A PILOT SURVEY TO ASSESS THE VITAMIN A STATUS OF CHILDREN AGED 6-72 MONTHS IN THE RAMU REGION OF PAPUA NEW GUINEA

By

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Arzt fur Augenheilkunde

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DECLARATION

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

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Nitin Verma

DEDICATED TO THE CHILDREN OF PAPUA NEW GUINEA

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Nitin Verma

FORWARD

"Every thousand mile journey begins with one small step"

Anon

The author was the Chief Ophthalmologist of Papua New Guinea from 1994 to 1997. This project was undertaken in response to a question of the vitamin A status of children in the country that remained unanswered for a long time and was the subject of some controversy and concern between the medical fraternity and the UNICEF representation in PNG.

The role of Vitamin A in the growth of children and in the maintenance of good health is becoming increasingly apparent, as are the subtle, yet serious, consequences of its deficiency. The classical ocular signs of Xerophthalmia subsequent to vitamin A deficiency (VAD) are a rarity in clinical practice in PNG. Observed ocular changes suggestive of VAD in PNG are often secondary to debilitating illnesses such as measles and tuberculosis in children. The problem of malnutrition in mothers and children is very real and the causes, multi-factorial. Deficiencies of other micronutrients possibly co-exist with VAD. These need to be addressed in addition, if one were to offer a holistic solution to the problem of high childhood morbidity and mortality that exists in PNG.

Based on an earlier study, Papua New Guinea has been classified by the WHO as a country where clinical Vitamin A deficiency exists and suggestions have been made to fortify foods so as to improve the intake of this vitamin. Singular administration of Vitamin A is fraught with the danger of taking the focus of involved governmental and non-governmental agencies away from the bigger problem of malnutrition and

infectious diseases, which are multifactorial in their occurrence. In addition, the dangers of Vitamin A toxicity are well known and therefore mass fortification of foods with the vitamin on a national scale needs to be looked at with some caution.

Papua New Guinea has a high infant mortality rate and it is quite possible that Vitamin A deficiency has some part to play in the increased prevalence of childhood infections. The per capita expenditure on health in many developing countries is low and PNG is no exception. Every dollar needs to be carefully spent and the health problems of the people and the possible solutions need to be addressed in a careful manner.

This pilot study was undertake to resolve this matter on a scientific basis and to pave the way for larger studies that need to be carried out in various parts of the country so that a national policy or guidelines could be formulated.

While the survey was going on, what can be described as one of the largest multi-disciplinary health patrols in the history of Papua New Guinea was carried out. Using boats, a barge, fixed wing aircraft and 2 helicopters, sixty health personnel were engaged in a nutritional survey, surgical eradication of cataract blindness, immunisation and provision of general medical services in one of the most remote and under served areas of Papua New Guinea. Feeding, housing, moving and looking after them in rural PNG was a task in itself. This effort was endorsed and supported by the PNG Department of Health and many Non Governmental organisations and individuals. Their help has been gratefully acknowledged earlier.

Health care delivery in developing countries is difficult because of many reasons and it is hoped that surveys such as this would in their own way give some direction to policy makers in the Government. This would give the people who participated ion the

survey a lot of satisfaction by making their efforts and personal sacrifice more rewarding and meaningful.

The main report attempts to be relevant to lay people without sacrificing content. I have left out a lot of details from the body of the report to try and make it uncomplicated and readable. I have tried to support the assertions with references and the figures and tables with statistical details but have not included any references to any appendix sections in order to keep the text and diagrams in the main body of the treatise, simple.

Nitin Verma

Darwin 2000

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LIST OF ABBREVIATIONS AND TERMS USED

ACC/SCN	United Nations Administrative Committee on Coordination/Subcommittee on Nutrition
AT	Alpha Tocopherol
AT/CT	Alpha Tocopherol/Cholesterol ratio
AUSAID	Australian Agency for International Development
BMI	Body Mass Index
CIC	Conjunctival Impression Cytology
CT	Cholesterol
DHS	Demography and Health Survey (1991-PNG)
DOH	Department of Health (PNG)
EPI	Expanded Program of Immunisation
FAO	Food and Agriculture Organisation of the United Nations
HAM	Height Age Median
HAP	Height Age Percentile
HAZ	Height Age Z Score
HKI	Helen Keller International
HPLC	High Pressure Liquid Chromatography
ICN	International Conference on Nutrition
ICT	Impression cytology with transfer
IDA	Iron deficiency anaemia
IDD	Iodine deficiency disorders
IEC	Information, education and communication
IMR	Infant Mortality Rate
IVACG	International Vitamin A Consultative Group
KAP	Knowledge Attitudes and Practice
MCH	Maternal and child Health
MDIS	Micronutrient Deficiency Information System
MOMASE	Morobe -Madang-Sepik (region in PNG)
MSG	Monosodium Glutamate
MUAC	Mid Upper Arm Circumference
NDOH	National Department of Health (PNG)

NGO	Non Governmental Organisation
NNT	Neonatal Tetanus
ORS	Oral Re-hydration Solution
ORT	Oral Re-hydration Therapy
PEM	Protein Energy Malnutrition
PMGH	Port Moresby General Hospital
PNG	Papua New Guinea
RDA	Recommended dietary allowance
RDR	Relative dose response
RE	Retinol equivalents
SEAR	South-East Asia Region
STD	Sexually Transmitted Diseases
UNICEF	United Nations Children's Fund
UNFPA	United Nations Population Fund
UPNG	University of Papua New Guinea
USAID	United States Agency for International Development
VAD	Vitamin A Deficiency
VAST	Vitamin A Supplementation Trials
VITAL	Vitamin A field Support Project
WAM	Weight Age Median
WAP	Weight Age Percentile
WAZ	Weight Age Z Score
WHM	Weight Height Median
WHO	World Health Organisation
WHZ	Weight Height Z Score
WPR	Western Pacific Region

SOME RELEVANT WORDS AND EXPRESSIONS IN

PAPUA NEW GUINEA PIDGIN

Aeroplane	balus
Baby	pikinini
Blood	blut
Boat	bot
Breast Feeding Mother	Susu mama
Doctor	dokta
Eye	ai
Food	kaikai
Faeces	pekpek
Green leafy vegetable	kumu
Injection	sut
Man	man
Medicine	marasin
Milk	susu
Mother	mama
Night blindness	ai tu tak long nait
Sweet potato	kaukau
Water	wara
Woman	meri

SYNOPSIS

Papua New Guinea has been classified by the World Health Organisation as an area where clinical vitamin A deficiency (VAD) exists. This is at variance with the experience of the local physicians who do not encounter classical VAD in clinical practice.

This pilot study was carried out to resolve this contradiction, since many suggestions have been made to fortify foods with Vitamin A. If done in the absence of concrete data to back up this classification, it could take the focus away from the real problem as well as potentially create problems of Vitamin A toxicity. Therefore, answers from this study could have far reaching implications in a country such as PNG, which has high childhood mortality and limited financial and manpower resources.

The objective of this study was to determine the vitamin A status and identify risk factors of VAD in children aged 6 months to 6 years in a rural area of Papua New Guinea.

The survey was carried out in the Ramu region of Madang province. Households and children were randomly selected and standard questionnaires were used to collect information about diet, previous illnesses and night blindness. The weight and height of all children was recorded and an ocular and physical examination carried out by trained personnel. In addition, haemoglobin estimation and examination of blood films for malaria parasites was carried out in all the children. In a randomly selected number of children, estimations of serum retinol and other micronutrient levels were carried out.

Results: A total of 609 children were enrolled in the study. Biochemical parameters were studied in 106 of them .The mean age of the children was 35 months. Possible night blindness was reported in 4 children. No xerophthalmia was seen. The prevalence of serum retinol levels ≤ 0.7 μmol/L (WHO suggested cut off values for subclinical VAD) was 10.3%. Anthropometric indicators indicated a high proportion of the children had stunting and wasting or both. Analysis of dietary patterns, maternal literacy, food availability and other surrogate indicators indicated that the population is at mild-moderate risk of developing VAD.

In conclusion, no evidence of clinical vitamin A deficiency was found. Subclinical vitamin A deficiency seemed to occur in this population at a level of mild-moderate public health importance. Further studies need to be carried out to assess the situation in different areas in PNG before policy decisions can be made with regards to mass vitamin A supplementation.

CHAPTER1:

WHAT WE DO KNOW- REVIEW OF LITERATURE

1.1 INTRODUCTION

The focus of this review is on the epidemiology of VAD and the situation of child health and VAD in PNG. An overview of the commonly used indicators of VAD is provided to justify the use and interpretation of these parameters. Pertinent facts about the public health aspects of its deficiency as well as evaluation of Vitamin A status in the studied population are elucidated in the sections below. The situation of maternal and child health in PNG is elaborated upon to create the background based on which the various global indices are discussed in the local context and suggestions are made for interventions and further research.

Vitamin A, its deficiency and consequences thereof have been the subject of much study and research. Our knowledge on the physiological role of Vitamin A in the body as well the manifestations of its deficiency are exhaustive and excellent references are available in the literature.

1.2 VITAMIN A (GENERAL)

Ocular manifestations of vitamin A deficiency, particularly night blindness, have been recognised for a long time. Animal research and clinical observations early in the twentieth century indicated that vitamin A was important for numerous bodily functions; animals and humans deficient in vitamin A grew poorly, suffered more persistent or severe infections, and subsequently developed characteristic ocular manifestations termed "xerophthalmia" or "dry eye"(Sommer et al, 1996). Vitamin A-deficient animals died prematurely of overwhelming sepsis, usually before developing xerophthalmia (Sommer et al1996).

Olson et al (1992) classified Vitamin A status into the following categories:

- deficient
- marginal
- satisfactory
- excessive
- toxic

Xerophthalmia clearly represents clinical findings in children who fit into the category of “deficient”. This is the penultimate stage before blindness develops and death occurs. This represents end stage VAD and is less commonly encountered than “marginal deficiency” which results from “precariously low” stores of Vitamin A and allows the patient to be readily pushed into a clinically apparent VAD (with eye signs) by relatively mild events (diarrhoea, fever, illnesses). This is in contrast to a ”sufficient” state in which there are enough reserves and the patient can weather stress or periods of reduced Vitamin A intake.

Plasma retinol concentrations of < 10μg/dL (0.35μmol/L) are associated with clinical signs of VAD whereas levels between 10-20μg/dL (0.35-0.70μmol/L) may be associated with Bitot’s spots and other signs of deficiency or be seen in a normal vitamin A sufficient child albeit plagued with infections. Body stores of Vitamin A can be assessed by isotope dilution studies. (Clifford et. al.1990)

1.3 EPIDEMIOLOGY OF VAD

Vitamin A deficiency occurs within an ambience of ecological, economical and social deprivations in the macro-environment in which populations are found (ie. regions and countries), and in the microenvironments in which families live (ie. communities and households). The relative influence of causal factors at both the macro-and micro-level will vary among countries, and even regions within countries, necessitating a situational analysis to understand and subsequently design appropriate and effective intervention programs to change specific undesirable situations. It is; therefore, with considerable reservation those national and global projections are applied to local situations. Nevertheless, there are some underlying epidemiological traits that tend to characterise most situations where VAD occurs as a public health problem (Sommer et. al.1996):

1.3.1 PERIODICITY

The seasonality of VAD is only partially related to ecological factors that influence food availability. The pattern of disease frequency is also important. VAD tends to reach its apex following the peak prevalence of diarrhoeal and respiratory diseases associated with flooding or lack of water. Overcrowded housing and contaminated environments associated with poor living conditions further contribute to the problem. Measles epidemics that occur under these conditions are especially devastating and often precipitate VAD, frequently resulting in blindness and death for many children (Sommer 1982).

1.3.2 ECOLOGICAL FACTORS

At the macro-level, hostile environments, eg. 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. Foods rich in Vitamin A include animal products (eggs, milk, cheese, liver, fish oils) which have a high availability of Vitamin A (70-90%) and vegetables containing provitamin A carotenoids which are less well utilised (dark green leafy vegetables, carrots, yellow sweet potatoes, mango, papaya, red palm). This applies particularly to vegetables (eg. green leafy vegetables), and fruits that require abundant water supplies and/or moderate temperature to grow. Where the necessary favourable growing conditions occur in food-scarce countries, even if only seasonally, national agricultural policies generally favour production of staples as food for local populations. 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. Even at community and household levels, however, the characteristics of a hostile environment, particularly where water is in short supply, limit home and community gardening activities and, as a consequence, the availability of inexpensive Sources of vitamin A. 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 with stable water supplies (Oomen et. al. 1973).

1.3.3 EDUCATION

Social underdevelopment 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 in social interactions where more modern concepts and practices are promoted (Sommer 1982). Due to under-education, they are less likely to learn from educational materials typically displayed at health centres and used in health-related community educational activities, including those concerned with appropriate child care and feeding practices. Under-educated males also are less likely to adopt within their household's 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. As noted above, these are prime conditioning factors for VAD and malnutrition (Mele et. al.1991, Nestel et. al.1993, and Hussain et. al.1993.Teilsch et. al.1986).

ECONOMIC FACTORS

1.3.4 POVERTY

Poverty is a root, though not invariable, cause of VAD in public health terms. Because only foods of animal origin contain preformed sources of vitamin A, which are generally relatively expensive, VAD is confined largely to impoverished countries, neighbourhoods and families which rely on less expensive provitamin A sources to meet their requirements. Provitamin A sources must be converted to retinol before they can provide protection from VAD. The series of events between consumption of provitamin A and its conversion to retinol include several steps that are dependent on normal physiological functions. It is more difficult to satisfy vitamin A-activity needs of infants and young children from foods of vegetable origin, which are cheaper than food from animal sources. (Sommer 1982)

Poverty contributes in other ways, some already noted, to inadequate living conditions that are associated with high death rates among infants and young children. Unemployment and low-wage jobs are major obstacles to overcoming VAD in depressed environments.

1.3.5 CLUSTERING

The occurrence of clinical VAD tends to cluster rather than to be evenly distributed. Clustering within countries at the macro-level is related to ecological factors noted above exacerbated by poorly developed infrastructures to distribute vitamin A-containing foods from excess-to deficient-areas. Because vitamin A-rich foods tend to be quite perishable, they are especially susceptible to inadequate intra--country distribution (Sommer 1981,1982).

Clustering has been described primarily based on the occurrence of clinical eye signs. Xerophthalmia has been found to cluster within provinces or districts, subdistricts, villages and even households. Population based surveys in Asia and Africa have shown that children living in villages where at least one other child has xerophthalmia are at a 1.2-2.3 times higher risk of having xerophthalmia than children where no other cases exist (Katz et. al.1993). Siblings of children with xerophthalmia in the same households are 7-13 times at risk of developing xerophthalmia as against children in xerophthalmia free households. It is likely to reflect the convergence of several risk factors that lead to depletion of vitamin A stores in the surrounding child population among which a few individuals who have been exposed to additional causal factors have developed clinical deficiency. For this reason severely sub-clinically

deficient populations of children up to 5 years of age, based on the distribution of serum retinol levels, are considered to be at as much at risk of severe morbidity and mortality as those populations experiencing clinical deficiency. Moderately sub-clinically affected populations are also likely to be at higher risk but the magnitude of risk is unknown.

1.3.6. HOST FACTORS: AGE

Varying levels of VAD can occur at any age, from subclinical effects that increase risk of morbidity and mortality to blinding malnutrition (keratomalacia).

The incidence of corneal xerophthalmia peaks after weaning, which in many cultures is between 2-4 years (Sommer et. al.1982). As a public health problem, VAD affects children of preschool 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. An increased risk of death of at least 60% is associated with severe, potentially blinding VAD malnutrition. The mortality risk associated with VAD of lesser severity extends at least from 6 months to 5 years of age, and perhaps beyond. The elevated risk of death among those less severely clinically affected, and severe to moderately sub-clinically affected, is estimated to be about 23%.

