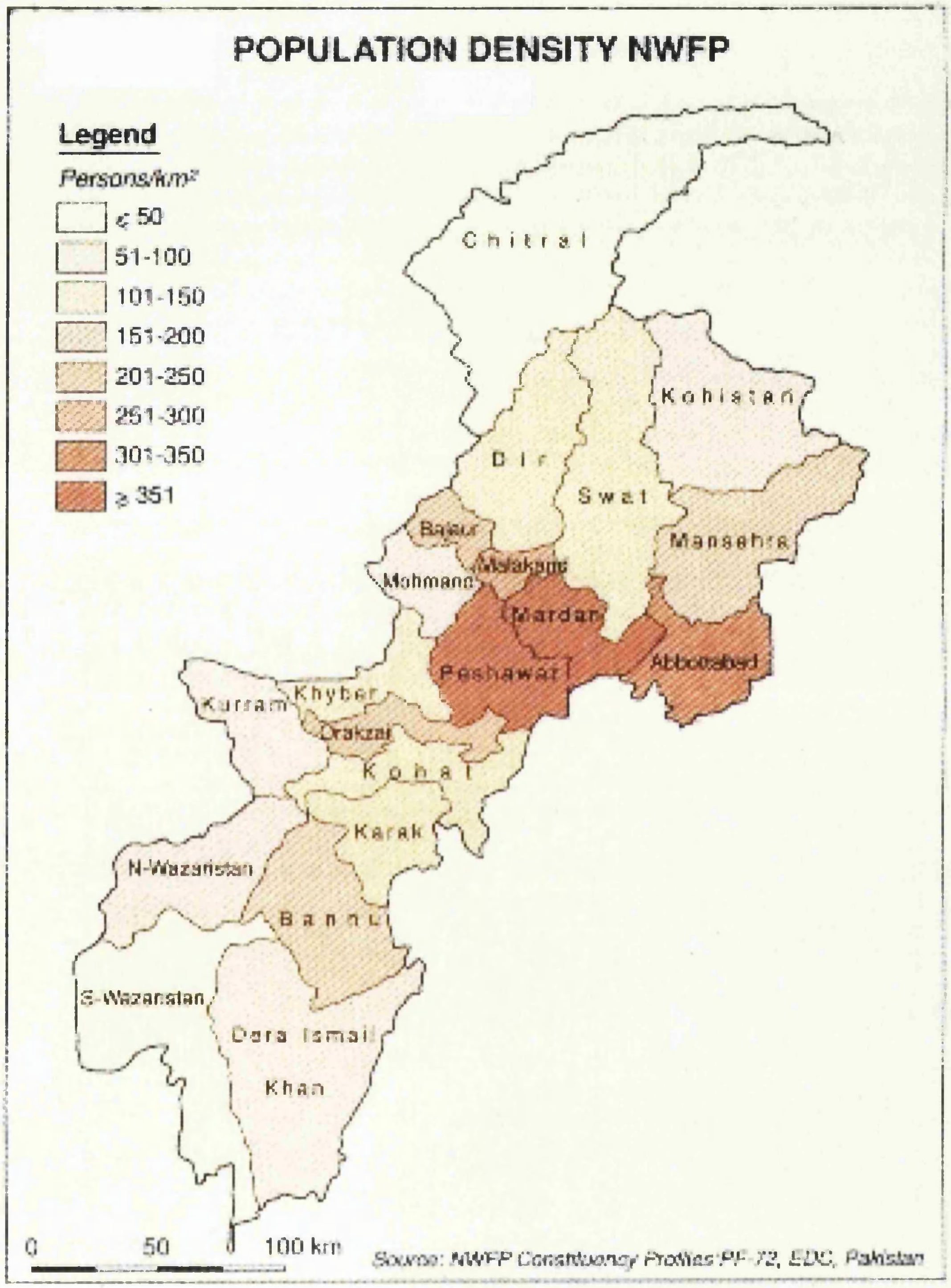


Figure 1.3 Weather Map of NWFP

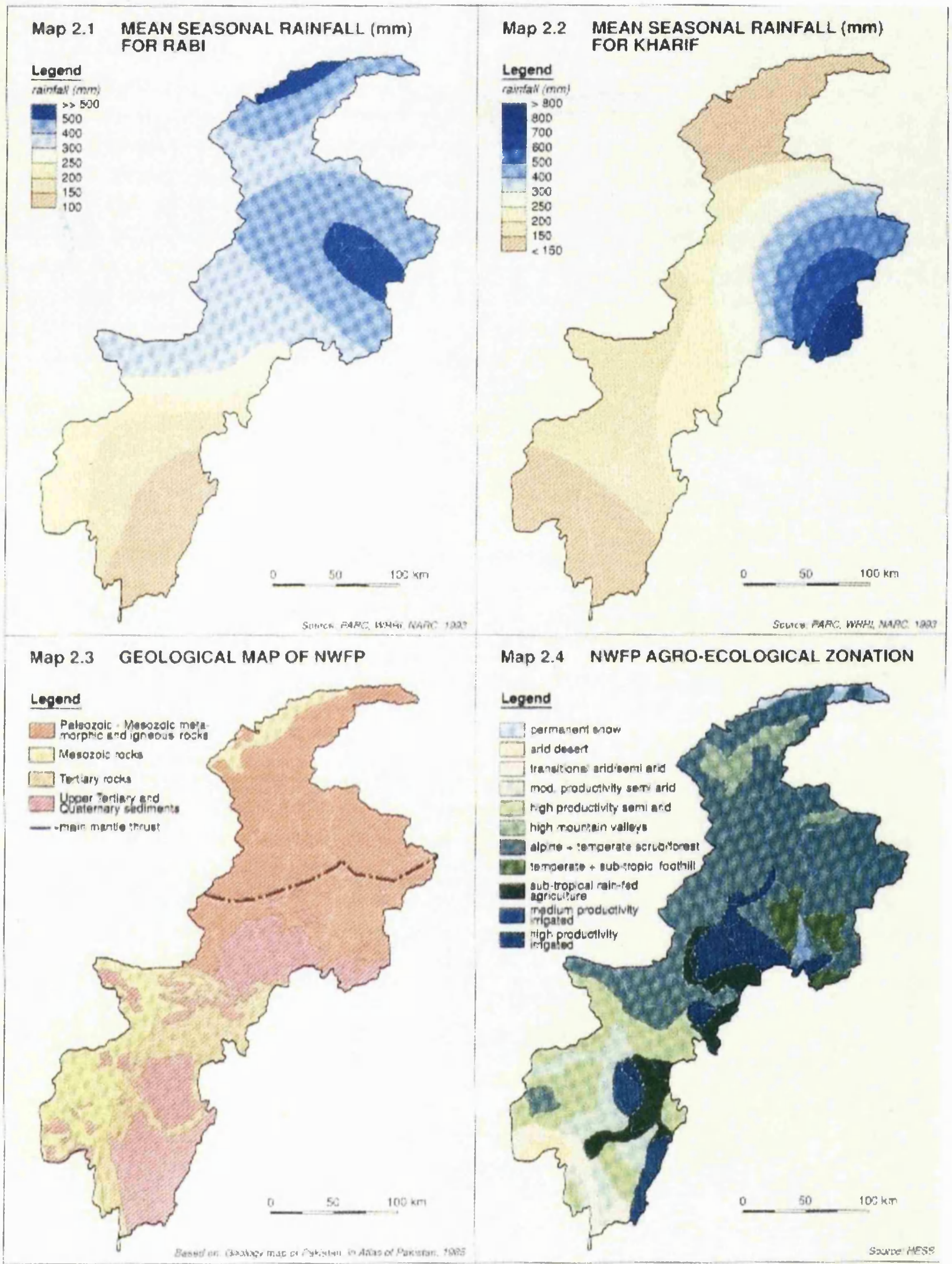


Table 1.1 - Age and sex distribution of Pakistan in the 1998 census

Age group	1998 Male	1998 Female	Sex ratio F : M
0-4	14.3	14.9	104.0
5-9	15.7	15.6	108.4
10-14	13.1	12.7	111.2
15-19	10.2	10.5	105.7
20-24	8.7	9.3	100.7
25-29	7.5	7.5	107.9
30-34	6.5	6.2	114.8
35-39	5.0	4.7	114.4
40-44	4.3	4.6	102.0
45-49	3.5	3.6	104.3
50-54	3.2	3.1	111.5
55-59	2.2	2.0	115.9
60-64	2.1	2.0	116.1
65-69	1.3	1.1	121.6
70-74	1.1	1.0	122.1
75+	1.2	1.1	118.9
All age groups	100	100	108.1

Table 1.2 - Average Household Size (Persons)

Area	Household Size	Total Households in (Million)
Pakistan	6.7	19.7
NWFP	7.6	2.3
FATA	8.8	0.4
Punjab	6.8	10.7
Sindh	5.8	5.2
Baluchistan	6.4	1.0
Islamabad	5.8	0.1

Table 1.3 Distribution of population of Pakistan, by Province 1998

Province	Land Area	Population	
	Km^2	%	
Punjab	25.8%	55.6%	72.6 million
Sindh	17.7%	23.0%	29.9 million
NWFP	12.8%	13.4%	17.5 million
FATA		2.4%	3.2 million
Baluchistan	43.6%	5.0%	6.5 million
ISLAMABAD		0.6	0.8 million
TOTAL		**100**	**130.5 million**