There is little information regarding the health consequences of VAD among school-age children. The prevalence of mild xerophthalmia, notably Bitot's spots, may be highest in the school-age group, although this may be more a reflection of past rather than current vitamin A status.

1.3.7 HOST FACTORS: GENDER

No consistent sex difference in vulnerability is demonstrated based on physiological parameters. Differences have been reported from some cultures, which are more likely to be related to sex differences in cultural practices of feeding and care rather than to physiological differences.

Boys are at a greater risk of developing mild xerophthalmia than girls during the preschool and early school years develop although this variation is not seen with severe Xerophthalmia (Sommer et. al.1996). This could be due to the cultural differences in the way boys and girls are cared for in populations.

In PNG girls start helping the mother in the household at a much earlier age (5-6 years) and assist in tending the garden, with household chores such as fetching firewood and cooking and are fully integrated in these roles by 10 years of age. Male children do not have a major role to play till they are physically capable of hunting, building houses and fishing. The child not only belongs to the parent but also to the community. The socialisation process in PNG is one of affiliation orientation in which group welfare comes before individual welfare. This is important in times of drought and famine where they all help each other and as evident in the recent tidal wave disaster in the country where children who were orphaned were immediately picked up and looked after by a clan member.

1.3.8:HOST FACTORS: PERIODS OF INCREASED PHYSIOLOGICAL NEED

a. FEEDING PRACTICES

Breast milk provides retinol in a readily absorbable form**.** Clinically apparent VAD

deficiency rarely occurs as long as a child is receiving breast milk. Nurslings of Russian mothers, severely malnourished from the Lenten Quadragisema fast, developed keratomalacia suggesting that a minimally adequate maternal diet was required to protect infants from early nutritional blindness (Blegvad et. al.1929). Depletion of an infant's body stores, leading to subclinical deficiency and consequent health risks, may occur by six months of age when maternal vitamin A status is inadequate and thus, breast milk vitamin A content is low. Breast fed infants rarely develop clinical VAD until the fourth year of life (Sommer et. al.1996). In general, he problem of subclinical depletion increases in significance between 6 months and 3 years of age during which complementary foods and later the family diets represents a large proportion of the infant's diet. These foods often do not contain vitamin A in amounts that adequately replace that provided from the diminishing contribution of breast milk. The diet of the newly weaned child frequently has very little vitamin A and often contains less fat than at any other period in the life cycle. Dietary fat is especially important for the absorption of vegetable sources of provitamin A. The post-weaning period, until a child has begun receiving a diversified family diet, is therefore one of great vulnerability to VAD.

b. DISEASE PATTERNS

The frequency, duration and seventy of infections contribute directly and indirectly to vulnerability to VAD. Infections influence appetite and are especially devastating for the weaned child. They also lessen efficiency of absorption, conservation and utilisation of vitamin A. Frequent acute infections damage mucosal surfaces required for absorption. Furthermore, intestinal worm infections may directly compete for uptake of vitamin A in addition to their more general impact on health by

suppressing appetite. The frequency of diarrhoeal and respiratory infections is associated with VAD vulnerability.

Disease prevalence rates, particularly diarrhoeal disease and febrile infections, are associated with depressed appetite, depressed absorption efficiency, and/or increased metabolic utilisation and urinary loss of vitamin A. Their prevalence can assist in identifying high-risk areas/populations. The synergistic relationship between diarrhoeal disease (DD) and VAD has been the focus of many epidemiological morbidity and mortality studies where vitamin A is concerned. The impact of vitamin A supplementation on diarrhoea incidence rates continues to be investigated. An increased risk of VAD, the severity of the diarrhoea episode, and hence the risk of fatality has been associated with DD at individual and population levels.

Vitamin A needs on a body-weight basis are increased during periods of rapid growth, which is one reason for the greater vulnerability of younger children. School-age children are growing but at a slower rate than at earlier ages, at least until adolescence. In areas where VAD is endemic, however, the prevalence of Bitot's spots in schoolchildren is often above that seen in younger age groups, and may not in fact be responsive to improved vitamin A status There is only limited information to determine if increased morbidity or mortality risks are associated with Bitot's spots in school-age children.

Other periods of increased physiological need are gestation and lactation. Women are vulnerable to VAD in these periods because of the increased need to provide for the developing foetus and, following parturition, to replace vitamin A transferred from maternal stores via breast milk to the nursing infant. Pregnant

and lactating women in underprivileged populations often report night blindness and studies have found that their breast milk frequently is low in vitamin A (breast milk vitamin A content reflects that of maternal diet and maternal vitamin A status). Little data is available to determine if there is an increase in morbidity or mortality risk to the mother that is associated with mild depletion of vitamin A stores. For this reason, pregnant and lactating women are not included in the global estimates of the at-risk population.

1.4: MAGNITUDE OF VAD

Surveys after the 1940's revealed that VAD was largely limited to developing countries. The World Health Organisation now classifies countries according to evidence of *subclinical* as well as *clinical* deficiency. There are 39 countries in which vitamin A deficiency is a clinically significant public health problem, and 11 countries where, sub-clinically, it is sufficiently prevalent and severe as to constitute a serious public health problem; 27 countries where this is the case in at least some regions; and 18 other countries where there is likely to be a problem. At least 5-10 million children develop xerophthalmia every year, of whom between a quarter and half a million go blind (Sommer et al 1981).

The World Health Organisation recently updated its information on the global prevalence of Vitamin A Deficiency (VAD) and established a databank as part of the Micronutrient Deficiency Information System (MDIS) which also covers iron and iodine deficiencies. In 1995 it was estimated that 3 million children aged 0-5 years were affected by xerophthalmia and 251 million were severely or marginally deficient. The classification of the various countries

according to the Vitamin A status of the population can be found in this excellent monograph.

Histopathological observations have demonstrated the importance of vitamin A for maintenance of normal epithelial integrity (Wollbach et al, 1920), thus providing one possible explanation for its role in resistance to infection. It has been shown conclusively that vitamin A also affects both humoral and cell mediated immune competence (Semba et. al.1994).

Recent data indicate that mortality rates are higher amongst children with mild vitamin A deficiency (Sommer 1983) and that, in many areas, improvement in vitamin A status can reduce the risk of mortality from childhood infections by as much as 19-54% (Beaton, et al, 1992, Sommer et al, 1992, Daulaire et al, 1992) .The reduction in mortality that results from improvements in vitamin A status exceeds what would be expected solely from reducing the numbers of deaths associated with xerophthalmia. Vitamin A deficiency appears to increase the risk of death even before xerophthalmia is clinically apparent. Vitamin A therapy reduces the severity of complications and the mortality rates associated with measles (Hussey et al, 1990). Improvement in community vitamin A status reduces the subsequent risk of measles mortality (Rahmatullah et al, 1990, West et al, 1991). Thus, WHO and UNICEF (1987) recommend vitamin A supplementation as part of the case management of measles in populations where vitamin A deficiency is known to is a problem or measles case-fatality rate exceed 1 %.

It is estimated that at least one million child deaths would be prevented each year if vitamin A nutrition were improved (Humphrey and West

1992). The impact of improved vitamin A status on preschool mortality varies from one population to another and depends on a wide variety of factors. These include severity and prevalence of pre-existing vitamin A deficiency; concomitant nutritional and related disorders; and the type, intensity, and frequency of prevailing infections and related factors (Beaton et. al.1992, Sommer et. al.1996).

All this prompted heads of state, ministers and other responsible officials to pledge to eradicate vitamin A deficiency and all its consequences, including blindness by the turn of the century (The World Summit for children (New York, 1990); The Policy Conference on Ending Hidden Hunger (Montreal 1991); the International Conference on Nutrition (Rome 1992) and the World Health Assembly (Geneva 1993)).

It is clear from the WHO data that there exists a significant VAD problem in parts of most countries in Africa, South and South East Asia, and some areas of Latin America and the Western Pacific. Generally speaking, VAD is not believed to be of public health significance in countries with established market economies. However, most of these countries have not recently conducted surveys that would detect subclinical deficiency amongst their less affluent populations. Details of VAD in the Western Pacific region and PNG are outlined in Table 1.1.

Table 1.1 VAD in the Western Pacific region (WHO 1996)

COUNTRY	YEAR		STATUS/COMMENTS
COOK ISLANDS	1989-92		NO VAD
FIJI			NO VAD LIKELY
KIRIBATI	1994		XEROPHTHALMIA 1.1%(KIRIBATI), GILBERT ISLANDS 1989 10.9% X1B. SUPPLEMENTATION PROGRAM COMPLETED
MICRONESIA	1988-89		X1N 14% AND X1B 6%. LOW SERUM RETINOL(15%<0.35 AND 64%<0.7
NAURU			NO DATA
PNG	**1990s 1993**		**ESP SERUM RETINOL 91%<0.7 AND 0.59% HAD VAD**
SAMOA			NO DATA
SOLOMON ISLANDS	1991		X1B PREVALENCE OF 1.42% AND XEROPHTHALMIA RATE OF 1.52%
TONGA			NO DATA
TUVALU	1991		NO XEROPHTHALMIA(NATIONAL SURVEY)
VANUATU	1991		NATIONAL SURVEY FOUND CORNEAL XEROSIS 0.05%

1.5 DEVELOPMENT OF VAD

There are many models put forward for VAD. A simple one is presented below: Vitamin A Deficiency is the result of two primary factors:

First, there is a *persistent inadequate intake of vitamin A* to satisfy physiological needs. This is frequently exacerbated by secondary dietary circumstances such as insufficient consumption of dietary fat, which leads to inefficient absorption of this micronutrient.

Secondly, a *high frequency of infections*. Infections depress appetite, prompting an elevation in the body's vitamin A utilisation and consequently the nutrient's inefficient conservation.

These conditions of deprivation are reflected in high infant and child mortality rates, which may be reduced to a degree by improved vitamin A status.

1.6 INDICATORS OF VITAMIN A DEFICIENCY (VAD)

An assessment of VAD is accomplished through surveys which are also helpful in identifying high risk populations for targeting interventions and providing a baseline for monitoring Vitamin A status and most importantly, stimulating action.

DEFINITIONS:

Clinical VAD: clinically apparent xerophthalmia reinforced, when possible by serum retinol levels of less than 0.35 μmol/L

Subclinical VAD: Tissue concentrations of Vitamin A low enough to have adverse health consequences even if there is no evidence of clinical xerophthalmia

1.6.1 INDICATORS:

The indicators of VAD used in this study are those suggested by the WHO (1996)

The indicators for VAD should be feasible, socially acceptable, obtainable under field conditions and be measurable at reasonable cost. They should act with sufficient sensitivity and specificity to assess reliably the magnitude and severity of the problem.

Cut off points have been established to grade the severity of the problem into mild, moderate and severe. The indicators in bold have been used in this study. For discussion of each indicator the reader is referred to texts published by the WHO (Indicators for assessing Vitamin A Deficiency and their application in monitoring and evaluating intervention programs. WHO 1996) which are easily obtainable.

1.6.2 CLINICAL INDICATORS

Normal Vitamin A Status implies that the individual has no physiological or pathological manifestations of VAD and has sufficient liver stores to protect against increased metabolic demands caused by disease or reduced absorption.

OCULAR SIGNS

The manifestations of VAD are related to serum retinol levels and are outlined in the Table 1.2.

Table 1.2 Serum retinol and clinical manifestations of deficiency

<1.0μmol/L	Impaired DA, abnormal CIC
<0.7μmol/L	Above changes accentuated, frank xerophthalmia may appear
<0.35μmol/L	frank xerophthalmia
Lower levels	Sepsis ,blindness and death

Table 1.3. Classification of xerophthalmia (Sommer 1996)

XN	Night blindness
XIA	Conjunctival XEROSIS
X1B	Bitot's spot
X2	Cornea Xerosis
X3A	Corneal ulceration/keratomalacia < 1/3 corneal surface
X3B	Corneal ulceration/keratomalacia > 1/3 cornea surface
XS	Corneal scar
XF	Xerophthalmic fundus

Table 1.4. Clinical Deficiency: Xerophthalmia

(In children 6-71 months of age (WHO 1996) **INDICATOR**	**MINIMUM PREVALENCE**
Conjunctival xerosis with Bitot Spots(XI B)	>0.5%
Corneal Xerosis/ulceration/ keratomalacia X2,X3,X3B	>0.01%
Corneal scars(XS)	>0.05%

Clinical signs and symptoms indicating that VAD is a problem are well established. When considering the subclinical biological indicators, one must remember that these are state of the art estimates and must be supported by another (a total of two) indicators at a level below the cut off value to conclude that a public

health problem exists. If only one indicator is used, then it must be strongly supported by other indirect demographic or ecological risk factors. This should then trigger off a response in terms of intervention, the modalities of which would depend on the severity of the VAD (WHO 1996).

1.6.3 SUBCLINICAL INDICATORS

NIGHT BLINDNESS

Night Blindness is a symptom included with xerophthalmia together with the other clinical eye signs. A prevalence of XN >1% in children 24-71 months of age indicates a public health problem. In addition, a serum level of retinol less than 0.35 μ mol/L is a strong corroborative evidence of any clinical criteria met to identify an urgent public health problem.

Table 1.5. Functional Indicators: Night Blindness

(Children 6-71 months of age- WHO 1996)

INDICATOR (cut off)	Mild	Moderate	Severe
Night blindness(XN) present at 24-71 months	>0-<1%	≥1-<5%	≥5%
Minimum sample size(20%)*	----	4706	1825
Minimum sample size(50%)*	----	753	292

*Minimum sample size for anticipated prevalence of 20% and 50% at the 95% confidence level

Assessment of night blindness by history taking has been validated in three studies (Sommer et. al.1980, De Sole et. al. 1987) in terms of its specificity and sensitivity of the of the procedure against other criteria and it is accepted that this is a reliable test for the diagnosis of VAD. The great advantage of this test is its simplicity,

non-invasiveness and speed. It is cheap and no laboratory facilities are required. The experience and skill of the interviewer plays a very important role. Attempts were made to train them well before the survey in this connection and standardise their approach in the pre survey workshop

Objective measurement techniques for assessing Night Blindness such as Vision Restoration Time (VRT) and pupillary and vision thresholds are being developed but are applicable to children 4 years and older and have not yet been standardised.

a. BIOCHEMICAL INDICATORS:

SERUM RETINOL

A normal well-nourished child will have enough liver stores to maintain a serum retinol level between 1-1.4μmol/L. Liver stores can be assessed directly by liver biopsy and assay in the excised specimens or indirectly by the RDR. The sample sizes for serum retinol as an indicator are outlined in Table 1.6.

Table1.6 Minimum sample size for anticipated prevalence with relative precision of 20% at 50% at 95% CI (WHO 1996)

LEVEL OF IMPORTANCE AS A PUBLIC HEALTH PROBLEM	PREVALENCE	MINIMUM SAMPLE SIZE 20%	MINIMUM SAMPLE SIZE 50%
MILD	≥2-10%	----	----
MODERATE	≥10%-<20%	865	139
SEVERE	≥20%	385	62

Some studies have shown that fewer than 5% of children with normal liver stores (as measured by RDR) have a serum retinol value less than 1.05μmol/L

The level of Serum retinol is a useful guideline and has been widely used to classify populations into mild, moderate and severe VAD (WHO 1996). The limitation of this parameter is that there are no defined levels of Serum retinol below which clinical manifestations of dysfunction are apparent. Though the widely accepted and recommended cut off values are ≤0.35μmol/lit (10μg/dl) for severe deficiency and between 0.35 and 0.70μmol/lit for moderate deficiency, there is enough evidence that the earliest clinical manifestations of deficiency can occur at levels above 30μg/dl (Sauberlich et. al.1974) which would otherwise be considered as a good level of serum retinol by the WHO classification. Studies in Indonesian children by Sommer et. al (1983) have demonstrated that the average serum retinol level in Indonesian children was 20μg/dl in the absence of any signs of clinical xerophthalmia.

It is important to point out that the cut off values for each country need to be defined keeping the local characteristics of infections, PEM and so on in mind (Sommer 1996). The classification suggested by Sommer (1996) has much merit in defining the Vitamin A status of populations using Serum retinol as an indicator. This concentrates on the possibility of clinical VAD in times of "stress". His suggestions are summarised below in Table 1.7.

TABLE 1.7 Suggested classification of VAD by serum retinol (Sommer)

Severe deficiency	High risk of blindness and death	<15µg/dl
Moderate deficiency	Increased risk of milder xerophthalmia ,serious infection and death	15-25µg/dl
Marginal deficiency		25-40µg/dl
Adequate/sufficient levels	Adequate stores in times of stress such as measles/gastroenteritis	≥40µg/dl

RETINOL BINDING PROTEIN

Retinol binding protein contains an anti parallel β barrel within its core within which all trans- retinol is bound. In well nourished adults the RBP levels are between 40µg/ml-50µg/ml, 80% of which exists as holo RBP. In children the levels are 60% of the adult level [24-30µg/ml](Olson et. al 1993, Soprano et. al 1994)

Retinol Binding protein is made primarily in the liver although MRNA has been identified in various other organs such as the kidney, adipose tissue, lachrymal gland and so on. The amount of RBP synthesised by non-hepatic sources is unclear. The Retinol binding protein circulates in the blood as either "holo RBP"(vitamin A molecule + RBP) or "apo - RBP"(bare RBP). The immunoassay techniques commonly used today do not differentiate between these two types and measure total RBP. The problem of high levels of apo - RBP in the final figure could give a misleading result.

VITAMIN E

Increased attention has been paid to the role of vitamin E. in human nutrition and disease viewing recent years. Vitamin E. plays an important role as the most potent natural fat-soluble anti-oxidant. It inhibits the oxidation of polyunsaturated fatty

acids of cell membrane lipids in by providing protons to free radicals thus protecting cells from the damage and lysis induced by oxidative stress.

Deficiency of vitamin E. in human occurs in children and young adults suffering from severe fat malabsorption. It has also been suggested that the anaemia of protein energy malnutrition may be caused by vitamin E. deficiency. Little information exists about the plasma vitamin E. levels of healthy children at different ages. Studies from Germany indicate that the mean values for vitamin E in the age group below 12 months was 879 $\pm$ 270 μg/dl and a mean of 1046 $\pm$ 283 μg/dl in children between 1 and 14 years (Laryea, Biggeman et al 1989).

All vitamin E. concentrations above 500 μg/dL were formerly regarded as the limit of normal for adults. Other investigators found a mean level of 590 μg/dl in the paediatric age group as compared to 790 μg/dl in adults. Since vitamin E. is bound to plasma lipids the ratio of plasma vitamin E. /lipids has been advocated in recent years as a more precise assessment of vitamin E. status. The criterion of 0.6 mg of vitamin E. /g of total lipid has been suggested as the lower limit of normal for children

b. HISTOLOGICAL INDICATORS: CONJUNCTIVAL IMPRESSION CYTOLOGY

Vitamin A deficiency generally means that the health of epithelial cells is compromised. The presence of vitamin A allows stem cells to transform into goblet cells while maintaining the columnar epithelial cells. Examination of cells obtained from the conjunctival surface on filter paper allows one to assess whether changes have occurred that are associated with VAD. Examination of conjunctival cells will reveal

sheets of small epithelial with an abundance of goblet cells. In vitamin A deficiency, the epithelial cells are flattened or enlarged with a marked reduction or absence of goblet cells.

Changes in conjunctival cell histology are a newer method of evaluating populations for VAD and are being increasingly used for this purpose. A disk applicator that has been developed allows better targeting of specimen location, is quicker, and generally provides a better quality specimen that, in turn, corresponds more closely to serum retinol levels (Keenum 1990). The disk applicator may be more widely accepted in clinics, while the hand-held strip is more exportable into homes and, in general appears less invasive.

Obtaining good samples is not easy, especially from young children. Someone who is well trained should do staining. This is all the more important where the CIC procedure is concerned since more processing steps are involved. A good reference Pathology laboratory is necessary. On the other hand, while specimen processing for ICT is simpler compared to CIC, the unreadable rate may be higher since the entire sample of cells is not transferred and available for evaluation.

PROBLEMS WITH INTERPRETATION:

Interpretation of slides is extremely important, and variability within and across studies has hindered this technique's widespread use. Standardisation exercises, therefore, become critical in evaluating inter- and intra- observer variability. In Thailand, it has been demonstrated that following 3 days of intensive field-worker training, there was approximately 70-90% agreement with an experienced trainer. Training should be

continued until Kappa values above at least 0.8 are achieved. It is important to have reference slides or photographs against which unknown slides can be compared. Possible ways of compensating for the subjective nature of this technique include having two readers and accepting as definitive only identical interpretations made by both. Discrepancies should be resolved by examining the slide further until a consensus is reached.

Performance of CIC or ICT against various standards reveals very different interpretations. The variability noted in the table is not surprising because each of the assessment indicators is measuring a different phenomenon in relation to vitamin A status. Probably the most logical comparison is between impression cytology and Bitot's spots because both indicators reflect different stages of altered cell morphology. The relatively low sensitivity and/or specificity relative to other non-ocular indicators of vitamin A status highlight the importance of using more than one indicator to assess subclinical vitamin A status to determine if an important public health problem exists.

There is no generally accepted reference standard for the classification of vitamin A status based on impression cytology readings. Currently three interpretation schemes are in use, one in which specimens are grouped as normal or abnormal based on the number of goblet cells or density of mucin spots and the other two with two additional intermediate gradations based on the quality of epithelial tissue. WHO recommends that an abnormal classification be made only when both eyes are observed to be abnormal, If a slide is available for one eye only, the following recommendation pertains: if the slide is normal, then the child is classified as normal; if the slide is abnormal, it should be classified as un - interpretable and the individual

excluded from the denominator for calculating prevalence rates since classification cannot be confirmed with a second impression.

The presence of mucin spots, which may be numerous in CIC specimens, has been difficult to interpret. With a defined training program by experienced personnel, specimen interpretation skills are said to be readily transferable. Based on general experience where such special training is not available, WHO recommends that interpretation of impression cytology specimens should be based exclusively on the morphology of the epithelial cells, and the presence and number of goblet cells. The prevalence suggested to identify a public health problem is shown earlier.

There is a higher probability of an abnormal reading in populations with a high incidence of inflammatory ocular diseases like trachoma and conjunctivitis. This technique cannot be used alone to determine the prevalence of VAD in such populations, ie. where the combined rate of conjunctivitis and trachoma is more than 5% of the population. Details of the prevalence of these two conditions in Coastal PNG are not known but the impression is that it is low.

The experience of most field staff has been that good quality impressions are difficult to obtain from children under 24 months of age. The technique is more easily replicated in children 24-72 months of age and older. Interpretation in older children and adults may be less reliable, however, due to non-responsive Bitot's spots and other changes in the conjunctiva which are not specific to vitamin A deficiency, eg. limbal vernal keratoconjunctivitis. Impression cytology has potential as an indicator of VAD for other age groups, in particular school children and pregnant

and lactating women.

Impression cytology reflects the long-term effects of vitamin A deficiency in population, ie. is slow to respond to change in vitamin A status, it is important to combine this indicator with an indicator of the acute VAD situation.

The specificity and sensitivity of CIC against other indicators is outlined in Table 1.8.

Table 1.8. Comparison of the sensitivity and specificity of impression cytology against different indicators of VAD

Reference Standard	Sensitivity	Specificity	Reference
Bitot's spots	95	78	Wittpenn (1986)
XN + Bitot's spots	93	94	Natadisastra (1987)
RDR	26	88	Resnikoff (1989)
RDR	23	80	Gadomski(1992)
Serum (μmol/L) <0.35	75	48	Resnikoff'(1989)
<0.70	62	63	
<1.05	59	100	
<0.70	26	81	Gadomski(1992)

.

Table 1.9: Prevalence of abnormal impression cytology in children 24-71 months of age and minimum sample size for identifying a VAD as a public health problem (WHO 1996)

Level of importance as a public health problem	% abnormal	Minimum Sample Size 20%	Minimum Sample size 50%
Mild	<20		62
Moderate	≥20-<40	385	24
Severe	≥40	145	24

1.6.4 ECOLOGICAL AND RELATED INDICATORS ASSOCIATED WITH RISK OF VAD

Ecological and related indicators help to identify areas/populations where VAD is likely to he 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 well-suited interventions, thus increasing the likelihood of program effectiveness at the community level.

These indirect indicators do not replace biological indicators and cannot be used alone for determining the vitamin A status of populations or to define whether a population has a VAD problem of public health significance. However, a composite based on them can be used to corroborate biological criteria to determine if there is a public health problem.

a. BREAST FEEDING PRACTICES

Weaning practices are important since infrequent consumption of DGLV or yellow fruits and vegetables is associated with an four to six fold increase in the risk of Xerophthalmia (odds ratio) as compared to fish, meat, milk and eggs which were associated with a 2-3 fold increased risk. Exclusion of all foods from a child's diet increased the risk of Xerophthalmia by about 3.5 times. (Mele and West 1991). A weaning diet poor in Vitamin A predicts a childhood diet that is also poor in Vitamin A. Studies such as this one have relied on food frequency questionnaires designed to assess consumption of food over the past few days (maximum one week) and have been proven to be capable of distinguishing intake distributions of key vitamin A containing foods by clinical or biochemical status, thus providing a basis for estimating risk and for partially understanding the dietary basis of VAD and the rationale for developing food based approaches(Sommer 1996). Knowledge of the locally grown foods and preferences are also helpful in deciding what approach to take when suggesting measures to increase the consumption of Vitamin A containing foods.

Where maternal malnutrition is prevalent, there is a risk of VAD in infants *when:*

(a) >50% are not receiving breast milk at 6 months of age;

(b) When <75% of 6-17 month olds do not receive vitamin A-containing complementary foods at least three times per week. (WHO 1996)

b. ANTHROPOMETRIC INDICATORS OF PROTEIN ENERGY MALNUTRITION (PEM)

Vitamin A is necessary for normal growth. Very often there is a combination of many factors such as PEM, micronutrient deficiency, infections and goitre that are responsible for decelerated growth. It is often difficult to determine how much VAD alone contributes to this. Children with VAD are known to be stunted and occasionally wasted.

Use of the term 'protein-energy malnutrition' (PEM) is being discouraged because it is now recognised that deficiencies of micronutrients, such as vitamin A, iron, zinc or iodine, may play a part along with the lack of energy or protein (UNICEF: The state of the worlds children 1998). The non-specific terms 'malnutrition ', 'growth failure' or 'underweight' are being used. PEM like VAD lowers overall resistance and predisposes the child to infection, which further worsens both these conditions. This malnutrition infection complex is important when considering intervention strategies.

The effect of Vitamin A supplementation on growth has been investigated although the results vary from improvement in some groups and no effect in others (Ramakrishnan et. al (1995) and Lie et. al (1993)). This is possibly because of the fact that growth is a complex process and depends on many factors.

Until quite recently, malnutrition was ignored in international mortality statistics, as it was as a cause of death in hospitals. Deaths of young children were attributed

almost entirely to infectious diseases. Pellettier at al (Bull WId Hlth Org 1995;l73: 443) took advantage of greatly improved databases worldwide for weight/age and mortality to demonstrate that they are related in a synergistic fashion. The study showed that as many as 56% of child deaths were attributable to the potentiating effect of malnutrition. 83% of this effect could be attributed to mild-to-moderate malnutrition and only 17% attributable to severe malnutrition. This is because mild-moderate malnutrition is so much more prevalent than severe form. (Xerophthalmia club Bulletin July 1998 DS McLaren Ed.)

Stunting *(<-2 Z-scores for ht/age)* is a surrogate measure of chronic dietary deprivation and other environmental factors that are associated with VAD. It can be regarded as a measure of past malnutrition (Waterlow 1972).

A prevalence of stunting (ht/age) >30% in children under five years, and wasting (wt/ht) > I0% in children under five years identifies a high-risk area/population for VAD (WHO 1996).

Wasting (*<-2 Z-scores for wt/ht)* is a measure of inadequate food intake, which is also associated with increased risk of VAD. The WHO has recently established updated age and sex-specific reference criteria for interpreting anthropometric indices. Wasting (wt/ht z scores> -2) $\underline{\geq}$ I0% in children under five years identifies a high-risk area/population for vitamin A deficiency. Wasting can be regarded as an indicator of present malnutrition. A study of anthropometric indices revealed that the prevalence of wasting (WHZ<-2 S.D. for wt/ht) was 30.8%(n=92 < 5 years of age)

Studies of children with xerophthalmia show that they are always more wasted (Pereira et. al 1967). When compared to their non-xerophthalmic malnourished

counterparts children with mild VAD (XN or X1B) are thinner. Even in healthier populations, children under 24 months of age with mild VAD are thinner than their peers (Mele 1991) are. There is enough evidence that there is a lower weight for height (Brink 1979) and MUAC ((De Sole et. al 1987) in populations that suffer from chronic food shortage and non corneal xerophthalmia.

The use of Z scores is recommended by the WHO as opposed to percentiles because Z scores have the property of being normally distributed thus allowing a meaningful average and standard deviation for the population to be calculated .In addition Z scores have a greater capacity to determine the proportion of a population that falls below extreme anthropometric values than do percentiles

Somatic measurements in general, however, have many advantages in surveys:

- They are simple
- Can be performed by unskilled personnel with simple apparatus
- Methods are accurate
- Results are reproducible
- Results are numerical and therefore classifications are possible

Anthropometric indices have their limitations since growth is a multi factorial and therefore one gets information about the status but not the process. Specific nutrient deficiency cannot be differentiated.

c. PREVALENCE OF LOW BIRTH WEIGHT (LBW)

Current data may be difficult to obtain from existing local demographic information. WHO has tabulated available global data. A prevalence of> 15% LBW

suggests a high-risk area/population(WHO 1996). A high prevalence of LBW (<2.5 kg) reflects maternal under- or malnutrition. It also suggests the likelihood that body stores of vitamin A, limited in all newborns, are even lower or virtually absent. LBW infants are thus at increased risk of VAD not only at birth but subsequently if they are breast-fed by malnourished mothers in areas of endemic VAD.

d. MARKET AND HOUSEHOLD FOOD AVAILABILITY

A community is at *high risk* when vitamin A and carotene-rich foods become scarce in the market and cost to meet the recommended dietary intake by eating them nears the cost of obtaining vitamin A from animal sources. A *low risk* exists when vitamin A-rich foods are available in the home >3 times per week for >75% of households.

In addition, adequate amounts of staples and fat/oil should be consumed. The risk of VAD is greater when consumption of foods of animal origin does not occur regularly.

An adequate dietary pattern among vulnerable groups means consumption of vitamin A-rich foods three or more times per week together with the use of sufficient staples, fats and some foods of animal origin in >75% of the population. (WHO 1996).

At-risk groups include pregnant and lactating women, infants and children during the period of complementary feeding and fully weaned children through 5 years of age.

e. SEMIQUANTITAVE AND QUALITATIVE MEASURES OF FOOD CONSUMPTION

When foods with high vitamin A content are consumed <3 times weekly in >75% of the vulnerable groups, there is a high risk of inadequate vitamin A status(WHO 1996)

f. ILLNESS RELATED INDICATORS

- **IMMUNISATION COVERAGE RATES**

The risk of VAD is increased when coverage rates for full immunisation particularly for measles, fall below 50% for I2-23 month-old-children(WHO 1996).

- **MEASLES CASE FATALITY RATES (CFR)**

A measles CFR of > 1 % in community, clinic or district hospital records denotes a high-risk area(WHO 1996).

- **DIARRHOEA EPISODE RATES (incidence/prevalence)**

A two-week period prevalence of DD >20% in the selected population may be used to identify populations at risk of VAD. (WHO 1996).