Table 1.4 - Social indicators

Items	Pakistan 1998-99	All developing countries
Population growth rate	2.4	2.1 (1995)
Adult literacy rate (%)	45.8	80 (1995)
Primary school enrolment (%)	63.2	85.7 (1997)
Life expectancy at birth (years)	63.6	64.4 (1997)
Infant Mortality Rate (per1000)	89.0	64.0 (1997)
Total Fertility (%)	4.9	3.0 (1997)
Rural population access to safe water (%)	59.2	71 (1995)
Rural sanitation (%)	25	42.0 (1995)
Contraceptive prevalence rate (%)	29.8	56 (1995)

Table 1.5 - Level of education

Level of Education	Both sexes	Male	Female
Below Primary	17.9	16.8	20.1
Primary	29.8	28.1	33.1
Middle	21.4	22.7	18.9
Matric	17.8	19.0	15.5
Intermediate	6.5	6.5	6.5
B A / B Sc & Equivalent	4.3	4.4	4.0
Diploma / certificate	0.4	0.5	0.2
Others	0.4	0.3	0.5

Table 1.6 - Health Indicators (year 1999)

Country	Life expectancy at birth	Under 5 Mortality rate per 1000	Infant Mortality rate per 1000
Pakistan	62	120	91
Bangladesh	59	96	73
China	70	36	31
India	63	83	70
Indonesia	65	52	43
Sri Lanka	73	18	16
Nepal	58	107	77
Malaysia	72	12	8
Philippines	69	40	32
Thailand	72	33	29

Table 1.7 - Source of drinking water in urban households (%) in Provinces

Sources	Punjab N=1691	Sind N=1655	NWFP N=1068	Baluc-histan N=788
Piped supply in dwelling	41	53	45	39
Hand pump in dwelling	41	36	29	34
Water delivered to house by water vendor, canister, water tanker, etc.	0	0	1	2
Public pipeline outside the house in street or in neighborhood.	1	5	5	3
Hand pump outside the house, in street or in neighborhood	1	3	7	1
Tube well or motorized bore-hole outside the house.	15	1	1	1
Protected dug well or spring or pond	0	1	12	16
Unprotected dug well or spring or pond	0	0	1	3
River, Canal Stream	0	1	0	0

Table 1.8 - Toilet facilities in urban households (%)

Toilet Facilities	Punjab (N=1690)	Sindh (N=1658)	NEFP (N=1066)	Baluc-histan (N=790)
Flush latrine connected with water born sewerage system	48	50	18	40
Flush latrine connected with septic tank	40	24	43	21
Covered dry latrine	2	9	11	29
Pour Flush latrine drained out off house in open	2	9	9	5
Any other method which leaves the stools exposed	2	2	16	5
No protected facilities, go out somewhere or in fields	6	6	3	0

Table 1.9 - Toilet Facilities in Rural Household (%) Area of Provinces

Toilet Facilities	Punjab (N=3210)	Sindh (N=1476)	NWFP (N=2128)	Baloc-histan (N=1577)
Flush latrine connected with water borne sewerage system	11	9	2	5
Flush latrine connected with septic tank	16	14	11	9
Covered by latrine	2	23	17	33
Pour Flush latrine drained our of house in open	1	18	9	8
Any other method which leaves the stools exposed	1	10	38	32
No protected facilities, go out somewhere or in fields	69	26	24	13

Table 1.10 Feeding behaviour in infants <months of age during last 24 hours (n=813)

	Breastfed only		Breastfed with liquids and solids		Breastfed combined with liquids, solid and bottle feeding	
	No	%	No	%	No	%
Pakistan	186	16	775	95	154	18
Urban	62	15	260	95	52	20
Rural	124	16	515	96	102	17
Gender						
Boys	92	14	421	95	89	19
Girls	94	18	354	95	65	18
Province						
Punjab	21	7	293	96	61	19
Sindh	16	9	175	95	32	17
NWFP	91	45	188	96	32	16
Baluchistan	58	45	119	94	29	22

Table 1.11 Complementary Feeding Rates

	4 – 5 months (n = 307)		6 – 9 months (n = 997)	
	No	%	No	%
Pakistan	37	15	309	31
Urban	19	19	131	36
Rural	18	12	178	27
Gender				
Boys	19	14	152	31
Girls	18	16	157	30
Province				
Punjab	13	14	87	24
Sindh	17	21	87	40
NWFP	7	8	66	28
Baluchistan	0	0	69	40

Table 1.12 Immunization Coverage in children aged 12 - 23 Months (%)

	Card (n=287)	History (n=1848)	Card + History (n+2223)
BCG	3	72	75
DPT1	5	64	69
DPT2	3	53	56
DPT3	5	30	35
OPV1	2	78	80
OPV2	1	69	70
OPV3	3	34	37
Measles	4	49	53

Table 1.13 Weight-for-age data from MICS. % Children <5 years 2 standard devlations below standard distribution

	Mild	Severe
Pakistan	38%	13
Urban	36%	11
Rural	40%	14
Gender		
Boys	38%	13
Girls	38%	13
Province		
Punjab	37%	11
Sindh	44%	27
NWFP	37%	12
Baluchistan	28%	9

Table 1.14 Causes of Blindness (Prevalence of Blindness Survey 1987-90)

Province	Blindness prev. (%)	Cataract (%)	Corneal opacity (%)	Refractive errors (%)	Glaucoma (%)	Others (%)
Sindh		73.6	11.6	6.9	2.5	5.5
Baluchistan	2.67	57.1	19.4	17.4	4.8	1.3
NWFP	1.00	70.1	16.5 *	7.5	-	6.0
Punjab	2.17	66.1	3.0	13.8	4.6	12.6
Pakistan	1.78	66.7	12.6	11.4	3.9	5.4

* 9% trachoma, 7.5% other causes of corneal opacity.

Table 2.1 - Summary of community based vitamin A intervention trials in Asia to reduce pre-school child mortality (> 6 months of age). Bellagio meeting on VAD & childhood mortality

Trial Country	Aceh Indonesia	W. Java Indonesia	Madurai S. India	Hydera-bad India	Sarlahi Nepal	Jumla Nepal
Ecology	Tropic	Tropic	Drought	Seasonal	Seasonal	Hills
Protein energy status	Stunted	Stunted	Wasted Stunted	Wasted Stunted	Wasted Stunted	Wasted (stunted)
Interven. Form Dose IU Frequen.	 Capsule 2000,000 q 6 mo	 MSG+VA 620 daily	 Liquid 8,333 weekly	 Capsule 200,000 q 6 mo	 Capsule 200,000 q 6 mo	 Capsule 2000,000 once
Design	RCT	FT	DMRCT	DMRCT	DMRCT	RCT
Unit	village	village	cluster	village	ward	sub district
No. units	450	10	206	84	261	16
Age at base-line in months	12-71	12-60	<72	12-59	6-60	6-59
Compliance	82%	High, passive	91%	92%	92%	88%
Sample size	21,147	8,867	15,141	12,217	28,630	6,139
Follow up	96%	NR	High	90%	96%	100%
Mort rate/1000: Vitamin A Control	 4.9 7.4	 16.9 31.1	 4.8 10.5	 5.5 5.85	 11.5 16.4	 86.8 122.3
Rel. Ris. 95% LL 95% UL	0.66 0.44 0.97	0.54 0.40 0.71	0.46 0.30 0.71	0.94 NR NR	0.70 0.56 0.88	0.71 0.55 0.92
% Reduction in mortality	34%	46%	54%	6%	30%	29%
Journal	LANCET 1986	AJCN 1988	NEJM 1990	LANCET 1990	LANCET 1991	BMJ 1992

DMRCT Double-Masked, randomised community trial
RCT Randomised Community Trial
FT Field Trial
NR Not Reported

Table 2.2 - Clinical Classification of Xerophthalmia (WHO 1981 Revision)

XN	Night Blindness
X1A	Conjunctival Xerosis
X1B	Bitot's spots
X2	Corneal Xerosis
X3A	Corneal ulceration / Keratomalacia < 1/3 Corneal surface
X3B	Corneal ulceration / Keratomalacia >= 1/3 Corneal surface
XS	Corneal Scar
XF	Xerophthalmic Fundus

Table 2.3 - Causes of VAD among young children

Immediate	• Low vitamin A and fat dietary intake • High incidence of diarrhoeal disease and measles • Low birth weight • Maternal deficiency of vitamin A • Breast-feeding of short duration and non-exclusive in first 6 months • Inadequate complimentary diet and feeding practices
Underlying	• Poor health infrastructure for services or programs (including, measles immunization) • Low production of vitamin A rich foods • No kitchen garden • Poor marketing / distribution / storage / preservation of vitamin A rich foods • Inadequate caring capacity (including maternal time) and practices • Intra-household food, health and care mal-distribution • Maternal awareness / education/ literacy
Basic	• Poverty with early childhood deprivation (marked by high prevalence of stunting) • Poor economic or physical access to markets • Little or no productive land • Seasonality of disease and food availability • Other environmental considerations • Other cultural considerations • Low status of women • Other considerations on the political system

(ACC/SCN State of the Art Series, Nutrition Policy Discussion Paper No 14 Controlling vitamin A Deficiency 28 - 30 July 1993, Ottawa, Canada)

Table 2.4 Epidemiological distinction between mild and corneal xerophthalmia

	Mild (XN, X1)	Corneal (X2, X3)
Age (peak incidence)	3-6 years	1-4 years
Protein energy malnutrition	Usually mild	Usually severe
Precipitating illness: (e.g. gastroenteritis, exanthematous disease, particularly measles, respiratory disease	Uncommon	Common

Table 2.5 Classification of xerophthalmia and prevalence criteria constituting a public health problem (prevalence in children <72 months)

Criteria		Minimum prevalence
Night Blindness	(XN)	1.00%
Bitot's spots	(X1B)	0.50%
Corneal xerosis and / or ulceration	(X2, X3A, X3B)	0.01%
Xerophthalmia related corneal scar	(XS)	0.05%

Table 2.6 - Prevalence of VAD in children equal to or > 1 year age of serum values equal to or < 0.7 μmol / L

Level of public health problem	**Prevalence**
Mild	> 2- < 10%
Moderate	>10- < 20%
Severe	> 20%

Table 2.7 Prevalence of a positive RDR or MRDR and minimum sample sizes for identifying a VAD public health problem

Level of importance as a public health problem	Prevalence RDR (>20%)	Prevalence MRDR (>0.06)	Minimum Sample Size[a]	
			20%	50%
Mild	<20%	< 20%	-	-
Moderate	>20%-<30%	>20%-<30%	395	62
Severe	>20%	> 0%	225	36

[a)]Minimum sample size for anticipated prevalence with relative precision of 20% and 50% at the 95% confidence level[50].

Table 2.8 Treatment schedule for xerophthalmia

Timing	Dosage	
	13-72 months, or >8kg	**<12 months, or < 8kg**
Immediate upon diagnosis	200,000 IU orally, or 100,000 IU injection*	100,000 IU orally, or 50,000 IU injection*
Next day	200,000 IU orally, or 100,000 IU injection*	100,000 IU orally, or 50,000 IU injection*
Within 1-4 weeks If clinical deterioration occurs Every 2-4 weeks for persistent kwashiorkor	200,000 IU orally, or 100,000 IU injection*	100,000 IU orally, or 50,000 IU injection*

* IM injection

Table 2.9 - Findings of studies on vitamin A deficiency in children in Pakistan

Year	Author	Study population	Findings	Comments
1961- 63	UNICEF Report 1990	5-12 years	X1B = 2-3%	Number not specified
1965-66	UNICEF Reports 1990	8831 (all ages)	X1b= 3.26% (Pregnant mothers) X1b= 3.9% (Lactating) Low serum levels of Vitamin A= 34 % of Population.	Children not mentioned separately
76-77	National Micronutrient survey (WHO Report)	Preschool children	X1B 1.5% Serum Retinol <0.70 umol/L 13% in school children	Marginal Serum Vitamin A levels in lactating mothers was 2.1%
1987		Orangi, Karachi	X1B= 3.8%	Sample size not given
1981	Nutritional status of infants and children. Survey Report for Gawadar, Kalat and Loralai districts of Baluchistan by Investment Advisory Centre of Pakistan for UNICEF	Age 0-6 years	Gawadar district Bitot's spots=4.81% Loralai Keratomalacia=1.4% Bitot's spots= 11.11%	Keratomalacia has been reported very high. Reasons have not been given No data for Kalat district has been given
85-87	National Nutrition survey	10406 (under 5 years)	X1B 0.2 % Punjab= 0.3% Sind=0.1% NWFP=0.0% Baluchistan=0.4%	Night blindness was not investigated
1987	Plasma vitamin A and Carotene levels in Karachi population[70]	0-3 years=110 4-15 years=365 under 15 years=485 Adults =541	Xerophthalmia and thicken bulbar Conjunctiva =2.7% (M=3.7%, F=1.75%) Xerophthalmia and thicken bulbar Conjunctiva =26.2 % (M=37%, F=17.4%) Bitot's spots= 1.85% (M=2.3%, F=1.4%) Marginal Retinol deficient 10-19 ug % = 18 % Xerophthalmia and thicken bulbar Conjunctiva = 5.6% (M=4%, F=5.6%)	A total 1036 healthy individuals were examined

Year	Author	Study population	Findings	Comments
1993	Molla A, et al[62]	Age 6-60 months Number =532	No clinical signs seen Marginal Retinol deficient <0.20 ug /dl 46% Deficient Retinol <0.10 ug / dl 2%	Slums area of Karachi
Year Not give	Dr Hemraj Rathi Prevalence of Night blindness	Age 5-15 years 15-45 years > 45 years	M= 1.5%, F= 2.4% M=1.2%, F=9.0% M=2.2%, F=5.2%	Prevalence of NB in and response to vit. A therapy in District Tharparkar
1998	Paracha P.I, Jamil A. & Pakistan Institute of Community Ophthalmology Assessment of (Micronutrient status in Preschool children in NWFP Pakistan)	Age 6-60 months Number 3061 Number 2057	NB 2 (0.06%) X1B 17 (0.6%) Marginal retinol deficient <0.7umol/L 31.8% Deficient <0.35 umol/L 3.3%	Retinol deficiency was highest in central zone and lowest in southern zone

Table 4.1 - Sampling strategy for population based surveys

Stratum	Admin. Level	Number of units selected	Sampling Method
1.	District	2	"NRC" district – simple random sampling of districts without reported cases. "RC" district – district with highest estimated prevalence of blinding xerophthalmia
2.	Village	8	4 villages selected using simple random sampling in "NRC" district. 4 villages selected using optimally biased sampling in "RC" district.
3.	Household	Sufficient house-holds in each village to generate 200 children aged 0-6 years	An optimally biased sample was obtained by going to the poorest part of each village.

Figure 5.1 - Age and sex of children presenting with blinding xerophthalmia

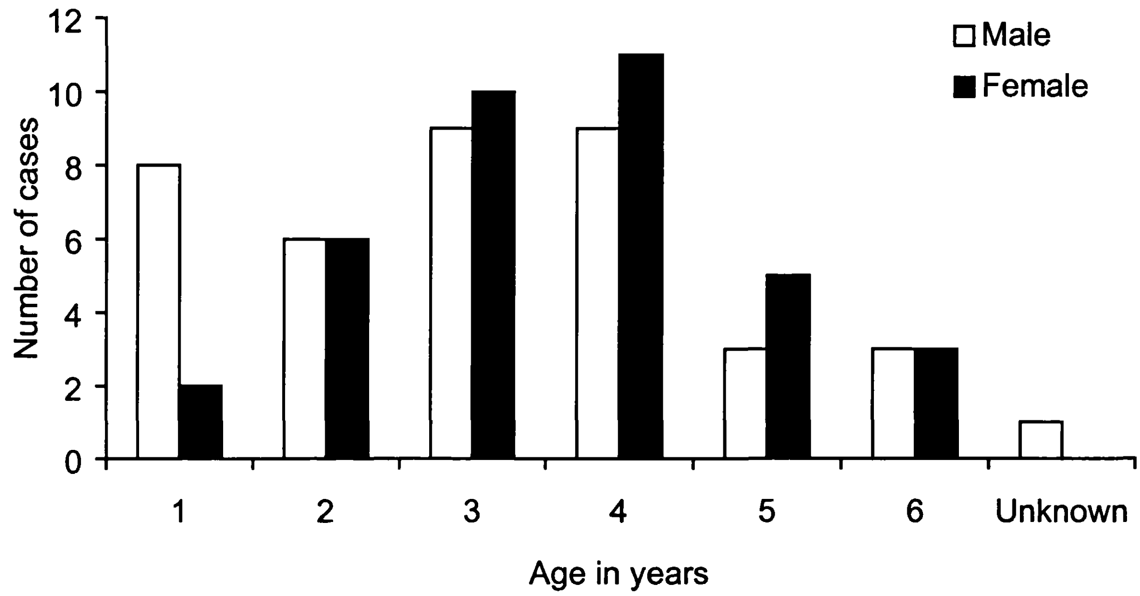


Figure 5.2 - Month of presentation of children with blinding xerophthalmia

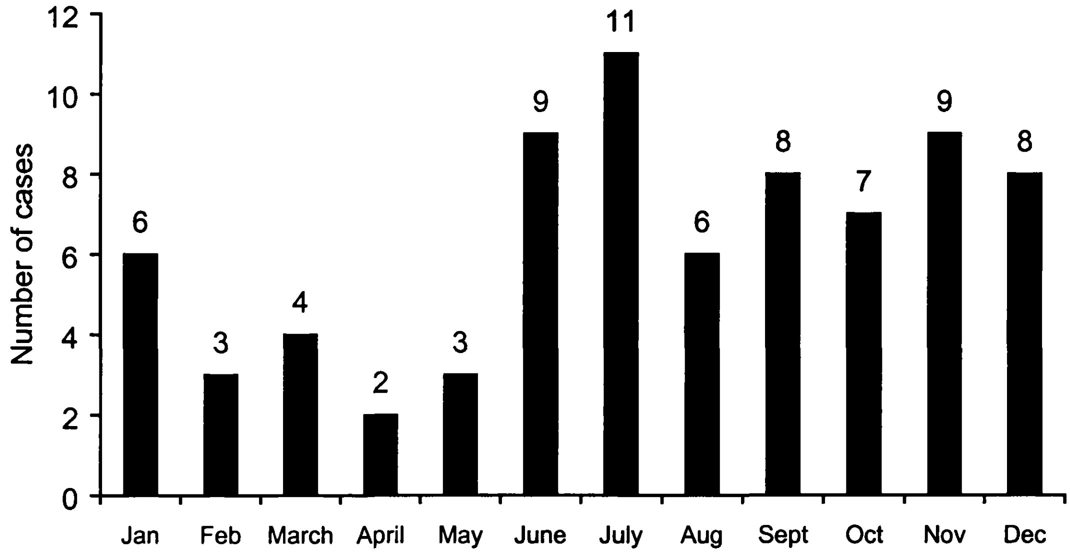


Table 5.1 - Place of identification of chiidren with blinding xerophthalmia

Where identified	Number	Percent
Out patient	53	69.7
Eye ward	20	26.3
Children's ward	3	3.9
Total	**76**	**100**