- **FEVER AND HELMINTHIC INFECTION RATES**

Both fever , irrespective of aetiology, and heavy worm loads usually depress appetite and nutrient absorption efficiency and retention. Both conditions are also associated with depressed circulating blood levels of vitamin A. In febrile conditions, there is evidence of an increased urinary loss of vitamin A which suggests

that frequent febrile states contribute to VAD. When period-prevalence rates are high, therefore, risk of VAD is expected to increase.

In preschool-aged populations, a two-week fever period prevalence of >20% indicates an area/population at increased risk of VAD as does prevalence of helminthic infection of >50% in the preschool-aged group(WHO 1996).

g. SOCIOECONOMIC INDICATORS

- **MATERNAL SCHOOLING AND LITERACY**

No schooling or illiteracy in >50% of women I 5-44 years of age is associated with a high vulnerability to VAD when evaluated along with food availability and dietary patterns of preschool-aged children(WHO 1996)

- **INCOME/EMPLOYMENT**

Suggested interpretation for high risk might be(WHO 1996):

Households: *no* regular employment (urban family) with >70% of income spent on food.

Community:: >50% households spend >70% of income on food

- **WATER SUPPLY AND SANITATION**

Countries have usually adopted their own criteria by which water supply and sanitation coverage is considered "low" or "adequate". Low percentages for these indicators point to low-income populations at high risk of infections from water- and faecal-borne diseases, especially diarrhoeal diseases or

Acariasis, which are liable to provoke frank vitamin A deficiency. This situation requires concurrent measures to improve environmental health including food safety and personal hygiene in any action program to improve vitamin A status.

There is a high probability of VAD if, in addition to being at risk based on diet and illness-related factors, <50% of households have a safe water supply(WHO 1996).

- **ACCESS TO HEALTH AND SOCIAL SERVICES**

Health services generally have data available, on a provincial or district basis, for the percentage of the population within a given distance from a health unit. These data would suffice to define relatively poorly served areas and populations, and it would thus not be necessary to make collection of this information a special part of vitamin A programs.

These indicators relate to:

- distance of the population from the nearest health unit;
- infection-related service indicators like immunisation rates (these are covered in the preceding section) and % use of ORS;
- utilisation of MCH services/1000 population in peripheral health units;

availability of nutrition education about VAD.

. Only data on nutrition education activities could be anticipated to have some direct relation to VAD prevalence. VAD could still occur in the presence of such activities, ie. reports on activities could be positive even though the relevance and efficacy of the activities may be low.

These data primarily indicate only populations generally at high risk, particularly if the services mentioned are completely unavailable. Populations living in poverty > 10 kilometres from services are hardly likely to benefit significantly from them unless there is some form of special outreach. The food system should be evaluated to confirm a population's vulnerability (WHO 1996).

- **ACCESS TO LAND**

Criteria for "inadequate access to land" for ultimate family food availability have to be defined in each context.

Table1.10: Summary of VAD indicators vs severity of the problem.

INDICATOR (Cut off)	Mild	Moderate	Severe
Serum retinol (<0.7μmol/l)	>2-<10%	10-20%	>20%
Breast Milk retinol (<1.05 μmol/lit or <8 mg/g milk fat)	<10%	>10-<25%	>25%
RDR(>20%)	<20%	20-30%	>30%
MRDR Ratio>0.06	<20%	>20-30%	>30%
+30SRDR (>20%)	<20%	>20-30%	>30%
HISTOLOGICAL CIC/ICT	<20%	20-40%	>40%

A public health problem of VAD is said to exist when at least two of the above listed indicators of Vitamin A status are below cut off,

Or when,

One biological indicator of VAD is supported by at least four of a composite of demographic and ecological risk factors such as:

-Infant Mortality Rates (IMR) > 75/1000 live births: under 5 year IMR >100/1000 live births

-Full immunisation coverage or particularly measles immunisation coverage <50% of children 12-23 months of age.

-<50% prevalence of breast feeding in 6 month old infants

-Median dietary intake<50% of recommended safe level of intake among 75% of children 1-6 years of age

-Two week period prevalence of diarrhoea>20%

-Measles Case Fatality Rates (CFR) rate>1%

-No formal schooling of children for >50% of women 15-44 years of age

-<50% of households with safe water source.

These cut off values are arbitrary and are useful in ranking areas / populations in terms of risk level.

The biological indicators are the most specific and useful for determining risk assessment and targeting programs as well as evaluating their effectiveness. Demographic and ecological factors may be sufficient to achieve some of the objectives if it seems that VAD is of public health importance. Before intervening it is still preferable to use some of the biological indicators for confirming the existence of VAD (Table 1.11).

Table1.11: Relative ranking on a population base of some biological indicators useful for surveillance purposes (WHO 1996)

INDICATOR	RISK ASSESSMENT	TARGETING PROGRAMS	EVALUATING EFFICACY
Night Blindness	+++	+++	+++
Breast milk retinol	++	+++	++
Serum retinol	++	+	++
RDR/MRDR	+++	+++	+++
CIC/ICT	+	--	--
+S30DR	--	--	+++

Table 1.12: Ecological indicators of areas/populations at risk of VAD: Nutrition and diet related indicators (WHO 1996)

INDICATOR	SUGGESTED PREVALENCE
Breast feeding pattern	
<6 months of age	<50% receiving breast milk
6-18 months of age	< 75% receiving Vitamin A containing foods in addition to breast milk, 3 times/week
Nutritional status (<2SD from WHO/NCHS reference for children <5 years of age)	
Stunting	>30%
Wasting	>10%
Low birth weight(<2500 g)	>15%
Food availability	
Market	DGLV unavailable >6 month/yr.
Household	<75% of households consume Vitamin A rich foods <3 times/week
Dietary patterns	<75% consume Vitamin A rich foods at least 3 times/week
Semi quantitative/qualitative Food frequency	Foods of high Vitamin A content eaten <3 times/week by >75% of vulnerable groups

Table 1.13:Illness related indicators in children 6-71 months of age (WHO 1996)

INDICATOR	SUGGESTED PREVALENCE
Immunisation coverage at 12-23 months of age	<50% fully immunised ,or, <50% immunised for measles
Measles CFR	≥ 1%
Reported diarrhoea rate(2 week period prevalence)	≥20%
Reported fever rates	≥20%
Helminthic infection rates (particularly Ascaris)	≥50%

Table 1.14:Socioeconomic indicators (SUPPORTIVE INFORMATION) (WHO 1996)

Levels of maternal education and literacy
Income/employment
Water supply and levels of sanitation
Access to health and social services
Access to land
Access to Agricultural services/inputs

Table 1.15: THE CORE INDICATORS FOR ASSESSING PROGRESS TOWARDS ACHIEVING THE GOAL OF THE VIRTUAL ELIMINATION OF VAD BY 2000AD (WHO 1996)

Functional indicator	Prevalence goal
Night Blindness Children 24-71 months of age	<1%
Biochemical Indicators	
Serum retinol≤.070µmol/L in children aged 6-71 months ,	<5%
OR, Breast milk retinol≤1.05 µmol/L or <µ/g milk fat	<10%

In conclusion, it is important to remember that though the values being used are global values, each country needs to individualise its own results of the survey and its cut off values.

1.7 PROFILE OF THE POPULATION IN PAPUA NEW GUINEA

(This section (1.7) quoted, adapted and reproduced with permission from: Children, Women and Families in Papua New Guinea, a situation analysis, 1990 National Population and Household Census and the 1991 Demographic and Health survey (DHS) This is the latest information available at the time of writing this research.)

1.7.1 THE POPULATION DISTRIBUTION

Children aged below 15 years account for almost 42 per cent of the population in PNG (Figure 1.1). The very even slope as one moves up the pyramid, for both

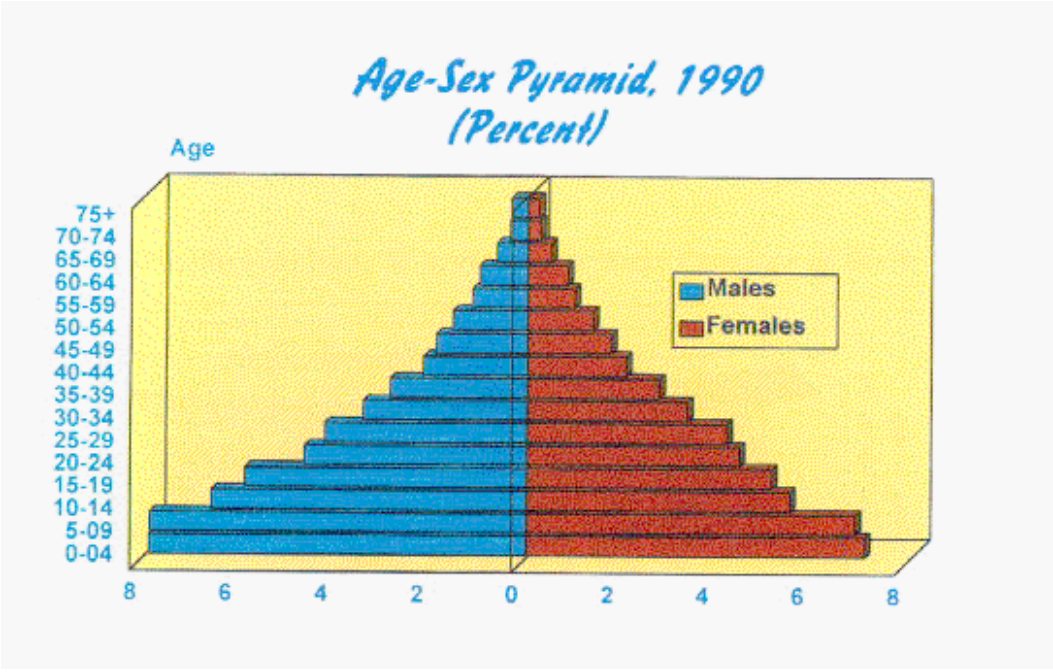

FIGURE 1.1: PNG POPULATION. AGE SEX PYRAMID

males and females suggest that there is very little migration into or out of Papua New Guinea. In 1990 only about 4% of the population were aged $\geq$ 60 years.

1.7.2 EDUCATION

While education is gradually extending its reach in Papua New Guinea, universal education is still a long way off. At ages 10-14, a little more than half the children attend school full time. By ages 15-19, the proportion falls below 23 per cent. At ages 10-14, females attend school almost as much as males. But at older ages, particularly at 20-24, males do much better, suggesting that they are likely to remain longer at an educational facility than females.

1.7.3 ECONOMIC ACTIVITY

The kind of work that people do for a living is important in defining them as individuals. It helps contribute to the well being of each household and each community and for the country, helps determine the direction and pace of national development. PNG is essentially an agrarian country. People of all ages' work towards producing food for their family or for sale

1.7.4 POPULATION DENSITY

Land area and population size together determine the density of population, The National Capital District (NCD) which comprises of the capital, Port Moresby and its pen-urban surrounds, has the highest density with 815 persons per square kilometre.

Western Province, on the other extreme, has a population density of barely one person per square kilometre. Taking physiological densities into account, Manus and West New Britain would be considered the most crowded provinces, apart from the NCD.

The population of PNG is predominantly rural, with almost 85% living in villages. Urban areas are defined as those that have a minimum population of 500 persons and a minimum population density of 195 per/km^2. Using this definition, the NCD was 100 per cent urban; other Provinces with high urban concentrations of population included Morobe and Manus. The least urban Provinces were Enga, Southern Highlands and Chimbu.

However, since 1966, the population in the urban areas has grown faster than that in the rural areas. In 1966, only 5-9 per cent of the population lived in urban areas. By 1990, this had increased to 15.4%. The rural areas have, of course, continued to grow, but more slowly than the urban centres; this indicates that the majority of PNG population can be classified as rural and will remain so in the foreseeable future (Figure 1.2, 1.3).

The areas with the highest populations extend westward from Morobe, with the highest population of all, through the Eastern, Western and Southern Highland Provinces. To the north are the relatively highly populated Provinces of Madang, Enga and West Sepik. In 1990, the Highlands region contained about 37 % of the total population

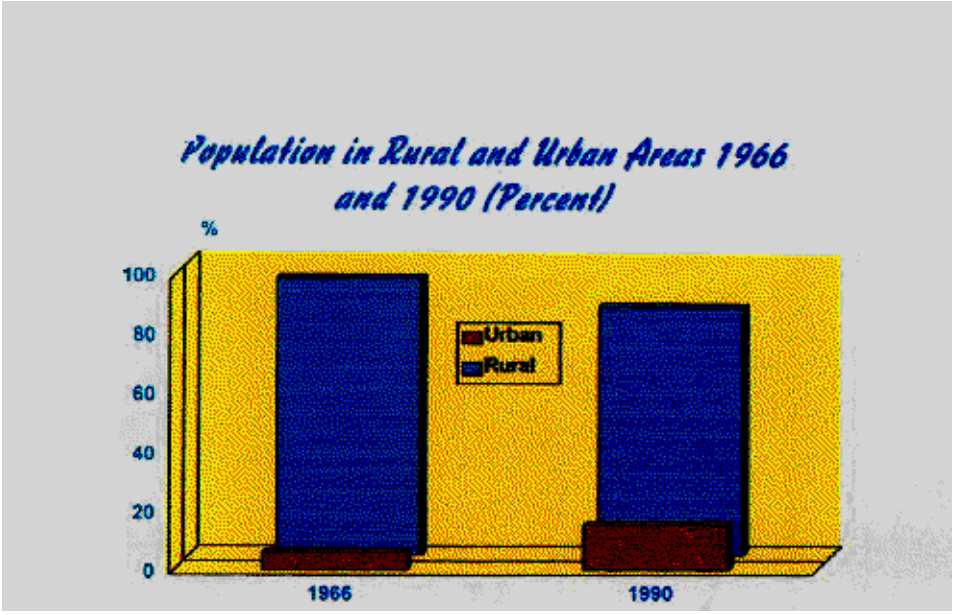

FIGURE 1.2: POPULATION DISTRIBUTION (PNG)

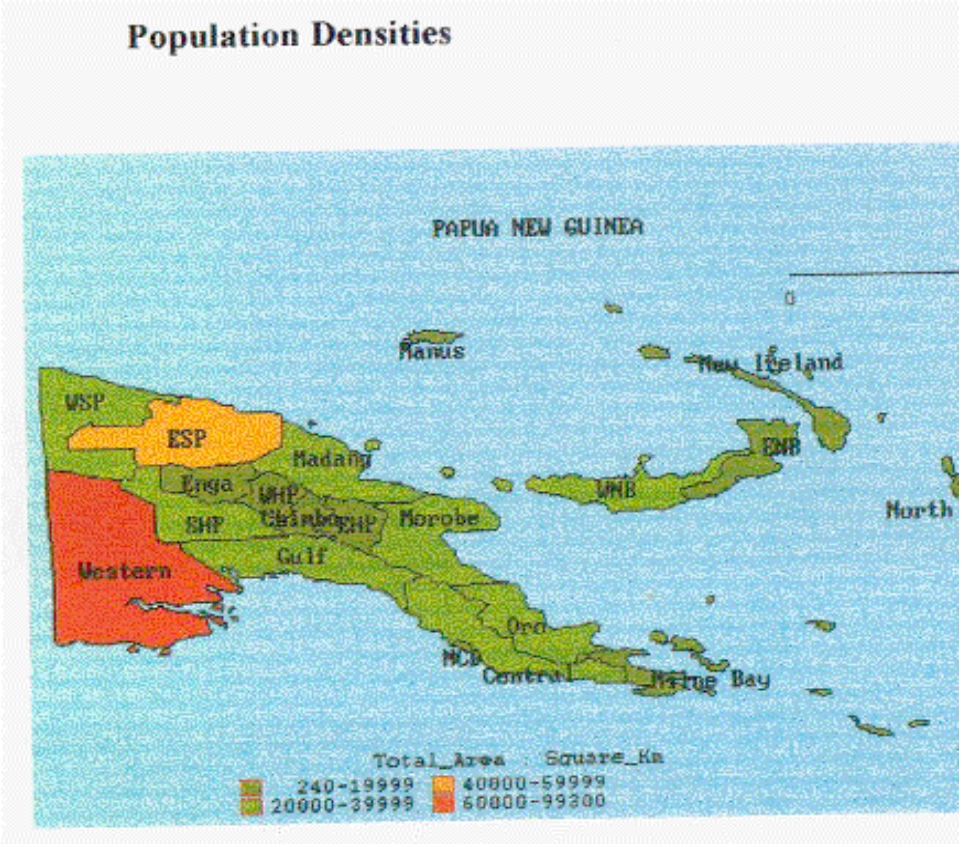

FIGURE 1.3: POPULATION DENSITIES IN PNG

1.8 CHILD HOOD MORTALITY AND MORBIDITY PATTERNS

a. VITAMIN A DEFICIENCY

Papua New Guinea has not documented Vitamin A deficiency as a public health problem although it has been classified by the World

Health Organisation (WHO) as an area where clinical Vitamin A deficiency exists. This was based on a study from the East Sepik region where 91% of patients tested had serum retinol levels of less than 0.70µmol/lit. In addition, a hospital-based study in 9 provinces carried out in 1992 by the USAID Vitamin A Field Support Project (VITAL) found

severe clinical vitamin A deficiency in 0.6 % of the survey sample of 1,027 children between the ages of six to 72 months. The data from the VITAL study in 1993 showed a prevalence of night blindness of 0.3%.

Nonetheless, the VITAL study emphasised that the risk of toxicity from Vitamin A must be weighed against the benefits of vitamin A supplements being made available in an effort to reduce child mortality (VITAL 1994).

Practicing paediatricians, ophthalmologists and other health care professionals have not encountered the classical ocular manifestations of VAD in the community in PNG.

Consequently, Vitamin A administration is only recommended by the DOH to be used strictly for children above six months who are already suffering from measles, diarrhoea, or severe malnutrition.

The role of Vitamin A deficiency in increased child morbidity and mortality even in the absence of clinical xerophthalmia is now well recognised. It becomes important to assess VAD in areas with high child morbidity and mortality. Papua New Guinea has a high infant mortality rate, the causes of which are multi factorial but related to infections such as gastroenteritis, pneumonia and tuberculosis. It is not known whether this increased susceptibility to infections is directly related to VAD or is due to other factors.

The danger of children dying from complications of malnutrition and disease is far more real when vitamin A deficiency is present. The high rates of measles, pneumonia, diarrhoea, and malnutrition in children under five years of age mean that even if children are eating foods rich in vitamin A, their vitamin A stores are continually being depleted by repeated infections.

b. INFANT MORTALITY RATES

The infant mortality rate (IMR) is defined as the number of deaths of children younger than one year of age per 1000 live births,

- Infant Mortality Rate (IMR) is estimated at national average of 82 per 1,000 live births. Regional variations are extreme varying from 111 per 1,000 in Gulf to 40 per 1,000 in Manus.
- The overall situation has worsened indicating a national increase of 14% in the IMR from the 1981 situation when the IMR was at 72 per 1,000.

As infants are the most vulnerable group among the population, it is regarded as a sensitive indicator of development conditions. An increase in the IMR suggests that there has been deterioration in public health, food availability, and in the supply of medicines for the population at large.

The child mortality rate, or the probability of dying between the ages of 1 to 5, is currently estimated at 56/1000, which represents an increase of around 25 per cent from the 1981 estimation of 45/1000.

Regional variations in IMR across the country are extreme. The highest rate in 1991 was in the Gulf province at 111/1000, with the lowest rate of 40/1000 in Manus. In 1991, the national IMR for males was 88/1000, and for females it was 77/1000.

Females generally have a longer life expectancy at birth than do males; however, current life expectancy estimates based on 1990 census data and 1991 DHS suggest that Papua New Guinean females do not live as long as their male counterparts.

There are several provinces that reveal a worsening trend in their IMR over the period 1980 to 1991(Table 1.16, Figure 1.4) increasing by over 20/1000 infants, which is twice as much as the rate of increase for the national average. These provinces are Gulf, Enga, Eastern Highlands, Morobe, Milne Bay and **Madang**. Provinces that appear to have made considerable progress in decreasing their IMR level are Western, Chimbu, Central, and Manus Provinces.

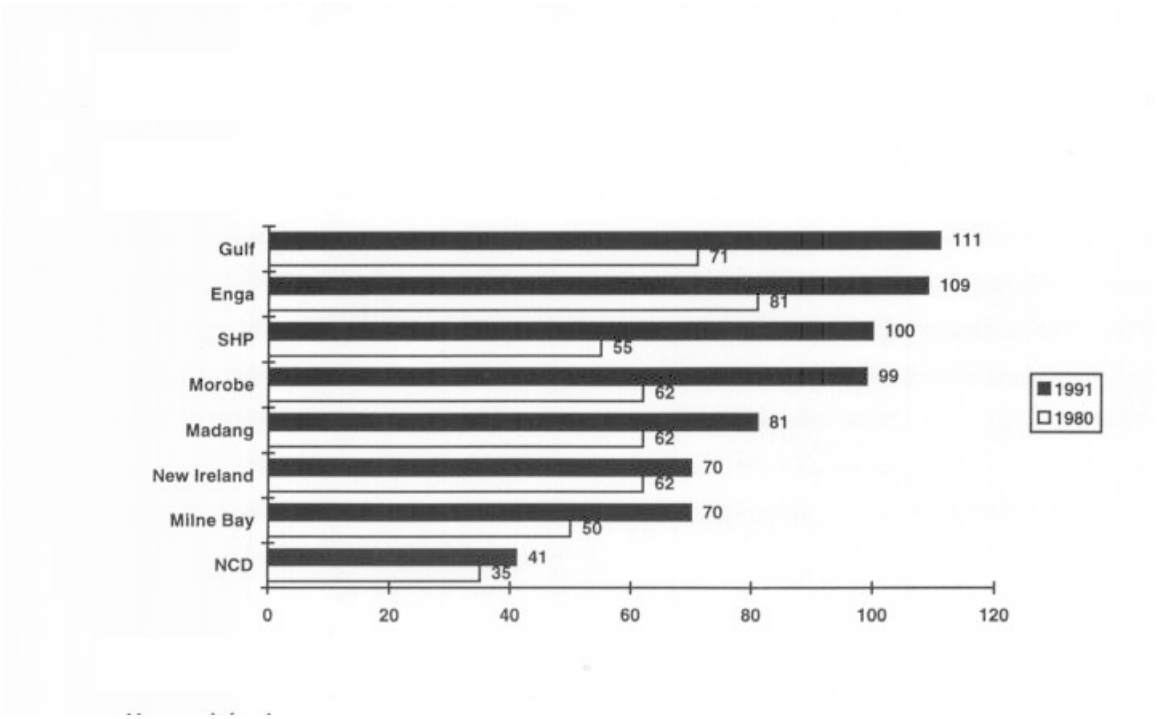

FIGURE1.4: PROVINCES WITH IMR WORSE IN 1991 AS COMPARED TO 1980

(SOURCE: TOWNSEND 1985, DOH 1991)

Table 1.16: Infant mortality rates by province, 1980 and 1991

rovince	MR (per 1000 live births) 1980	1991
Vestern	83	62
Gulf	71	111
Central	59	51
NCD	35	41
Milne Bay	50	70
Northern	67	63
Southern Highlands	116	110
Enga		
Western Highlands	81	109
Chimbu	81	76
Eastern Highlands	87	75
Morobe	55	100
Madang	62	99
East Sepik	**62**	**81**
West Sepik	94	87
Manus	104	97
New Ireland		
East New Britain	55	40
West New Britain	62	70
	57	58
	60	62
NG	**72**	**82**

Source: Townsend 1985; DOH 1996

c. CHILDHOOD MORTALITY RATES

Child mortality (under 5 years of age) is estimated to be 133/1000 live births, which represents an increase from 114 in 1981 (Hayes 1996).

d. NEONATAL DEATHS

Between 1990 to 1994, the DOH reported that babies less than one month old died of neonatal conditions at a rate of 16.5 per 100,000 newborns, Male babies were slightly more vulnerable at 8.9/100,000 compared to female babies at 7.6/100,000.

The most common causes of reported neonatal deaths are related to the condition of the mother before and especially during pregnancy. Peri- natal conditions, slow intra-uterine foetal growth, malnutrition, and prematurity account for almost 70 per cent of deaths (Table 1.7)

Because of the low tetanus toxoid coverage in pregnant mothers over the last five years, due to a decline in maternal health service coverage, many infants are not protected against neonatal tetanus (NNT). Neonatal tetanus is an important contributing factor to neonatal deaths and infant mortality. On the average, 160 cases of NNT were reported annually since 1992.

Newborn babies who die within the first week of life are usually of low birth weight. Low birth weight babies in PNG are those born less than 2.2 kg. (The

International standard for low birth weight is 2.5 kilograms).

Low birth weight can often be prevented by good antenatal care. The main reasons for low birth weight babies in PNG were:

- Prematurity often due to diseases in the mother, such as malaria, pneumonia, anaemia, or malnutrition;
- Poor maternal nutritional food intake during pregnancy:
  - Smoking (more than 25% of women in PNG smoke tobacco).

Table 1.17: Leading causes of neonatal deaths in 1990(*DOH1996)*

	Number of infant deaths (<28 days)	Percentage
Neonatal conditions	219	39%
Slow foetal growth, malnutrition and immaturity	165	29%
Hypoxia, asphyxia, and other respiratory conditions	146	26%
Birth trauma	15	3%
Other	22	5%
Total neonatal deaths	57	100%

Between 1989 and 1993, there was considerable regional variation in the average rates of reported deaths from neonatal conditions. Although the national average for the period was 16.3/100,000, the Islands region had the highest rate at 25.6, followed by Southern region, MOMASE and Highlands region, at 17.8, 14.9 and 13.6 per 100,000 population respectively. These variations are not necessarily due to worse conditions in the Island provinces, but follow a pattern of higher child clinic attendance and better antenatal coverage.

e. INFANT AND CHILD DEATHS

The leading cause of death among infants under the age of one year is pneumonia, responsible for 51% of deaths in 1990. During 1990-1994, the rate of death due to pneumonia was around 7.5 /100,000 infants.

In this age group, the other leading causes of death were:

- meningitis at 1.5/100,000
- malaria at 0.8/100,000
- diarrhoea at 0.6/100,000
- Anaemia at 0.4/100,000.

Pneumonia is also the leading cause of death in children from 1 to 4 years of age, at 2.5/100,000; followed by malaria at 1.6/100,000; and meningitis at 1.1/100,000.

The living conditions throughout most of the country make children susceptible to pneumonia. Overcrowding and smoke-filled interiors, poor sleeping arrangements; poor nutrition, low general resistance to infections and poor immunisation rates contribute to this.

Meningitis is the second most common cause of infant deaths in PNG and the third most common cause of death of children under five years of age. The rates of death from meningitis are fairly similar throughout the country, although the

MOMASE region (which includes Madang) has the highest rate.

Malaria is also a major cause of infant and child mortality. Children between the ages of 3 months and five years of age are in the greatest danger of contracting malaria, as they have insufficient immunity.

Diarrhoea is a common cause of childhood illness and death in Papua New Guinea. In 1994, a total number of 66,308 children under five were treated for diarrhoeal diseases; and *4,705* children were admitted which accounts for 24 per cent of all child admissions. A survey of Expanded Program of Immunisation (EPI) and Control of Diarrhoeal Diseases (CDD), conducted in NCD and Central province in 1993, found that on average young children get three episodes of diarrhoea per child per year. Diarrhoeal diseases are also an important cause of malnutrition and low resistance to other childhood infections. Diarrhoea is a disease that reflects sanitation and hygiene conditions. Only about a quarter of the population in PNG has access to safe water, while approximately 10% of people have adequate means of excreta disposal. High rainfall and the mountainous terrain make ideal conditions for faecal contamination of surface water, which is the most common source of drinking water in many communities throughout Papua New Guinea.

f. MALNUTRITION

Mortality and morbidity among young children are exacerbated by high levels of malnutrition, *which is estimated to affect about 34% of all children under five years of*

age. The DOH has stated that the overall rate of malnutrition in children malnutrition (below 60 % weight for age) has remained high without much change over the years (Table 1.18).

In 1994, about 73 per cent of children attending MCH clinics were normal weight for age, while 26 per cent were moderately malnourished (below 80 per cent weight for age) and 1.6 per cent were severely malnourished (below 60 per cent weight for age). However, these figures represent only that portion of the population with access to health facilities.

While many mothers continue to breast feed for at least two years, the early introduction of supplementary foods seems to be common. Mashed yam and sweet potato, ripe banana, and other semi-solid foods and juices are often introduced to infants before they reach four months of age. A recent study on infant and child feeding practices covering several provinces showed that weaning foods were introduced as early as the first month; by the age of four months less than a quarter of the infants surveyed were exclusively breast fed, and by the age of six months only 3.5 per cent were exclusively breast fed (Friesen 1995).

The main forms of malnutrition seen in PNG children are protein-energy malnutrition (PEM), nutritional anaemia, and Iodine Deficiency Disorders (IDD).

Table 1.18: Malnutrition rates in 10 worst districts in PNG, 1982
(Source: National Nutrition Survey 1982)

Province	District	% of Children <5y with weight for age below 80%
Western	Kiunga	57.5
Gulf	Kererma	55.8
	Kaintiba	69.9
Eastern Highlands	Wonenara	61.1
Central	Goilala	55.0
Milne Bay	Rabaraba	60.6
	Alotau	50.0
	Esa'ala	55.7
	Misima	61.7
	Losuia	56.5
East Sepik	Maprik	57.0
Madang	Ramu	63.8
Morobe	Menyamya	64.7
West Sepik	Lumi	68.2
	Amanab	61.7

Table 1.19: Nutritional status (*Townsend 1985. DOH 1996)*

Proportion of children 0-4 years attending MCH clinics who were under 80 of standard weight for age, 1978 and 1994			
	Per cent below 80 per cent weight for age		
	1978	1990	1994
Western	53	23	24
Gulf	61	46	27
Central	46	36	29
NCD	28	15	8
Milne Bay	54	53	49
Northern	40	16	21
Southern Highland	37	22	19
Enga	31	17	14
Western Highlands	29	19	24
Chimbu	28	17	12
Eastern Highlands	32	8	20
Morobe	32	24	26
Madang	**38**	**36**	**37**
East Sepik	44	37	38
West Sepik	59	41	44
Manus	23	25	20
New lreland	41	26	25
East New Britain	22	17	17
West New Britain	36	0	17

Malnutrition is most often seen in the second and third year of life, which is the time when the mother is likely to be pregnant again and the child has been weaned from breast-feeding. Diseases are an important contributing factor to general malnutrition. Pneumonia, diarrhoea, measles, and tuberculosis can cause malnutrition or worsen existing malnutrition in a child. Likewise, a child with malnutrition is also more susceptible to infections and diseases, thereby triggering a vicious cycle, which is likely to eventuate in the death of the child.

g. ANAEMIA

The extent to which nutritional anaemia is a problem is not known. The DOH believes it to be a serious and widespread problem, despite the lack of complete and accurate data. Anaemia was amongst the top ten causes of admissions and deaths in health facilities for infants between 1990 and 1995. Anaemia in a pregnant mother may have a profound effect on the outcome of the pregnancy, causing the infant to suffer from iron deficiency anaemia right from the womb, or from insufficient iron in breast milk. Most cases in children are believed to be iron deficiency anaemia caused by inadequate nutritional intake. repeated malaria attacks hookworm infestations, or a combination of the above factors.

h. IODINE DEFICIENCY DISORDERS

Iodine deficiency disorders (IDD) have been documented in PNG since the 1950s, and the first ever trials of iodised oil injections to treat IDD were conducted in Papua New Guinea. Recent surveys in school children have shown goitre rates of around 28 %. From schools on the coastal belt in Sogeri, Central Province, to the highlands and islands areas, goitre rates have been recorded as ranging between 12.6 and 44 per cent. Part of the reason for the occurrence of goitre in coastal and island provinces is PNG's mountainous topography, which causes leaching of iodine from the soil. Seafood is not consumed widely enough to have a substantial preventive effect among the population as a whole.