Table 5.2 Clinical signs in children with blinding xerophthalmia, by eye

	Right eye	Left eye
Normal eye	5	6
Corneal xerosis	25	27
Corneal ulcer	17	11
Keratomalacia < 1/3	11	14
Keratomalacia > 1/3	9	10
Corneal scar/phthisis bulbi	9	8
Total:	**76 eyes**	**76 eyes**

Table 5.3 Clinical signs in children with blinding xerophthalmia, by child

Clinical signs of VAD	Unilateral signs, one eye normal	Bilateral, symmetrical signs
Corneal xerosis	1	21
Corneal ulcer	6	8
Keratomalacia	4	17
Corneal scar/phthisis bulbi	0	6
Total:	**11 children**	**52 children**

Table 5.4 Estimated prevalence of blinding xerophthalmia in NWFP

District	Ophthal-mologist	Estimated total pop. (x 1,000)	Est. pop. aged 0-6 years (x 1,000)	Number of cases	Estimated prevalence/ million 0-6yr olds
NWFP:					
Peshawar	40	1,748	262	12	46
Swabi	1	915	137	11	80
Nowshehra	3	943	142	9	64
Haripur	1	756	113	5	44
Bunair	1	509	76	5	66
Charsada	2	1,048	157	5	32
Chitral	1	336	50	4	79
Kohat	1	913	137	3	22
Mardan	1	1,515	227	3	13
Swat	5	1,480	222	3	14
Dir	1	1,238	186	2	11
Khyber Agency	1	448	67	2	30
Batagram	0	534	80	2	25
S. Waziristhan	0	488	73	1	14
Laki Marwat	1	490	73	1	14
DI Khan	5	863	129	1	8
Shangla	0	No data	No data	1	No data
Bajaur Agency	1	456	68	1	15
Hangu	0	No data	No data	1	No data
Subtotal:		**14,680**	**2,199**	**72**	
Districts with no cases:					
With ophthalmo but no cases	16	5 districts		0	0
Total:	**81**				
Afghanistan:					
Ningar Har Afgh.		No data	No data	1	No data
Khost Afghanistan		No data	No data	1	No data
Punjab:					
Attock Punjab		No data	No data	1	No data
Not known:		No data	No data	1	No data
Total:				**76**	

Table 5.5 Age and sex of children presenting with blinding xerophthalmia

Age group (months)	Males		Females		Total	
	N	%	N	%	N	%
1-12	8	20.4	2	5.4	10	13.2
13-24	6	15.4	6	16.3	12	15.8
25-36	9	23.1	10	27.0	19	25.0
37-48	9	23.1	11	29.7	20	26.3
49-60	3	7.7	5	13.5	8	10.5
61-72	3	7.7	3	8.1	6	7.9
Unknown	1	2.6	0	0	1	1.3
Total	**39**	**100**	**37**	**100**	**76**	**100**

Table 5.6 Nationality of children with blinding xerophthalmia

Nationality	Number	Percent
Pakistani	55	72.4
Afghan Refugees	19	25
Others	2	2.6
Total	**76**	**100**

Table 5.7 Number of children living in the household

Children	Number	Percent
1	5	6.6
2	24	31.6
3-5	36	47.4
6 and above	6	7.9
Not Known	5	6.6
Total	**76**	**100**

Table 5.8 Number of family members in the household of affected children

Family members	Number	Percent
2-4	5	6.6
5-9	37	48.7
10-15	22	28.9
16 and above	6	7.9
Not Known	6	7.9
Total	**76**	**100**

Table 5.9 - Education of mothers of children with biinding xerophthalmia

Educational status	Number	Percent
No education	71	93.4
Some education	2	2.6
Not known	3	3.9
Total	**76**	**100**

Table 5.10 - Average monthly income, of families of affected children (Rs)

Monthly income	Number	Percent
<1500	35	46.1
1500-3400	28	36.8
3500-9900	3	3.9
Not known	10	13.2
Total	**76**	**100**

Rs 52.00 = 1US$

Table 5.11 Ownership of land by families of children with xerophthalmia

Ownership	Number	Percent
Owns land	15	19.7
Lease or rent land	2	2.6
Landless	52	68.4
Not known	7	9.2
Total	**76**	**100**

Table 5.12 Immunization status of children with blinding xerophthalmia

Immunization status	Number	Percent
None	19	25
Fully immunised	40	52.6
No measles immunisation*	23/71	32.4
Not Known	11	14.5
Total	**76**	**100**

* Only includes children over 9 months of age

Table 5.13 Systemic disease in 4 weeks preceding presentation

Systemic disease*	Number	Percent
Measles	3	3.9
Diarrhoea	48	63.2
Fever with cough	43	56.6
Fever with out cough	9	11.8

* One child may have reported more than one illness

Table 5.14 - Breast-feeding in children with blinding xerophthalmia

Adequacy of breast feeding	N	%
Adequately breast fed: (=12 months in children =12 months of age, and currently breast fed in children < 12 months)	51	67.1
Inadequately breast fed: (<12 months in children =12 months of age)	18*	23.7
Unknown	7	9.2
Total:	**76**	**100**

* Includes 7 children who were never breast fed

Table 5.15 Observations on villages included in the population-based surveys

Village	Observations in RC District (Swabi)
1 Shah-Mansoor	• Typical rural village • Child identified through surveillance was traced and examined • Many young people from the village work in Gulf States and send money home. • Slow and late start in this village because of delay in getting local LHWs.
2 Topi	• Many houses built with brick and stone, from compensation money after a dam was built nearby • Child identified through surveillance had died • Children with xerophthalmia lived very close to each other. • One child aged 8 years was found with Bitot's spot, treatment was given but not included in study.
3 Nabi	• Very active LHW • Team joined by member of social welfare organisation of the village. • Lying on bank of river Indus, people have access to fish in diet.
4 Afghan settlement	• No LHWs, but community health worker and traditional birth attendant assisted the field staff • Grade 5 and 6 school students accompanied the team, to explain and translate • Village leaders knew a lot of children in the village had night blindness, which improved after eating liver • Mobile population, and surveillance child could not be identified as the family had moved away
	Observations in NRC District (Malakand)
5 Zulamkot	• A dispersed village, with households more isolated than in other villages • Many households keep live stock • Homogeneous village with respect to socio-economic conditions • Active community welfare organisation • Village has had electricity for only 4 years
6 Pakistan Banda	• Very small village, with mainly mud built houses • Adjacent village included, which was more prosperous
7 Brah	• Good roads and many houses stone built • A measles epidemic had occurred over the preceding 4 weeks
8 Bazargai	• Very difficult access, as the village was on the top of a hill • Most households kept live stock • Households were spread out from each other, but everyone knew each other

Table 5.16 Number of children examined, by district, village and sex

District	Village	Male		Female		Total	
		N	%	N	%	N	%
"RC"	1	108	54.3	91	45.7	199	100
"RC"	2	108	46.4	125	53.6	233	100
"RC"	3	99	45.2	120	54.8	219	100
"RC"	4	105	50.0	105	50.0	210	100
	Subtotal:	**420**	**48.8**	**441**	**51.2**	**861**	**100**
"NRC"	5	103	48.6	109	51.4	212	100
"NRC"	6	106	52.0	98	48.0	204	100
"NRC"	7	109	54.2	92	45.8	201	100
"NRC"	8	89	44.1	113	55.9	202	100
	Subtotal:	**407**	**49.7**	**412**	**50.3**	**819**	**100**
	TOTAL	**827**	**49.2**	**853**	**50.8**	**1680**	**100**

No statistically significant difference in sex between those examined in the two districts (Chi sq test, p=0.7)

Table 5.17 Age of children included in the study

Age in years	N	%
1	323*	19.2
2	296	17.6
3	335	19.9
4	298	17.8
5	311	18.5
6	107	6.4
Unknown	10	0.6
Total:	**1680**	**100**

Table 5.18 Number of children examined, by district, village and age

District	Village	Examined	Age range	Mean age +/- SD
"RC"	1	199	1-72	32.2 +/- 20
"RC"	2	233	1-72	34.6 +/- 24
"RC"	3	219	1-72	34.7 +/- 20
"RC"	4	210	1-72	37.6 +/- 21
	Subtotal:	**861**	1-72	**35.1 +/- 21**
"NRC"	5	212	1-72	34.9 +/- 20
"NRC"	6	204	1-72	37.7 +/- 21
"NRC"	7	201	1-72	36.2 +/- 20
"NRC"	8	202	1-72	35.2 +/- 21
	Subtotal:	**819**	1-72	**36.5 +/- 21**
	TOTAL	**1680**		

There was no statistically significant difference in the mean ages between the districts (Kruskal-Wallis test, p = 0.22), and comparing the eight villages (Kruskal-Wallis test p=0.19).