1.9 FEEDING PRACTICES IN CHILDHOOD

a. BREAST FEEDING

Breast-feeding is the single most important traditional childcare practice in PNG that

ensures a secure infancy for those babies who survive childbirth. Breast-feeding is almost universal in PNG, and is often prolonged well into the second year of the child's life. In contrast to the problems associated with low birth weight, nutrition is not a problem during the first six months of life for the majority of PNG babies who are breast-fed. In addition, the traditional adoption practices of the extended family ensure breast-feeding support to children deprived of their own mother's milk. There is concern, however, that traditional beliefs in a significant number of areas throughout the country view colostrum as 'dirty milk,' and discourage mothers from putting their newborn infants to the breast until their milk has come in.

b. WEANING

While many mothers continue to breast feed for at least two years, the early introduction of supplementary foods seems to be common. Mashed yam and sweet potato, ripe banana, and other semi-solid foods and juices are often introduced to infants before they reach four months of age. A recent study on infant and child feeding practices covering several provinces showed that weaning foods were introduced as early as the first month; by the age of four months less than a quarter of the infants surveyed were exclusively breast fed, and by the age of six months only 3.5 % were exclusively breast fed (Friesen 1995).

Papua New Guinea promotes breast-feeding as the best source of nutrition for infants and actively discourages mothers from bottle feeding their babies. It was the first country to enact legislation to restrict the use of bottles for feeding. The Baby Feed Supplies (Control) Act was introduced in 1977 in an effort to protect babies from infections, diarrhoea, and malnutrition brought on by artificial feeding, and as a

measure to support and encourage traditional feeding practices. The Act prohibits the sale of feeding teats, bottles, and dummies without prescription, Despite the legislation, it is apparent that more women are now choosing to bottle feed their babies, and they are obtaining bottles and formula without legally required prescriptions. A survey by Friesen in 1995 showed that:

- Better educated mothers had a higher bottle feeding rate than less educated mothers, regardless of whether the mother was working or not;
- 62.5 % of the bottle feeding mothers obtained the bottle from a shop or friend or relative, without a legally required prescription;
- Out of 1,791 mothers surveyed, 22.6 % did not give colostrum to their babies at birth due to various misconceptions; this is especially significant in Eastern Highlands province where more than half of the mothers did not give colostrum to their newborns; Of the 1601 children of women surveyed whose weight was known, about 22 % were malnourished, with the highest proportion of low weight for age being in the second year of life
- Bottle-feeding is not restricted to urban areas, as the highest rate was found in Western Highlands province.

c. NUTRITIONAL STATUS OF SCHOOL AGED CHILDREN

The ability of a child to recover quickly from disease is greatly influenced by his or her nutritional health status. Under nutrition in school age children is a concern that has not been addressed adequately.

Observations and anecdotal evidence suggest that large numbers of children go to school hungry without eating the first meal of the day, and many children do not eat any food while at school. This is often the situation of children from low-income households, and children who have to travel long distances to school. In some boarding schools, students are required to make gardens for their own consumption. Adequate diets for boarders often depend on support and supervision provided to the school by the community and provincial education authorities. Studies have shown that anaemia is widespread in both boys and girls living in lowland areas.

The National Health Plan outlines a school health program that is an integral part of MCH services. In rural areas, the activity is undertaken by the Community Health Nursing Services as part of their outreach program, and in urban areas, the school health program forms part of the activities of urban clinics. Services focus on community schools, targeting children aged 7 to 12 years. The MCH services conduct second and third doses of BCG and tetanus vaccinations, and examinations to check hearing, vision, nutrition, and physical disabilities or illnesses. The DOH estimated a school health coverage rate of 18 per cent in 1994, indicating the need to upgrade the provision of services to schools.

The National Health Plan aims to increase the proportion of school children screened and vaccinated to 80 per cent or more by the year 2000. In addition to annual visits from local health clinic staff, the strategy to be carried out includes the incorporation of health education into the curriculum of community and secondary schools, and for schools to provide first aid and health promotional activities. It should be pointed out that while the National Health Plan does cover this age group in the

disease control program, there is a need to target and design messages specifically for school age children, including the majority of young people not enrolled in the formal school system. It would be useful to support a study on the health status of school age children, and the most effective strategies for communicating information and promoting awareness on health issues and personal development in the PNG context, as there is little information available in this area.

1.10 IMMUNISATION COVERAGE

Vaccine preventable diseases are still common in PNG, as vaccination coverage for all antigens except BCG has generally been below 70 per cent since 1991. There has been an increase in whooping cough from 1992 to 1995. Papua New Guinea has not yet been able to achieve the high coverage of immunisation needed to protect children against this major disease.

Although the measles immunisation rates are low, at a national level, there has been a considerable reduction in the number of measles cases, at 3,730 in 1995, compared to pre-1990 levels when over 10,000 cases of measles per annum were the norm. This suggests that vaccination coverage may be higher than reported. Since the vaccination schedule of measles changed from one dose at nine months of age to two doses per child, it has been difficult to accurately assess the proportion of children receiving measles vaccines after nine months. The children are counted as having been successfully vaccinated against measles only after receiving the two doses. Those who receive one dose after nine months are not counted. It may also be that sick children brought to clinics are presenting complications of measles, such as pneumonia,

diarrhoea, or meningitis, and as such, measles is not recorded as the illness.

Immunisation rates have increased significantly over the last two decades, except for a low point in 1992; however, with the exception of BCG, they are still below the level of 80 per cent which is necessary to protect communities from immunisable diseases. Improvements in the rates reflect the strengthened capacity and commitment of the government to implement immunisation programs despite the difficulties faced. For a number of provinces, improvements in the immunisation coverage rates of children under one year old have played an important role in decreasing IMR. The best coverage rates have been in NCD, Simbu, Enga, New Ireland and Manus provinces, while the lowest rates are in Western, Northern, and West New Britain province (DOH 1996a).

The measles immunisation rates (national) were 65% in 1990 and dropped to 42% in 1995 indicating a general breakdown of the primary health care services. The immunisation rates reported by the NDOH in 1996 were 48% for Madang province and 35% for PNG as a whole.

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Clinic attendance of infants has been declining over the last five years. In 1990, 42 % of infants attended a clinic, but by 1995 this had dropped to 34 per cent. The general deterioration of rural health services undoubtedly is a major factor. Many clinics operate on minimal funding and face severe shortages of drugs and pharmaceutical supplies, which has a negative effect on the quality of services and the willingness of people to access them.

Table 1.20: Immunisation coverage rates of infants, under 1 year of age, 1990 to 1995(PNG)

Immunisation	1990	1992	1993	1994	1995
BCG **(1)**	89%	60%	91%	82%	88%
Hepatitis B		12%	7%	19%	22%
TA (2)	67%	54%	56%	59%	61%
Sabin (3)	67%	55%	55%	58%	67%
Pigbel (4)	65%	55%	61%	43%	2%
Measles	65%		27%	35%	42%
Drop out rate TA	29%	32%	37%	33%	36%
% measles given> 1	34%	41%		38%	41%

Table 1.21: Immunisation coverage by province, 1994

(Percentage of children under one year receiving vaccination (DOH 1996))

	BCG	TA	OPV	HEP B	PIGBEL	MEASLES
Western	18	24	18		31	12
Gulf	67	32	32	8	0	5
Central	49	64	63	51	2	44
NCD	103	92	90	92	0	67
Mime Bay	67	54	53	14	0	29
Northern	74	42	42	14	0	0
Southern Highlands	98	73	66	12	57	56
Enga	85	67	69	28	54	51
Western Highlands	98	48	49	3	44	8
Chimbu	130	109	107	23	80	53
Eastern Highlands	88	52	51	0	0	8
Morobe	78	49	49	1	5l	34
Madang	**113**	**73**	**74**	**27**	**0**	**48**
East Sepik	78	55	56	11	0	37
West Sepik	69	44	44	8	0	30
Manus	80	75	75	51	0	21
New Ireland	85	79	83	11	0	52
East New Britain	50	42	52	18	0	14
West New Britain	78	56	43	6	0	63
Papua New Guinea	**52**	**59**	**58**	**19**	**43**	**35**

1.11 FAMILY SIZE AND BIRTH SPACING. FAMILY PLANNING

It has been well established that birth spacing has a beneficial influence on maternal and child health, and that family planning provides an important means to reduce high-risk pregnancies and infant mortality. Low birth weight is associated with short birth intervals, and the risks of both small-for-gestation age and premature delivery are increased. There is an association between maternal age and foetal and infant mortality. Stillbirths and infant death rates are highest when the mother is under 18 or over 35 years of age. The risks to the mother's own health is also greater if pregnancies

occur before the age of 18 or after 35 years of age. Encouraging women to delay their first pregnancy until after adolescence can prevent infant deaths. The birth order of children is also another factor affecting the health of the infant. Perinatal and infant deaths are high in first births, lowest in second births, and rise sharply after the fifth birth.

Traditionally in PNG there existed obligatory behaviour and taboos that ensured long birth intervals, thereby protecting the health and well being of the mother and child. With the process of modernisation and urbanisation, these traditional beliefs and taboos are dying away (Gillet et. al 1990). However, in the National Study of Sexual and Reproductive Knowledge and Behaviour (1994), a number of women reported that they use reversible traditional methods such as herbs, potions, and symbolic gestures, to try to control their fertility. In addition to this, abstinence during lactation was the most common method of traditional fertility control still used, though many women reported that sexual activity resumed one year after giving birth (NSRRT and Jenkins 1994).

Research on contemporary marriage patterns indicates that there is a move away from large families of five or more offspring to smaller families, and that young educated adults employed in the formal sector show a preference for smaller families (Montiovani et. al 1993)

The National Population Policy and the National Health Plan actively promote birth spacing. Family planning is considered a voluntary activity in which each couple is free to decide the number and spacing of their children. Most fixed MCH clinics operate separate clinic sessions for children, pregnant women, and family planning. The need to

fully integrate the maternal and children's clinic has been talked about for a long time but this can only be done with the provision of additional support staff.

1.12 ADDITIONAL MATERNAL HEALTH ISSUES

- Papua New Guinea has one of the highest Maternal Mortality Rates (MMR) in the world at 930 per 100,000 births (This means that 1,200 mothers die each year as a result of pregnancy.)
- Poor maternal nutritional food intake and lack of antenatal care results in high incidence of low birth weight babies and contributes to the high IMR.
- Census data indicates that life expectancy in PNG is lower for women than men, which is contrary to the general trend in the world.
- The overall literacy rate has greatly improved since 1971 when the national literacy rate was at 22.8%. However, female literacy rate (40.3%) and male literacy rate (49.5%) are still very low and there are considerable regional variations (eg. 23.3% in Western Highlands and 81.3% in the National Capital District).
- While over 90% of all 7-12 year olds begin formal education in Grade 1, only 56.5 % complete six years of primary school.
- There is considerable evidence from the Law Review Commission that violence against women, rapes, and sexual child abuse is on the increase.

TUBERCULOSIS: Although statistics are not readily available on other diseases affecting women, the general rates of newly detected cases of common diseases are likely to be more or less the same for women as for men. In 1994, there were 7843

registered cases of tuberculosis, with a rate of 185 per 100,000. The worst area for tuberculosis is in the Southern region, with a rate of 618.2 per 100,000 in the NCD alone; and in the Islands region, with a rate of 270 per 100,000. In 1994, treatment completion rates for tuberculosis averaged at 67 per cent.

PNEUMONIA AND MALARIA: The other two most common diseases in PNG are pneumonia and malaria. In 1994, the death rates per 100,000 population were 14.3 for malaria, and 31.1 for pneumonia. Provinces experiencing the highest rates of malaria in 1994 were West Sepik, at 31.5 per cent; New Ireland, at 29 per cent; and West New Britain, at 25.8 per cent. Pneumonia is most prevalent in the Highlands region, in particular Eastern Highlands and Enga, and Gulf province in the Southern region, all of which have high rates ranging from 47 to 59 per 100,000 population.

TRAUMA AND DOMESTIC VIOLENCE: Trauma is one of the leading causes of hospital admissions for older children and adults, and is directly related to the prevalence of domestic violence. The number of cases has been steadily increasing from 18,337 in 1989 to 20,115 in 1993. The national average rate of trauma in 1993 was 490 per 100,000 population, with the highest rates experienced in the Islands region at 721.7 per 100,000 population.

HIV / AIDS: The HIV / AIDS epidemic poses serious consequences for PNG's social and economic development and political stability, and is bound to have a devastating impact on the country's future. The epidemic threatens PNG at a time when the economy is under considerable stress, the delivery and coverage of health services are inadequate, and the social environment is greatly affected by an increase in poverty,

crime, and sexual violence. The costs of dealing with the epidemic will divert limited financial resources away from development efforts. Furthermore, the number of parentless children is likely to escalate over the next decade, which will have major implications for the emotional, mental, and physical well being of children, as well as the capacity of the extended family and the community to provide support (Jenkins et. al 1996; UN 1996).

In the Pacific region, the AIDS epidemic has grown slowly compared to other parts of the world, except for in PNG, where it has grown at the same rate as in much of Africa. By the end of 1994, when it was estimated that a total of 4000 persons were infected by the virus, the prevalence of HIV infection in PNG on a per capita basis had already surpassed that of Australia (Jenkins et. al 1996). The World Health Organisation has warned that there is a strong likelihood that without appropriate interventions, an epidemic similar to epidemics found in sub-Saharan Africa will occur in PNG in the next five years (DOH 1996).

Apart from the limitations of blood testing, the real number of HIV infections is not visible because the virus takes several years to manifest, and opportunistic diseases which are prevalent in PNG tend to mask the symptoms of AIDS. It is estimated that for every known case of HIV there could be up to 100 unreported cases. The low estimate of the cumulative HIV-infected population in 1996 is 6092, with an estimated high of 14,893. By the year 2000, it is projected that the cumulative incidence of HIV infections will range from a low estimate of 10,851 persons to a high of 26,523 persons, with 5,065 cumulative deaths from AIDS (CPHL 1996).

The most recently available gender disaggregated data show that 46 per cent of HIV cases are female; 53.5 per cent are male; and 0.5 per cent are unknown. The risk of acquiring HIV for women in PNG is increased significantly by the social conditions that affect their status and their access to and control of resources. Even though the spread of HIV is more likely to occur among people who engage in high-risk behaviour with multiple sexual partners, most cases of infection in women in the developing world result from sexual relations within regular partnerships, usually between an infected husband and wife. This aspect of HIV infection strikes at the heart of family life...(and) it often makes its first explicit appearance when a newborn child sickens and dies" (Black 1990)

The AIDS threat to young children is directly associated with HIV infection in women, with nearly all cases being Perinatal in origin. Symptoms in babies and small children are easily misread, as they are the typical ailments of childhood diseases, such as chronic diarrhoea, fevers, loss of appetite, and respiratory infection. It is currently estimated that, on average, nearly half of HIV-infected children die before their second birthday, and that by the age of five, 80 % succumb to the virus (Black 1990).

1.13 COMMUNICATION AND TRAVEL

Papua New Guinea's surface transport and communication infrastructure is relatively poor, especially in rural areas. Lakes, fast-flowing rivers, and mountainous terrain make walking to the nearest health clinic difficult even when distances are

short. For many people in the rural areas, travelling on foot is their only link to the nearest road, airstrip, or health clinic.

1.14 HOUSEHOLD INCOME

Household income is an important issue affecting access to health services. Many rural people do not participate in the formal economy, nor do they regularly earn cash to pay for transportation fares to the hospital, hospital charges, or medicine.