Table 5.19 Number of households visited, by district and village

District	Village	Number of households	Percent
"RC"	1	98	13.6
"RC"	2	117	16.3
"RC"	3	112	15.6
"RC"	4	66	9.2
	Subtotal:	**393**	**54.7**
"NRC"	5	86	11.9
"NRC"	6	85	11.8
"NRC"	7	93	12.9
"NRC"	8	63	8.8
	Subtotal:	**327**	**45.4**
	TOTAL	**720**	**100**

Table 5.20 Children with xerophthalmia, by district and village

District	Village	Number examined	Children with xerophthalmia			
			All cases*	%	Excl. index case	%
"RC"	1	199	9	4.5	8	4.0
"RC"	2	233	8	3.4	8	3.4
"RC"	3	219	7	3.2	6	2.8
"RC"	4	210	15	7.1	15	7.1
	Subtotal:	**861**	**39**	**4.5**	**37**	**4.3**
"NRC"	5	212	3	1.4	NA	NA
"NRC"	6	204	2	1.0	NA	NA
"NRC"	7	201	7	3.5	NA	NA
"NRC"	8	202	2	1.0	NA	NA
	Subtotal:	**819**	**14**	**1.7**		
	Total	**1680**	**53**	**3.2**	**51**	**3.0**

* Includes index case   NA = not applicable

RR excluding index cases = 2.5 95% CI 1.4-4.6, Chi sq 6.3; p=0.001
RR including index cases = 2.6, 95% Ci 1.5 – 4.8, Chi sq 10.9, p=0.0009

Table 5.21 Eyes signs of vitamin A deficiency, by district

District	Night blindness		Bitots spots	
	N	%	N	%
"RC"	30	81	9	56
"NRC"	7	19	7	44
Total:	**37**	**100**	**16**	**100**

Table 5.22 Distribution of xerophthalmia by sex

Sex	Examined		Children with xerophthalmia	
	N	%	N	%
Male	827	49.2	29	3.5
Female	853	50.8	24	2.8
Total:	**1,680**	**100**	**53**	**3.2**

(RR = 1.25, 95% CI 0.70 - 2.2, MH Chi sq = 0.66, p = 0.41)

Table 5.23 Distribution of xerophthalmia by age group

Age group in years	Examined		Children with xerophthalmia	
	N	**%**	**N**	**%**
1	323*	19.2	0	0
2	296	17.6	4	1.4
3	335	19.9	7	2.1
4	298	17.8	15	5.0
5	311	18.5	20	6.4
6	107	6.4	7	6.5
Unknown	10	0.6	0	
Total:	**1680**	**100**	**53**	**3.2**

* 134 children were aged less than 6 months

Chi sq test for linear trend Chi sq = 15, p = 0.0001

Table 5.24 Distribution of xerophthalmia by ethnic group

Ethnic group	Number examined	Children with xerophthalmia	
		N	**%**
Pakistani/other/unknown	1,460	40	2.7
Afghan	220	13	5.9
Total:	**1,680**	**53**	**3.2**

(Odds RR 2.2, 95% CI 1.2-4.0, MH Chi sq = 6.3, p = 0.012)

Table 5.25 Comparison of villages by social development factors

	"RC" district (n=4 villages)		"NRC" dist. (n=4 villages)		Total (N=8 villages)	
	N	%	N	%	N	%
Mosque in the village	4	100	4	100	8	100
Primary health centre	4	100	2	50	6	75
Primary school	4	100	4	100	8	100
Secondary school	4	100	2	50	6	75
College in village	1	25	0	0	1	12
Tarred roads	3	75	2	50	5	50
Irrigated farms	3	75	1	25	4	50
Community groups	2	50	2	50	4	50

Table 5.26 Other village variables

% Houses	"RC" district (n=4 villages)	"NRC" district (n=4 villages)
% Houses with tap water	10 - 60	0 - 90
% Houses with well	40 -90	5 - 90
% Houses use pond water	0	0
% Houses with mains drainage	0 - 30	0 - 2
% Houses with electricity	70 - 95	50 - 90
% Female literacy	5 - 40	2 - 5

Table 5.27 (a) Socio-economic and other variables in households, by district

	"RC" district (n=393 hshds)		"NRC" district (n=327 hshds)		Unadjusted Rel risk [95% CI]	p value
	N	%	N	%		
Quality of house:					2.0 [1.8 - 2.3]	<0.001
Brick/ Stone	216	55.0	65	19.9		
Mud	151	38.4	250	76.5		
Ownership of TV:					2.0 [1.8 – 2.4]	<0.001
Yes	177	45.1	75	22.9		
No	132	33.6	251	76.8		
Electricity supply:					2.2 [1.6 – 3.1]	<0.001
Yes	357	90.8	229	70.0		
No	28	7.1	74	22.6		
Cleanliness of house:					2.2 [1.6 – 3.1]	<0.001
Clean	182	46.3	88	26.9		
Dirty / very dirty	197	50.1	230	70.3		
Water supply to house:					1.5 [1.2 – 1.9]	<0.001
Tap/well	321	81.7	241	73.7		
River/pond/none	45	11.4	75	22.9		
Sanitation in household:					1.3 [1.1 – 1.4]	<0.001
Flush system / Pit latrine	159	40.5	79	24.2		
None/other	221	56.2	209	63.9		
House ownership:					1.2 [0.99 – 1.4]	0.05
Own their own home	312	79.4	237	72.5		
Rent / other	73	18.6	79	24.2		
Number sleeping rooms:					0.7 [0.5 – 0.9]	0.001
4 or more	35	8.9	52	15.9		
1-3	334	85.0	235	71.8		
Land ownership:					0.6 [0.5 - 0.7]	<0.001
Own/lease land	120	30.3	173	52.9		
Landless	236	60.1	134	41.0		

Table 5.27 (b) Socio-economic and other variables in households, by district

	"RC" district (n=393 hshds)		"NRC" district (n=327 hshds)		Unadjusted rel risk [95%CI]	p value
	N	%	N	%	N	
Ethnic group:					0.52 [0.48 – 0.52]	<0.001
Pakistani	308	78.4	302	92.4		
Afghani	69	17.6	2	0.6		
Domestic animals:					0.4 [0.36 – 0.46]	<0.001
Any type of animal	189	48.1	304	93.0		
None	177	45.0	11	3.4		
Education of head of household:					0.64 [0.57 – 0.73]	<0.001
Some education	127	32.3	103	31.5		
No education	266	67.7	43	13.1		
Literacy of mother:					0.9 [0.75 – 0.98]	0.03
Yes	176	44.8	164	50.1		
No	201	51.1	133	40.7		
Father's job:					0.9 [0.78 – 1.02]	NS
Some regular income	202	51.4	188	57.5		
Daily labourer	156	39.7	114	34.9		
Education of mother:					0.86 [0.7 – 1.7]	NS
Some education	24	6.1	10	3.1	34	
No education	369	93.9	78	23.9	447	
Total income:					0.96 [0.78 – 1.2]	NS
>1,500 Rs/month	329	83.7	261	79.8		
<1,500 Rs/month*	46	11.7	33	10.1		
Use of cooking oil:					NA	NA
Daily	370	94.1	268	82.0		
Weekly	0	0	4	1.2		

Table 5.28 (a) Household risk factors for children with xerophthalmia:

	Household with case (n=49)		Household without case (n=671)		Unadjusted Rel. risk [95% CI]	P value
	N	%	N	%		
Ethnic group:					0.3 [0.2 - 0.5]	<0.001
Pakistani	30	71.4	580	90.8		
Afghani	12	28.6	59	9.2		
Literacy of mother:					0.3 [0.2 – 0.6]	0.003
Yes	11	24.4	329	52.3		
No	34	75.6	300	47.7		
Own domestic animals:					0.45 [0.25 – 0.8]	0.005
Any type of animal	25	54.3	468	73.7		
None	21	45.7	167	26.3		
Father's job:					0.44 [0.24 – 0.8]	0.001
Some regular income	16	37.2	347	60.6		
Daily labourer	27	62.8	243	39.4		
Use of cooking oil:					0.13 [0.05 – 0.36]	0.025
At least weekly	42	95.5	596	99.7		
Rarely	2	4.5	2	0.3		
Number of sleeping rooms:					1.08 [0.57 – 2.05]	NS
2 or more	33	73.3	438	71.7		
One only	12	26.7	173	28.3		
Electricity supply:					1.02 [0.47 – 2.51]	NS
Yes	41	85.4	545	85.2		
No	7	14.6	95	14.8		
Cleanliness of house:					0.92 [0.52 – 1.61]	NS
Clean	18	36.7	252	38.9		
Dirty / very dirty	31	63.3	396	61.1		
Land ownership:					0.65 [0.35 – 1.23]	NS
Own / lease land	14	34.1	279	44.9		
Landless	27	65.9	343	55.2		