In July 1995, the DOH introduced hospital fees for a number of services that were previously free, and the existing fees were revised upwards. Consequently, a fee of K20 is now levied on a mother coming to deliver in hospital. There is good rationale for hospital fees, in that they encourage clients not to by-pass appropriate lower level services and they encourage the valuing of services. However, fees have already been known to prevent rural women from accessing hospital services. Family planning services also are charging a fee now.

1.15 HEALTH SERVICES

Health services in PNG are provided by both government and non-government partners. The DOH is the policy and standards formulation body and is the lead agency for national objectives in health. Each province has a division of health, which has overall responsibility for provincial health activities and plans. Provincial health offices have in most cases a full complement of staff. A District Health Extension Officer has usually managed the districts. Currently the on-going provincial and local

government reforms aim to decentralise to districts.

In terms of health facilities, the aid posts at the village level are the initial points of contact with the formal health system for rural communities. They are manned by an aid post orderly who usually has two years of formal training. In the middle sector are approximately *550* health centres and sub-health centres, which provide basic preventive and curative services, including in-patient care where available. A sub-health centre serves between 2,000 and 10,000 people and is staffed by a nurse, nurse aides, and orderlies. Health centres are usually run by a health extension officer trained specifically to provide rural health services with support from nurses, nurse aides, and orderlies. Health centres serve between 5,000 and 20,000 people.

In 1991, a study of health worker case management was conducted on a random sample of four provinces, representing each of the four regions in PNG. (Thomason) The study found that:

- Health centre and aid post staff lack a systematic approach to clinical case management,
- History taking was rudimentary; physical examination of cases was poor; and health workers showed little diagnostic precision and little inclination to record their diagnosis;
- Treatment practices were often incorrect, with inappropriate or insufficient drugs prescribed;
- Very little advice was given to mothers, although when given the advice was appropriate.

The villages in PNG have an aid post or health centre. Very often the aid post orderly has to travel to town to collect medication and also his meagre salary. This creates a problem of retention of staff and many health centres are closed due to lack of funding. Those areas fortunate enough to have a parish are better off since there is support and supervision from the priest and nuns who often take on a health care delivery responsibility.

Clinic attendance of infants has been declining over the last five years. In 1990, 42 %of infants attended a clinic, but by 1995, this had dropped to 34 per cent. Monthly attendance of infants has been consistently poor in Western and East New Britain provinces since 1990, with a low of 20 % in 1994. As for children aged 1 to 4 years, there has also been a serious drop from 23 % in 1990 to 16 % in 1995 (DOH 1996). The reasons for the decline are not fully known, but the general deterioration of rural health services undoubtedly is a major factor. Many clinics operate on minimal funding and face severe shortages of drugs and pharmaceutical supplies, which has a negative effect on the quality of services and the willingness of people to access them.

A recent initiative from the Madang Provincial Government to install radios in all the health centres has been successful since it reduces the problem of professional isolation and also allows better monitoring of the field staff by the health department. These data primarily indicate only populations generally at high risk, particularly if the services mentioned are completely unavailable. Populations living in poverty > I0 km from services are hardly likely to benefit significantly from them unless there is some form of special outreach (WHO 1996).

HEALTH WORKFORCE

A provisional estimate of the size of PNG's active health workforce shows that between 12,500 and 13,000 health personnel are currently employed in the country's health care system. Data from the National Inventory of Health Facilities 1995 survey indicates that 48.1 per cent of the personnel employed in government facilities are located in health centres or sub-centres, and 17.4 per cent are located in aid posts. The remaining 34.5 per cent are employed in provincial hospitals (including PMGH) or urban clinics.

There are wide differences between provinces in staff population ratios for almost all categories of health personnel, which do not necessarily relate to geographic or demographic differences.

The highlands region generally seems to have lower numbers of health staff for its high levels of population, in particular Health Extension Officers and nursing officers. When information on the district level is examined, it is apparent that 48 districts, out of a total of 89, do not have a doctor. There are at present 766 medical practitioner registered with the Medical Board, although it is said that this does not reflect the true size of the active medical practitioner workforce.

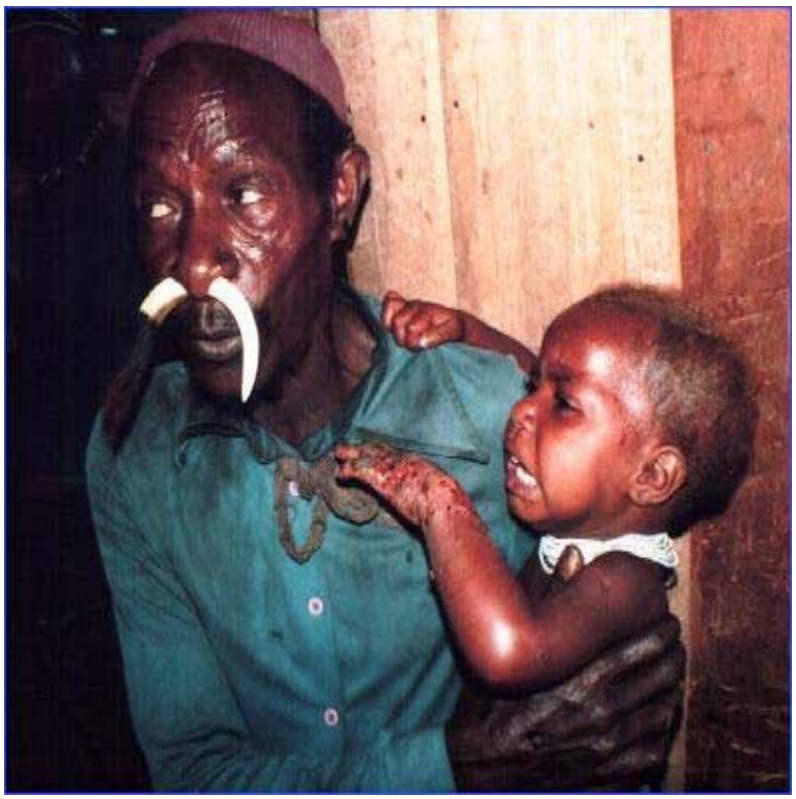
FUNDING FOR HEALTH AND RELATED SERVICES

For the period 1990 to 1995, there was a decline in funds for program operations. Allocations to provinces mainly cover salaries and emoluments to staff. Consequently, basic repair and maintenance, health services outreach, and

supervision of health facilities and staff have virtually come to a standstill. Currently, however, the financial situation is uncertain, with many provinces, church agencies, and departments periodically warning that services will come to a standstill if they do not receive their share of allocated resources.

In essence, a lot remains to be done and there is scope for much improvement in health services in PNG. The picture is gloomy but yet quite different from that in other developing countries in Africa and Asia. Since the people have access to their own land and almost all have access to water and food and the country is extremely fertile, the chance of famine is remote although there was a drought in 1997 due to the El Nino weather phenomenon.

CHAPTER 2:STUDY OBJECTIVES



The aim of this pilot study was s to establish the Vitamin A status of children in the rural Ramu region of Papua New Guinea.

In doing so it aimed to:

- Determine the prevalence of clinical and subclinical Vitamin A deficiency, if any, in children aged 6 months to 6 years in an isolated rural area of Madang Province in PNG.

- Determine the general nutritional status of these children.

- Determine possible risk factors associated with clinical and subclinical vitamin A deficiency and malnutrition in children below 6 years of age.

- Determine any risk factors that may account for the high infant mortality in the region

- Determine any potential interventions that may be useful in improving the state of child health in the region.

- Assess the state of basic health service delivery in the region.

- Capitalising on the value of locally collected information

- Test the methodology and techniques for nutrition and vitamin A surveys which later may need to be carried out on a larger scale on a National level,

More specifically the study will attempt to establish whether the previous classification of PNG by the WHO as a country where clinical Vitamin A deficiency exists is still appropriate.

CHAPTER 3

METHODS: HOW THIS STUDY WAS DONE

This was a prospective study to evaluate the nutritional status of children aged between 6 months and 6 years living in the lower and middle Ramu region of the Madang Province of Papua New Guinea with specific emphasis on assessment of their Vitamin A status.

3.1: CHOICE OF LOCATION FOR THE STUDY

The total population of Papua New Guinea is approximately 4 million people, of which 1.3 million live in the Highlands region, 400,000 in the Islands region and the bulk of the people (2.5 million) in the regions along the North and the South coast of the island. (Appendix 1).

The area was chosen because Madang province in general and the Ramu region in particular are in the middle of the spectrum in terms of the health services (DOH 1996), educational facilities and the general status of the people. When looking at infant mortality which is a sensitive indicator of the general health of the people and also an index of the efficacy and availability of health services, in PNG as a whole, some provinces have higher rates (Gulf 111. Southern Highlands 110, Eastern Highlands 100) and some lower (Manus 40, West New Britain 62, Milne bay 70) than Madang (81/1000 live births) The IMR rates have shown a considerable worsening in Madang and some other provinces over the last decade. (1980 to 1991).

Madang province has a population of about 253,195 with a total land area of 29,000 km2, about a fourth of which, is arable. It has a population density of 9/ km^2

with physiological population density of 41/ km^2. The majority of the people live in rural areas.

Globally, VAD is more common in the southern and pre-equatorial regions of the world. The WHO data indicate that the list of high risk countries has not changed significantly over the last three decades when Oomen, McLaren and Escapini first drew up their list in 1964. In all reports, Papua New Guinea has been classified as an area where clinical VAD exists.

The study was carried out in the area of the Ramu River and Ramu valley in the Madang province (Appendix 1). This area was chosen because it is an isolated, rural area with limited health care facilities and a high infant mortality rate (81/1000 live births (1991: DOH 1996). This area had "middle of the spectrum" health indicators in the country and where if it existed, VAD was likely to be found. It seemed to be an appropriate place to carry out this pilot study.

Villages in each region were selected in cooperation with the Provincial health staff and church. The main issues taken into account were the considerations of security, accommodation, population accessibility and size.

The estimated total population of the area was 48,000, living in 11 different villages. Details of the exact population numbers of each village were not available.

The study was part of a major immunisation campaign (EPI) and a surgical eye patrol using a barge borne mobile operating theatre as had been carried out in other areas of the country. Medical care was provided to anybody who needed it. Sick children were seen by the paediatric physicians who took part in the survey and

were treated on site as far as practicable. For further care, patients were transferred to Madang Hospital. All children were immunised according to their individual needs according to the EPI protocol.

3.2: THE TARGET POPULATION

The Vitamin A status in pre-school children and their mothers, women of child-bearing age (including pregnant and lactating mothers), is known to reflect the Vitamin A status of a community. Children between the ages of 6 months and 6 years were chosen because this group of preschool children is highly vulnerable to VAD. This also allows a comparison of this our results with those of other studies carried out elsewhere that have used a similar age group.

Children under 6 months of age are almost universally breast fed and are not a good target group for the assessment of VAD. In two large series of patients with Xerophthalmia in Indonesia [Sommer et. al 1982 (n=162)] and Nepal [Hennig et. al 1991(n=295)] presenting in referral centres over a 24 month period, 85-90% were below the age of 5 years. The increased risk of mild to moderate VAD during early childhood is a combination of chronic dietary inadequacy in the setting of increased nutritional demands of continued growth and repeated infections (Sommer 1996). Subclinical VAD would be expected to increase through early childhood but this has not been well established. Fifteen percent of Papua New Guineans are below 5 years of age, which is a significant proportion of the population (DOH 1996).

Although the risk of severe VAD and blindness declines with age, VAD can also be found in adolescents and young adults. Women of the reproductive age are particularly at risk as reported from India (Belavady and Gopalan 1959).

Thus, the target population consisted of children between 6 months and 6 years of age and their mothers. The estimated number of children between 6 months and 6 years of age in this area was approximately 7000. Some of them lived in very remote areas accessible only by helicopter (or a few days walk).

All 11 villages in the area (located in 4 regions: Anaberg, Kwanga, Bogen and Bunapas) were included in the survey and a village information form was completed. The major constraint was the number of children available in a village on the day of the team's visit. Anaberg was the largest of the villages.

In this pilot study, six hundred and nine healthy children between 6 months and six years of age presented themselves for examination and were studied with respect to their nutritional status. Due to financial and logistical constraints and the fact that the survey was carried out in very remote areas, it was not feasible to perform laboratory studies in all the children and only 106 had their biochemical parameters assessed after informed parental consent. One of the major considerations was the availability of a refrigerator and a freezer to store the samples within a few hours of collection. The villages to be included in the survey were selected based on accessibility of the sites and those that were included in the immunisation campaign. The survey team followed the same itinerary as the immunisation teams. As far as possible a quick census was carried out in the village to determine the number of households with children in the target age group. This census did not interfere with

the immunisation programs, which aimed to immunise all children below 5 years of age.

All the 609 children included in the study had:

- a child information form completed(Appendix 2),
- Physical and ocular examination carried out and nutritional status assessed (height/length. weight, and mid upper arm circumference (MUAC) measured.

In 106 of these children blood was collected and processed for biochemical and other tests (see laboratory investigations below) and conjunctival impression cytology carried out.

INCLUSION CRITERIA:

- Age between 6-72 months
- Geographical location

EXCLUSION CRITERIA

- Presence of obvious illness or diarrhoea
- Diarrhoea or fever in the last two weeks
- Visitors to the village
- Children on medications
- Age of child not known
- Major injuries
- Incomplete forms/interviews
- Unreliable information from mother

3.3 CONSIDERATIONS WHILE SELECTING INDICATORS FOR VITAMIN A DEFICIENCY ASSESSMENT

NORMAL Vitamin A Status implies that the individual has no physiological or pathological manifestations of VAD and has sufficient liver stores to protect against increased metabolic demands caused by disease or reduced absorption (Sommer1996).

Bitot spots, Corneal xerosis, keratomalacia and corneal scars are well-established indicators of clinical VAD and are rarely seen in population surveys. They are the classical signs of severe functional VAD and are usually late manifestations. Because of clustering of VAD, they require a very large population sample to establish their presence and are inadequate for assessing the prevalence of non-clinically observable deficiency (depletion of body stores of Vitamin A to the level where important functional consequences for health are likely).

Two decades ago, the ocular manifestations of VAD were the most frequently used indicators in Vitamin A surveys. As better techniques for the estimation of the biochemical parameters used to classify populations have become available and the realisation made that more children were dying because of VAD than being blinded by it, the value of eye signs in surveys have decreased (Sommer 1996).

Earlier, ocular signs were an important way of determining VAD since the concern then was to identify countries with blinding VAD and also because these signs were the least likely to be confused with anything else. Moreover, other techniques were not so well developed (Sommer 1996).

It is now clear that Xerophthalmia reflects severe VAD. Many devastating changes such as growth retardation, increased susceptibility to diseases such as diarrhoea, pneumonia, tuberculosis and malaria as well as anaemia and ultimately an increased mortality occur before xerophthalmia manifests (Sommer).

In order to determine the Vitamin A status of the population studied the guidelines and cut off values suggested by the World Health Organisation and the IVACG were used (Underwood et. al 1990).

SPECIFIC INDICATORS

Functional Indicator **: night blindness**

Biochemical Indicators **: serum retinol**

: Breast milk vitamin A levels

: Serum retinol binding protein

: Dose response measurements

-Relative dose response (RDR)

-Modified relative dose response (MRDR)

-Serum 30 day response (+S30DR)

Histological indicators **: Conjunctival Impression cytology (CIC)**

: Impression cytology with transfer (ICT)

Composite non-specific but supportive demographic and ecological indicators

Nutritional status and diet **: breast-feeding patterns**

: Anthropometric indicators of PEM

: Prevalence of low birth weight

: Market and household food availability

: Dietary patterns of vulnerable groups

: Beliefs and attitudes concerning foods

: Semi-quantitative and qualitative indicators of food consumption levels

Illness and disease patterns	**: Immunisation coverage rates**
	: Measles CFR
	: Disease prevalence rates
Socioeconomic variables	**: maternal education and literacy**
	: Income and employment
	: Water supply and sanitation
	: Access to health and social services
	: Access to land
	: Agricultural services and inputs

(Indicators in bold type have been evaluated in this pilot study)

Basically, these indicators are of two types:

Outcome indicators provide an impact on VAD status. These can be categorised according to exposure, impact or function. They can also be classified according to whether the assessments are direct, (functional or biological) or indirect.