Table 5.28 (b) Household risk factors for children with xerophthalmia

	Household with case (n=49)		Household without case (n=671)		Unadjusted Rel. risk [95% CI]	P value
	N	%	N	%		
Ownership of TV:					0.63 [0.33 – 1.21]	NS
Yes	12	29.3	240	40.4		
No	29	70.7	354	59.6		
Water supply:					0.66 [0.34 - 1.27]	NS
Tap/well	34	75.6	528	82.9		
River/pond/none	11	24.4	109	17.1		
Sanitation:					0.67 [0.36 - 1.24]	NS
Flush system / Pit latrine	13	27.1	225	36.3		
None/other	35	72.9	395	63.7		
Quality of house:					0.65 [0.36 -1.16]	NS
Brick/ Stone	17	37.8	264	41.4		
Mud	28	62.2	373	58.6		
Total income:					0.54 [0.27 - 1.07]	NS
>1,500 Rs/month	36	80.0	554	88.8		
<1,500 Rs/month*	9	20.0	70	11.2		
House ownership:					0.72 [0.39 - 1.34]	NS
Own their own home	34	72.3	515	78.7		
Rent / other	13	27.7	139	21.3		
Education Household head:					0.51 [0.26 - 1.0]	NS
Some education	11	27.5	219	43.9		
No education	29	72.5	280	56.1		
Education of mother:					NA	NA
Some education	0	0	34	7.7		
No education	37	100	410	92.3		

NA = cannot analyse

Table 5.29 Comparison of age in children with and without xerophthalmia

	Range (months)	Mean / SD (months)	Kruskal-Wallis Chi sq	p value
All children (n=1680)				
With VAD	18 - 72	50 +/- 14	29.9	<0.001
Without VAD	1 - 72	35 +/- 20		
Children >5 mns (n=1546)				
With VAD	18 - 72	50 +/- 14	23	<0.001
Without VAD	6 - 72	38 +/- 19		

Table 5.30 Childhood risk factors

	Child with xerophthalmia (n=53)		Child without xerophthalmia (n=1,527)		Unadjusted Rel risk	P value
	N	%	N	%		
Recent measles infection:					2.57 [1.28 - 5.13]	0.013
Yes	9	17.0	115	7.1		
No	44	83.0	1512	92.9		
Measles immunization:*					0.8 [0.47 - 1.60]	NS
Yes	38	74.5	1051	77.3		
No	13	25.5	309	22.7		
Sex:					1.25 [0.73 - 2.12	NS
Male	29	54.7	798	49.0		
Female	24	45.3	829	51.0		
Recent diarrhoea:					1.08 [0.59 – 21.98]	NS
Yes	14	26.4	404	24.8		
No	39	73.6	1223	75.2		
Recent fever with cough:					1.17 [0.68 - 2.03]	NS
Yes	20	37.7	556	34.3		
No	33	62.3	1064	65.7		
Recent infestation with worms:					1.05 [0.90 - 2.20]	NS
Yes	8	15.1	235	14.1		
No	45	84.9	1392	85.6		
Breast feeding:**					4.29 [0.60 – 30.8]	NS
Adequate	51	98.1	1435	92.0		
Inadequate	1	1.9	124	8.0		
Birth order:					0.92 [0.53 - 1.62]	NS
First or second born	18	34.6	588	36.5		
Later child	34	65.4	1022	63.5		
Child hygiene:					0.48 [0.19 - 1.20]	NS
Clean	5	10	285	19.1		
Dirty face and/or clothes	45	90	1206	80.9		

* Children aged 9 months of age and older only

** Adequately breast-fed = currently breast-fed if less than 12 months of age, or was breast-fed for at least 12 months in older children. Inadequately breast fed = never breast fed, or not currently breast fed if aged less than 12 months, or was breast fed for less than 12 months in older children.

Table 5.31 Estimated proportion of target population aged 0-6 examined in each village and district

District	Village	Estimated population 0-6 years	Number examined	Proportion of children aged 0-6 examined
"RC"	1	1800	199	11%
"RC"	2	3000	233	8%
"RC"	3	600	219	37%
"RC"	4	1800	210	12%
	Subtotal	**7200**	**861**	**12%**
"NRC"	5	900	212	24%
"NRC"	6	750	204	27%
"NRC"	7	600	201	34%
"NRC"	8	750	202	27%
	Subtotal	**3000**	**819**	**27%**
Total:		**10200**	**1680**	**16.5%**

The proportion of children examined in the "RC" district was statistically significantly less than in the "NRC" district (Chi sq= 362 P = < 0.001).

Table 5.32 - Distribution of VAD by village size

Estimated population aged 0-6 years	Number examined	Children with xerophthalmia	
Population more than 1500 (n = 3 villages)	642	32	5.0
Population less than 1500 (n = 5 villages)	1038	21	2.0
Total:	**1680**	**53**	**3.2**

Rel risk 2.46 95% CI 1.4 - 4.2, Chi sq = 11.4; p= <0.007

Table 5.33 (a) Household data in small and big villages

	Households in big villages (n=281)		Households in small viiiages (n=439)		Unadjusted Rel risk [95% Ci]	P value
	N	%	N	%		
Sanitation in household:					2.0 [1.7 – 2.4]	<0.001
Flush/pit latrine	143	52.4	95	24.1		
None/other	130	47.6	300	75.9		
Electricity supply:					2.2 [1.5 – 3.3]	<0.001
Yes	254	92.7	332	80.2		
No	20	7.8	82	19.8		
Ownership of TV:					1.9 [1.6 – 2.4]	<0.001
Yes	121	56.0	131	31.3		
No	95	44.0	288	68.7		
Quality of house:					2.7 [1.4 – 2.1]	<0.001
Brick/ Stone	148	54.8	133	32.3		
Mud	122	45.2	279	63.7		
Ethnic group:					0.3 [0.3 - 0.4]	<0.001
Pakistani	200	74.3	410	99.5		
Afghani	69	25.7	2	0.5		
Own domestic animals:					0.34 [0.29 - 0.41]	<0.001
Any type of animal	122	47.3	371	87.7		
None	136	52.7	52	12.3		
Land ownership:					0.42 [0.33 - 0.54]	<0.001
Own / lease land	63	25.0	230	56.0		
Landless	189	75.0	181	44.0		
Education Household head:					0.71 [0.54 - 0.85]	<0.001
Some education	97	34.5	133	51.6		
No education	184	65.5	125	48.4		
Father's job:					0.7 [0.58 - 0.84]	<0.001
Some regular income	129	50.2	261	64.8		
Daily labourer	128	49.8	142	35.2		

Table 5.33 (b) Household data in small and big villages

	Households in big villages (n=281)		Households in small villages (n=439)		Unadjusted Rel. risk [95% CI]	P value
	N	%	N	%		
Cleanliness of house:					1.35 [1.12 – 1.62]	0.001
Clean	126	46.0	144	34.0		
Dirty / very dirty	148	54.0	279	66.0		
Literacy of mother:					0.91 [0.76 - 1.10]	NS
Yes	131	48.2	209	52.0		
No	141	51.8	193	48.0		
Number of sleeping rooms:					0.89 [0.57 - 1.17]	NS
2 or more	178	69.3	293	73.4		
One only	79	30.7	106	26.6		
Water supply to house:					1.15 [0.88 - 1.50]	NS
Tap/well	220	84.3	342	81.2		
River/pond/none	41	15.7	79	18.8		
Total income:					0.92 [0.70 - 1.20]	NS
>1,500 Rs/month	240	87.3	350	88.8		
<1,500 Rs/month*	35	12.7	44	11.2		
House ownership:					0.94 [0.75 - 1.16]	NS
Own their own home	213	77.2	336	79.1		
Rent / other	63	22.8	89	20.9		
Education of mother:					0.90 [0.65 - 1.25]	NS
Some education	18	6.4	16	8.0		
No education	263	93.6	184	92.0		
Use of cooking oil:					NA	NA
At least weekly	264	100	374	98.9		
Rarely	0	0	4	1.1		

NA = cannot analyse

Table 5.35 Comparison of surveillance children with population based children with xerophthalmia

Source of cases	Sex	Age	Family income/month
Surveillance system (n=76 cases)	39 males (51.3%)	Range 3-72 mns Mean 3.4 years	Range 200 - 9,900 Rs Mean 2760 Rs
Population based survey (n=53)	29 males (54.7%)	Range 18-72 mns Mean 4.4 years	Range 0 - 9,500 Mean 3,440 Rs

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Appendix 1 – Form used in surveillance

EXAMINATION RECORD FOR BLINDING XEROPHTHALMIA

Date: ☐☐ ☐☐ ☐☐ Hospital Admission No.

Name .... Father's name: ....

Age : ☐☐ (in completed months) Sex Male ☐1 Female ☐2

Weight : ☐☐ ☐ (kgs) Height ☐☐☐ ☐ (cms)

Full postal address ....

District .... ☐☐

			R.E	L.E	
A:	Eye condition at presentation: [Tick one box for each eye]	corneal xerosis	☐1	☐1	
		corneal ulcer	☐2	☐2	
		keratomalacia	☐3	☐3	<1/3 of cornea
		keratomalacia	☐4	☐4	>1/3 of cornea
		Corneal scaring/ Staphyloma/phthisis	☐5	☐5	

Right eye Left eye

B: Person interviewed [Tick the relevant box]
- mother ☐1 father ☐3
- grand mother ☐2 other ☐4

C: Breast feeding: [Tick one box
- never breast fed ☐1 no longer breast fed ☐3
- currently breast fed ☐2 not known ☐9

D: Duration of breast feeding in months: ☐☐
[Complete the box] not known ☐

E: Illness within 4 weeks of presentation: [Tick all that apply]
- none ☐O
- measles ☐Y ☐N Fever with cough ☐Y ☐N
- diarrhoea ☐Y ☐N Fever with out cought ☐Y ☐N
- not known ☐9

F: Socio-economic status of head of house hold: [Tick one box]
- owner of land ☐1 land less ☐3
- rent/lease land ☐2 not known ☐9

G: Number of family members in the house hold earning an income: [Complete in box] ☐
not known ☐

H: Average monthly income of family:

[Complete the box] Rs. [ ][ ][ ][ ]

not known [ ]

I: Mother's education:

[Tick one box] mother died [ ]1

no schooling [ ]2

1-4 years schooling [ ]3

5 years or more [ ]4

not known [ ]9

J: Total number in household (i.e. resident for a t least 6 months)

[Complete the box] [ ][ ]

not known [ ]

K: Number of children, aged 0-6 years living in the family for 6 months or more:

[Complete the box] [ ][ ]

not known [ ][ ]

L: Immunisation: none [ ]0 not of measles [ ]2

[Tick one box] all [ ]1 not known [ ]9

M: Vitamin A treatment given: 200,000 I.U./100,000 I.U. Day [ ]1 day [ ]2 day [ ]14

Other comments:

Name of examining ophthalmologist ....

DISTRICT HEADQUARTER HOSPITAL ....

Appendix 2

EXAMINATION RECORD FOR BLINDING XEROPHTHALMIA (MANUAL)

INTRODUCTION:

- The examination record for blinding xerophthalmia has been developed to document children with blinding xerophthalmia seen by ophthalmologist in hospitals of NWFP, Pakistan.
- The aim is to document all cases of xerophthalmia occurring in province and to know the geographical distribution of these cases.
- Children aged 0-6 years only will be included in the study.
- Corneal ulcers because of vitamin A deficiency only will be included.
- Sick children presenting to pediatricians with xerophthalmia will be included in the study.

OBJECTIVES

1. To diagnose and record all cases of blinding xerophthalmia in children agreed 0-6 years presenting to eye departments in the province.
2. To develop a surveillance system for the recording of blinding xerophthalmia,.
3. To determine individual risk factors for blinding xerophthalmia
4. To determine the geographical distribution of blinding xerophthalmia in NWFP
5. To determine the public health significance of vitamin A deficiency in districts with affected children by undertaking population based surveys of children aged 0-6 years.
6. To plan an intervention strategy for the area if needed.

HOW TO USE RECORD FORM:

The examination record will be used for every child 0-6 years of age suffering from corneal xerosis, corneal ulcers and keratomalacia due to vitamin A deficiency. These children will need admission in eye wards. Each child will be given a hospital number. The hospital number will be entered in the form. The weight and height will be filled in with the help of pediatrics department of the hospital according to a standard procedure e.g. standard weighing scale and height chart.

Date: The date, when child presented to the hospital will be entered as day month and year. If a patient comes on 4th August 1996, the date entered will be 04 08 96. A patient presenting on 30th December 96 will be entered as 30 12 96.

Hospital Admission No: This is the number given to the child on admission in the ward.

Name: Name of the child will be written along with his/her father's name to help in the identification of child in future if needed. The name may also be written in local language (This will not be included in data processing)

Age: Enter the age of the child in completed months. If age of the child is 5 years and 2 months it will be entered as 62 months, 3 years and 2 months will be entered as 38 months.

Sex: Tick the relevant box for male or female child.

Weight: The children are weighed in normal clothes without shoes and with out warm clothes on a standard weighing scale used by paediatrics unit. Weight is recorded in kgs, to the nearest 0.1kg. Weight is recorded as 10.7kg.

Height: It is recorded to nearest 0.5cm. For example 120.7cm is entered as 121cm and 120.2cm, is recorded as 120cm.

Address: Write full postal address of the child including name of the village post office and the nearest known town.

District: Enter the name of the district where the child's parents are living.

Eye examination:

A: Eye condition at presentation:
Tick the condition of each eye under either right eye **(RE)** or left eye **(L.E).** If an eye has keratomalacia **and** corneal xerosis, the more advanced sight threatening condition should be recorded. In this case keratomalacia is recorded for the eye.

If an eye has corneal ulcer and corneal xerosis, the advanced sight threatening condition is recorded for the affected eye i.e. corneal ulcer. The eye examination record **should not** be filled in for corneal ulcers due to trauma, herpes simplex and suppurative keratitis etc. Draw the location of the pathology on the diagram for each eye.

B. Person interviewed: The information about the condition of the child will be more reliable if stated by the mother or grandmother. Try to interview the mother if possible. Tick the relevant box.

C. Breast Feeding: Tick one box for the child. **"Never breast fed"** means that child has not been given breast milk at all. Because the mother says, she does/did not have any breast milk, or does not want to breast feed her baby or because the mother died.

"Currently breast fed" means that the child is breast fed at least once a day.
"No longer breast fed" means that the child has been breast fed for some time but is no longer breastfed (this includes children who are breastfed occasionally but less than once a day).

D. Duration of breast-feeding: Tick one box. If the child has been breastfed for some time, ask about the duration of breast-feeding and enter accordingly in months.

E. Illness with in 4 weeks of presentation:
Tick all that apply.
"None" means child had no illness in the past 4 weeks.
"Measles" means typical rash and fever. Tick yes [Y] or no [No].
"Diarrhoea" means 3 or more liquid or semisolid stools per 24 hours .
Tick yes [Y] or no [N] accordingly.
"Fever with cough" means respiratory infection. Tick Y or N accordingly.
"Fever with out cough" means other parasites or infections causing fever.
Tick Y or N accordingly.

F. Socio-economic history:
Tick one box.
"Owner of land" means the family owns land.
"Rent\lease land" means the family has some land to cultivate but they are not the owner.
"Landless" means no land to own, rent or lease.

G. Number of earning members in the family: Ask about the number of members in the household who earn at least 200 **Rs.** each month.

H. Average annual Income of family: Tick one box only. Ask about average annual income of head of family in rupees and enter accordingly.

I. Mother's education: Tick one box only. If the person interviewed is not mother, ask about the mother's health. If she is alive, ask about the number of years she has been going to school and enter accordingly.

J. Total number In the household: Ask about the total number of people living in one house, including grand parents, uncles, uncles, aunts and children for the last 6 months and enter in box.

K. Total number of children aged 0-6 years: Ask about the number of children aged 0-6 years living i8n the household in the last 6 month and enter in the box.

L. Immunization: Ask about the history of immunization. If all has been done except measles or none has been done or it is not known.

M. Treatment given: Vitamin A must be given if the child is suffering from xerophthalmia.

Treatment schedule.

Child aged one year or older is given 3 doses, 200,000 IU day 1, day 2 and then after 2 weeks. Child aged less than one year or weighing less than 8 kg, 3 doses of 100,000 IU, day 1, day 2, then after 2 weeks. (100,000 IU is half capsule).

Other comments. Any other information about the child or his family is entered here if it has not been entered in about mentioned section.

Name of the examining ophthalmologist

If there is more than one ophthalmologist in a hospital the one who examined the patient, should enter his name in this section. The record form should be sent to Dr. M. Aman Khan, using the stamped addressed envelop on the 1st of every month to Centre for Community Eye Health Lady Reading Hospital PO Box 125 GPO Peshawar Pakistan.

If no children were seen during a particularly month, return the envelop empty.

Appendix 3 - PROFORMA FOR VILLAGE RISK FACTORS

District No [ ] Village No [ ][ ]

1) Who interviewed: (Tick one box)
- [ ] 1 Imam
- [ ] 2 Other leader

2) Population - all [ ][ ][ ][ ][ ]

3) Population - 0-6 yrs [ ][ ][ ][ ][ ]

4) Mosque in village (Tick one box)
- [ ] 1 Yes
- [ ] 2 No

5) Health Facility (Tick one box)
- [ ] 1 Yes ______________
- [ ] 2 No

6) Roads feeding village: (Tick one box)
- [ ] 1 Tarred
- [ ] 2 Untarred

7) Agriculture: (Tick one box)
- [ ] 1 Irrigated fields
- [ ] 2 Not irrigated

8) Piped drainage in [ ][ ] % houses

9) Electricity supply in [ ][ ] % houses

10) Literacy women 15 yr+ [ ][ ] % women

11) Water supply: (Complete all boxes)
- Tap supply [ ][ ] % houses
- Well supply [ ][ ] % houses
- Pond/river supply [ ][ ] % houses
- Other [ ][ ] % houses

12) Primary school: (Tick one box)
- Boys only [ ] 1
- Girls only [ ] 2
- Boys and girls [ ] 3
- None [ ] 4

13) Secondary school: (Tick one box)
- Boys only [ ] 1
- Girls only [ ] 2
- Boys and girls [ ] 3
- None [ ] 4

14) College: (Tick one box)
- Boys only [ ] 1
- Girls only [ ] 2
- Boys and girls [ ] 3
- None [ ] 4

15)Food supplementation: (Tick one box)
- [ ] 1 Yes
- [ ] 2 No

16) Comm. organisation: (Tick one box)
- [ ] 1 Present and active
- [ ] 2 Present, but not active
- [ ] 3 None

Appendix 4: MANUAL FOR VILLAGE RISK FACTORS

	FIELD	CODES	COMMENTS
	District No	1-	Number each District in study, starting with 1
			Name of districts
		1	
		2	
	Village Number	1-	Number each village visited in the Districts, starting with 1. Give each village a unique number
			Name of Village
		1	
		2	
		3	
		4	
		5	
		6	
		7	
		8	
		9	
		10	
1	Who interviewed	1,2,9	1= Imam, 2= Other leader, 9 = not recorded
2	Population - all		Enter estimate of total population. 99999 = unknown
3	Population - 0-6		Enter estimate of number of children aged 0-6 years. 99999 = unknown
4	Mosque in village	1,2,9	Refers to mosque in the village 1 = yes, 2= no, 9 = not recorded
5	Health facility	1,2,9	Refers to health facility in the village 1 = yes, 2 = no, 9 = not recorded

	FIELD	CODES	COMMENTS
6	Roads feeding village	1,2,9	Refers to the state of the roads leading to the village, not within the village 1 = yes, 2 = no, 9 = not recorded
7	Agriculture	1,2,9	Refer to whether the majority of the field are irrigated 1 = yes, 2 = no, 9 = not recorded
8	Piped drainage	%, 99	Enter the % of houses that have a piped drainage system 99 = unknown
9	Electricity supply	%, 99	Enter the % of houses that have an electricity supply 99 = unknown
10	Literacy in women 15 yrs +	%, 99	Enter the % of women aged 15 years or older who can read and write 99 = unknown
11	Water supply	%, 99	Enter the % houses that have the different types of water supply
12	Primary school	Tick box	Refer to whether a primary school is present in the village.
13	Secondary school	Tick box	Refers to whether a secondary school is present in the village.
14	College school	Tick box	Refers t whether there is regular food supplementation of preschool age children.
16	Community Organization	Tick box	Refers to any welfare organisation in the village. May be for any age group. Active means they meet regularly, and take an active part in village activities / decision making
	District No	1 or 2	Enter district number
	Village number	1 - 10	Enter village number
	Household number	1-	In each village give each household a unique number, starting with 1. Put number of village / house on door / lintel i.e. 1.9 where 1 = village number and 9 = house number
	Head of household		Name and gender of head of household NB Make an extra field in Epi-Info for gender 1=male 2=female

Appendix 5 PROFORMA FOR HOUSEHOLD RISK FACTORS

District No ☐ Village No ☐☐ Household No ☐☐☐ Head of h'hold________________

1) Education: ☐☐ yrs, household head; ☐☐ ys, mother

2) Can mother read: 1 Yes; 2 No

3) Ownership of house: 1 Own house; 2 Rent house; 3 Other

4) Quality of house: 1 Brick; 2 Stone; 3 Mud

5) Sleeping rooms in house ☐

6) Total living in house: (at least 6 months) ☐☐ persons

7) Children 0-6 years: (at least 6 months) ☐☐ children

8) Land ownership: Tick one box — 1 Own land; 2 Lease land; 3 Landless; 9 Unknown

9) Livestock: Tick one box — 1 CowsC/buffaloB; 2 SheepS/goatsG; 3 C or B and S or G; 4 None of these

10) Water supply: Tick one box — 1 Tap water; 2 Well; 3 River/pond; 9 Other

11) Electricity in home: Tick one box — 1 Yes; 2 No

12) Who feeds kids: Tick one box — 1 Mother; 2 Grand mother; 3 Other

13) Time to collect water Tick one box — 1 <10 mins; 2 >10 mins

14) Sanitation in house: 1 Flush; 2 Pit latrine; 3 Other/none

15) Household clean: 1 Clean Recently swept; 2 Dirty Veg/other rubbish; 3 V dirty Human/animal faeces

16) Ownership: 1 TV; 2 Radio; 3 Bicycle; 4 Watch

17) Use cooking oil: 1 Daily; 2 Weekly; 3 Less

18) Veg. eaten weekly: 1 Potato; 2 Carrots; 3 Bindi Kadu; 4 Spinach

19) Meat eaten by kids: 1 Daily; 2 1-3/week; 3 Monthly; 4 Rarely

20) Staple diet: 1 Rice; 2 Wheat; 3 Mixed

21) Availability flour: 1 Always; 2 Sometimes; 3 Never

22) Ethnic group: 1 Pakistani; 2 Afghani; 3 Other

23) Father' job: 1 Farmer; 2 Business; 3 Other

24) Income of H of H: ☐☐☐☐ Rs

25) Income of mother: ☐☐☐☐ Rs

26) Total income members: ☐

Comments:

Appendix 6 - PROFORMA FOR CHILDREN

District No [ ] Village No [ ][ ] Household No [ ][ ][ ] Head of h'hold________________

ID number of child: [ ][ ][ ][ ][ ] Name of child: ________________________________

Address: ____

1) Age of child: [ ][ ] months

2) Sex of child: (Tick one box) [ ] 1 Male; [ ] 2 Female

3) Weight in kgs: [ ][ ] . [ ]

4) Height in cms: [ ][ ] . [ ]

5) Mid arm circ, in cms: [ ][ ]

6) Who interviewed: (Tick one box) [ ] 1 Mother; [ ] 2 G'mother; [ ] 3 Father; [ ] 4 Other______

7) Who feeds child: (Tick one box) [ ] 1 Mother; [ ] 2 G'mother; [ ] 3 Father; [ ] 4 Other __________

8) Birth order: [ ][ ]

9) Education, carer [ ][ ] years

10) Total no in house: [ ][ ]
(Living for at least last 6 months)

11) Children 0-6 years [ ][ ]
(Living for at least last 6 months)

12) Breast feeding: (Tick one box)
[ ] 1 Never
[ ] 2 Has been if this No months breast fed [ ]
[ ] 3 Currently bf No months breast fed [ ]
[ ] 9 Not known

13) Recent illness (within one month, or current):

	Yes	No	Not known
Diarrhoea (Tick one box)	[ ] 1	[ ] 2	[ ] 3
Measles (Tick one box)	[ ] 1	[ ] 2	[ ] 3
Fever with cough (Tick one box)	[ ] 1	[ ] 2	[ ] 3
Fever no cough (Tick one box)	[ ] 1	[ ] 2	[ ] 3
Other	[ ] 1	[ ] 2	[ ] 3

14) Measles immunis. (Tick one box) Yes [ ] 1 No [ ] 2 Not known [ ] 9

15) Child's hygiene: (Tick one box)
[ ] 1 Very clean
[ ] 2 Dirty face, clean clothes
[ ] 3 Dirty face + clothes
[ ] 9 Not examined

16) Eye signs:

	Yes R	No R	Not examined R		Yes L	No L	Not exam L
Tick one box	[ ] 1	[ ] 2	[ ] 9	Night blindness	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Bitot's spot	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Corneal xerosis	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Corneal ulcer < 1/3 cornea (keratomal.)	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Corneal ulcer >1/3 cornea (keratomal.)	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Corneal scar	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Phthisis bulbi	[ ] 1	[ ] 2	[ ] 9
Tick one box	[ ] 1	[ ] 2	[ ] 9	Other, ______________________	[ ] 1	[ ] 2	[ ] 9

17) Child has VAD [ ] 1 [ ] 2

18) Child given vitamin A [ ] 1 [ ] 2

Interviewer/examiner: ______________________________

Appendix 7. MANUAL FOR XEROPHTHALMIA IN CHILDREN

	FIELD	CODES	COMMENTS
	District No		
1.	Age of the child	Age in Months	Record the actual age in completed months e.g. two year and 10 days will be 24 months.
2.	Sex of child.	Male or Female	Tick the appropriate box
3.	Weight in kilograms:	Actual weight	Record the weight in kilograms to the nearest = 0.1 mark. weight the baby without shoes and worm cloths.
4.	Height in centimetres	Actual height	Record the height in Cm to the nearest 0.5 mark, without shoes.
5.	Mid arm circumference in centimeters	Actual length	Measure the mid arm circumference in Cm.
6.	Who interviewed	1,2,3,4	1= mother 2= grandmother, 3= father , 4= other
7.	Who feeds the child	1,2,3,4	Person who is generally responsible to give food, milk to the child 1=months 2= other, 3=Father, 4= other
8.	Birth order	Actual number	Mention on which number the child was born, 1^{st}, 3^{rd}, or 5^{th},
9.	Education, career	Number in year	Years of education of the person, who cases for the child
10.	Total number in the home	Actual number	Enter the number of persons living in the houses, living for at least 6 months. Do not count guests.
11	Children 0-6 years	Actual number	Enter the number of children below 6 years living in the house for the last 6 months

	FIELD	CODES	COMMENTS
12.	Breast feeding	1,2,3,4	1= breast feeding has never been done, 2= If breast feeding has been done then enter the number of months for which breast feeding has been done, 3= the child is currently breast fed. Indicate the number of months, 9= when it is not known whether breastfeeding has been done or not.
13.	Recent illness	Yes, No	Tick in the box whether, the child was having the disease or not
14.	Measles Immunisation	Yes, No, not know	Enter Yes or No or 9 if the interviewer does not know.
15.	Child's Hygiene	1,2,3,9	1= Clean face, Clean clothes, 2= face is dirty clothes are clean, 3= dirty face and dirty clothes, 9= when child is not observed for this.
16.	Eye signs	Enter actual signs	Enter actual findings in front of each sign and 9 if it is not known.
17.	Child has VAD	Enter Y or N	After examining the eyes of the child, enter the actual clinical condition weather the child is having VAD or not.
18.	Child given vitamin A	Yes or No	Enter whether vitamin A was given or not.