Process indicators measure whether or not the intervention is functioning effectively.

The acceptability of a particular indicator may vary amongst different populations and is an issue for field workers because some measures are more acceptable (dietary intake assessment) than others (drawing venous blood).

Technical feasibility is an important issue:

- Ease of data or sample collection

- Sample storage and transport requirements
- Transportability and durability of field equipment
- Availability of specialists to obtain and analyse specimens
- Availability of equipment ,spare parts and maintenance personnel

Costs are an important factor:

- Capital costs for facilities and equipment
- Recurring costs for supplies and reagents
- Maintenance costs
- Training costs
- Personnel, administrative and related expenses
- Security issues

Indicator Performance:

Useful measures of indicator performance in identifying VAD include:

- Sensitivity
- Specificity
- Reliability
- Acceptability

These performance attributes are best evaluated when there is an agreed reference standard against which they can be compared.

- Clinical eye signs are a suitable standard when clinical deficiency is considered but are insensitive when considering mild and subclinical deficiency.

- Total body stores are difficult to assess on the total population.
- The RDR and MRDR are the most useful indicators when assessing total Vitamin A stores in the liver. They have their limitations but are becoming increasingly popular.

3.4: REFERENCE DATA

Interpretation of VAD status depends on the availability of reference data. Data on serum retinol levels collected from NorthEast Brazil and the USA (National Health And Nutrition Examination Survey-NHANES) were used as a reference. Available cut off values for CIC, ICT, Breast Milk retinol; Dose Response tests have been used. No "reference data" is available from Papua New Guinea.

3.5:DATA COLLECTION AND MANAGEMENT

Village leaders were informed about the planned visit of the survey team by the staff of the local health centre. When the survey team arrived in the village, the purpose of the survey was explained to the village leaders and informed consent obtained to carry out the study in the village. Mothers were asked to bring their children to a central point for examination (usually the school or aid-post). The questionnaires are attached in Appendix 2.

The interviews and examination were carried out at the central site and the data recorded in the questionnaire forms. Further details on recording techniques, questionnaire design and quality control are outlined in a later section.

The data was transferred from the individual and household questionnaires to the EPINFO 6 program (Centre for Disease Control, Atlanta, USA) and Microsoft Excel ™. These two programs were used for analysis of the data.

The criteria and indicator cut off values suggested by WHO (1996) were used to classify the population's Vitamin A status. The prevalence of each indicator of VAD as suggested by WHO was calculated. Nominal factors viz. age, sex, biochemical indicators and nutrition, were used as explanatory variables. Some variables were discrete eg. sex and region, while nutrition status, biochemical indicators and age were continuous variables. Some quantitative factors were categorised into discrete variables.

The null hypothesis was fitted initially to assess the total variance and number of degrees of freedom in the model. The null hypothesis is the hypothesis that would explain variance in model due to chance alone.

Each factor, and all possible combinations of the factors, was fitted to the model and the change in deviance noted. The prevalence of the indicators of under-nutrition, ie. The percentage of children below a 'cut-off' point for an index such as weight-for-age; and disease prevalence, ie. the percentage of children with a positive indicator condition such as malaria, diarrhoea or fever were calculated for each of these groups. The way in which each variable was treated is outlined in the results and discussion section.

The rationale for analysing nutritional status has been well established in the literature as an indicator of children "at risk" of disease and delayed development. (Jelliffe et. al, 1966; Waterlow et. al 1976; Eveleth et. al 1977; WHO,

1986)

Graphs were constructed to describe the distribution of each group for weight-for-age, weight-for-height. and height-for-age and were compared with the distribution for the reference (National Centre for Health Statistics(NCHS) normalised population recommended by WHO (1986).

Definition of "wasting', 'stunting and wasting' and normal nutritional status was done by using Waterlow's (1976) classification and 'cut-off' points.

INDIRECT INDICATORS

Indirect indicators are associated with clustering of VAD and help identify areas/ populations where VAD is likely to be prevalent by focussing on factors that are responsible for or contribute to the problem's occurrence. These indicators do not replace biological or clinical indicators for determining the Vitamin A status of a population or to define if VAD is of public health significance. A composite based on them can be used to corroborate biological criteria to determine if there is a public health problem.

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

- identifying areas/populations likely to be at high risk for vitamin A deficiency and where more specific biological investigations are needed;
- planning VAD control programs where there is a problem;
- monitoring progress of vitamin A control programs within a development framework;

- engaging in advocacy to ensure that vitamin A health is given appropriate consideration within programs to improve health, and social and economic development.

These indicators are often collected in the course of any demographic, socioeconomic or health and nutrition surveillance activity. In practice, much of the information is already available through existing national surveillance systems. The locally collected data during the survey was compared with nationally collected information (DHS) in this study.

The interpretations used have been proposed by the WHO and need to be modified in consideration of local contexts.

3.5.1 The interviews:

When the mothers and their children collected, objective of the survey was again explained to them. Children between 6 months and 6 years of age were randomly selected and enrolled in the survey. When verbal consent had been obtained, a child information form was completed by one of the health workers (" interviewers") by asking questions in the local language. Information was collected about past or present illness, the immunisation status, diet and night blindness. (Questionnaire: Appendix 2).

In approximately 50% of the children a household information form was completed which focussed on the educational level of the mother, water supply, gardens and the source of income of the family (Appendix 2). These parameters were chosen based on the IVACG and WHO guidelines for assessment of VAD.

THE INTERVIEWS

The primary purpose was to determine whether vitamin A-containing foods are consumed frequently enough in families as a whole, or by at-risk individuals within families, to meet their probable needs, ie. To rank them as being at risk of inadequate intake. Most adults can recollect what they ate over the past day or week well enough to place them reliably in tertiles or sextiles. Recalls of actual food consumption during the previous 24- to 48-hour period are the most reliable, with the maximum period thought to be a month. However, since the food items are limited, usual or customary habits and relative ranking's going back much farther in time is probably also recalled.

A recall method gives quick and useful information, but:

it represents consumption patterns over only a limited time (usually a week or less), it can be atypical of unusual diet (especially in case of illness or on festive occasions), and it can miss seasonal variations; random sampling is essential to avoid bias in villages selected and households interviewed;

if there is a special market in the village on a particular day, the timing of the visit in relation to the market may influence the results;

it does not directly provide information on why certain foods are or are not given (eg. before a certain age).

The mother (or other care-giver) of each child of the age range chosen in the randomly selected households was interviewed in a neutral public place, and not in a health facility or by a regular health worker since this would likely produce biased answers. The interviewer was fluent in the language of the person being interviewed and questions were asked in the vernacular. Care was taken to avoid asking leading questions or prompting replies. The data collected is useful for population assessment but not for identifying the needs of the individual.

This community comprised of a single ethnic group living in one ecological zone with similar socioeconomic status. The mothers were forthcoming with information requested and their cooperation and good will of local leaders was very encouraging. A nutritionist who was also part of the survey team checked the questionnaires on completion, provided the training of the team members. All national team members were familiar with the local language and customs.

3.5.2 Physical examination:

The equipment used during the study had been previously calibrated and compared for reliability and any zero errors noted.

When the interviews had been completed, the following anthropometric data was recorded by the interviewers:

- weight (kg),
- height/length (cm), and,

- mid-upper arm circumference ((MUAC) in cm.

- For the *weight,* an altar weighing scale was used and a standing scale utilised for older children.
- For children below 2 yeas of age *length* was measured. For those over 2 years of age, *height* was measured.
- Following the collection of the anthropometric data the child was examined by the paediatrician, with emphasis on the general condition, eye examination and size of the spleen (by palpation).
- Some mothers were advised on proper feeding and child rearing practices.
- At the conclusion of the interview, examination and blood collection, the questionnaire was checked for completeness and inconsistencies by the team leader and obvious mistakes corrected.

HEIGHT MEASUREMENTS DURING THE STUDY

3.5.3: Laboratory investigations:

Each child was assigned an identification, household and laboratory number.

For biochemical tests, blood was taken with steel butterfly needles from a forearm vein and put in non-Zinc containing Vacutainer™ tubes. A laboratory numbers were stuck onto the tubes and questionnaire. The tubes were then wrapped in Aluminium foil and stood on ice for an hour. Serum was separated by the same person using a hand operated portable centrifuge and a pipette. The serum was stored in a foil wrapped foil and temporarily stored in a vaccine container. It was later frozen (-70° C) and transported to the New Children's Hospital Westmead on dry ice for estimations of:

- serum retinol and α-Tocopherol (HPLC technique of Catigani and Bieri 1983)
- Retinol Binding Protein(RBP), Prealbumin and C Reactive Protein(CRP) :(Nephelometry using Behring reagents, standards and controls)
- β Carotene(Isocratic Method (Gatautis and Pearson, 1987))
- Cholesterol, Triglycerides and Proteins(Beckman Analyser using Beckman reagents)

The apparatus for biochemical investigations were not available in PNG and therefore all samples were sent to the Biochemistry division of the New Children's Hospital, Westmead, NSW, Australia (NATA accredited). Dr John Earl who has significant experience in vitamin and micronutrient assays did the tests. All precautions were taken to prevent degradation of Vitamin A by ensuring that the samples were stored away from light and that the cold chain was not broken once the sample had

been frozen. Adequate precautions against HIV and hepatitis transmission were taken when handling the blood and serum samples.

Haemoglobin levels were estimated immediately by the laboratory technician in the field, using a BMS ™Haemoglobinometer (Oxyhaemoglobin method).

Blood films were made on glass slides and labelled with the name, study and laboratory numbers. They were then transported to Port Moresby Hospital and examined by a technician in the Malaria Laboratory.

Human Immunodeficiency Virus and Hepatitis

Universal precautions were taken during collecting and handling blood to guard against transmission of HIV and Hepatitis.

3.5.4: CONJUNCTIVAL IMPRESSION CYTOLOGY

Of a randomly selected number of children (100) conjunctival impression cytology was done. The method described by Wittpen, Tseng and Sommer (1986) was used for collection and analysis of the cells.

For conjunctival impression cytology (CIC) cells retained on filter paper were stored in a small bottle in a fixative of acetic acid, water and formaldehyde, in which can be maintained at room temperature for months. Further processing was carried out at Port Moresby General Hospital. After staining cells retained on the filter paper, the paper was sequentially dried serially in 95% alcohol and then I00% alcohol baths that totally dehydrated the paper with the stained cells. The dried paper was made transparent by soaking in Xylene, which dissolves the cellulose in the filter paper. The disc was then mounted using Permount. Care was taken to avoid

moisture during mounting and storage because this would render the strip opaque and unreadable

Sampled cells were stained and evaluated for described histological changes that are specific for vitamin A deficiency by Prof. D.P.Murthy, Department of Pathology, Port Moresby General Hospital. No details of the patient were available to him.

3.5.5:*Selection of Households and Children*

Village households were randomly selected (every third presenting mother and her family ("household") was included. Where villages were small, every second household was enrolled and in bigger villages, every fourth or fifth household was included. This selection procedure assumed that most people in the village lived in one central area. In places where people lived scattered over a relatively large area, the selection procedures were adjusted and clusters of households and children were enrolled in the survey.

Only households with children between 6 months and 6 years were included in the study. Where there was more than one child in a household in this age group, every other child was included.

Fifteen mothers with children aged 6-72 months were randomly selected at the immunisation session and asked to take part in the survey. The survey team members were aware that mothers mostly brought their young children for immunisation. In cases where the children in the older age group did not come

for immunisation, one of the health workers sought the children out and brought them in for immunisation.

3.5.6:Staffing

Four teams consisting of two health workers trained in paediatric and ophthalmic examination, a nutritionist and a paediatrician (team leader) carried out the survey. A local health worker accompanied each team from the nearest health centre or aid post. The Malaria slide was made and Haemoglobin estimation carried out on site.

All children, (also those not enrolled in the survey), were immunised with the standard Expanded Program for Immunisation (EPI) vaccines using established protocols.

3.5.7 DUTIES OF THE DIFFERENT TEAM MEMBERS:

- ***Team leader***

The paediatrician was the team leader. A health worker who spoke the local language assisted the team. The team leader completed the village information form and later checked all completed forms before the team left a village. The “summary section ” of the village information form was also completed.

The immunisation session was supervised by the paediatrician who also examined and treated any sick children presented to them.

- ***Health worker and nutritionist***

The health worker and nutritionist (supervised by the paediatrician) interviewed the mother/child carried out the physical examination of the children, including the assessment of the nutritional status

The household and child information forms were completed by one of the health workers and the nutritionist.

- ***Laboratory technician***

The laboratory technician was responsible for the laboratory tests (Haemoglobin) and processing of the blood smears for malaria.

- ***Ophthalmologist***

The Ophthalmologist checked for eye signs, collected specimens for Conjunctival Impression Cytology, assisted in the collection, and processing of the blood samples. In addition, the ophthalmic team carried out cataract surgery

<u>The staff who participated in the survey was:</u>

- 8 trained health workers,
- 4 health workers from the local health centres
- 4 nutritionists
- 4 paediatricians
- 2 laboratory technicians
- 4 Ophthalmologists

Each village was visited by a team which spent, on the average, a day to complete the survey and immunisation in a village. The duration of the stay in a village depended on the transport available (boat, helicopter or fixed wing aircraft).

3.6:ACTIVITIES PRIOR TO THE ACTUAL SURVEY

As the survey was part of an immunisation and blindness eradication campaign, provincial authorities and provincial health staff were part of the survey team. Details about logistic arrangements were clarified and the local health centre staff and village leaders informed in advance about the visit.

Training of the health workers in examination techniques and the use of the questionnaires was done prior to the actual survey in Madang Hospital. A 3 days workshop was held to train the participating health workers for the survey.

The workshop was residential, so that the different people got to know each other and various issues could be discussed in a less formal way in the evenings. This facilitated the building of team spirit, which is important in improving the quality of the fieldwork.

The Program:

Day 1: Lectures

Background on Vitamin A

- Explanation of survey objectives
- Explanation about the procedures and job descriptions of the different health workers
- Review of logistic arrangements

- Review of the survey design and questionnaires
- Discussion on selection procedures for households and children
- Question time

Day 2:

- Review of the first day session and discussion of any questions
- Role-play by the participants practicing the different interviews
- Field test in a community in Madang

Day 3:

- Further field test in a community in Madang
- Discussion and review field-test experience
- Discussion of any questions or other issues which had been raised

Sufficient Information forms blood drawing equipment, weighing scales, etc were transported in advance to designated villages. (For a list of equipment used, see Appendix 8).

3.7 ETHICAL CONSIDERATIONS

The Vitamin A survey was part of a major immunisation campaign in an isolated rural area with very limited health care facilities. No data was available about the nutritional status of the children in this area or about their general health status.

Vitamin A is an important micronutrient, which plays an essential role in child health and mortality. Data from other countries have shown that in a number of

regions VAD is an important factor in child mortality which is known to be high in PNG in general and the Madang province in particular. Although these investigations may not benefit the surveyed population directly, it was the only way of establishing whether VAD is a problem in this area of the country.

As the Vitamin A status may vary greatly between different populations within PNG, it may not be possible to draw conclusions for the whole country. However, it would provide an indication as to the possible situation in rural areas in the country and indicate if further studies in different regions are required. The investigations carried out as part of the survey were not invasive, except phlebotomy, which generally does not carry a great risk of morbidity for the children.

Ethical approval for the survey was granted by the Ethics Committee of the PNG National Department of Health prior to commencement of the study.

CHAPTER 4:

RESULTS OF THE STUDY

The results are tabulated in this section and discussed in the next chapter.

All children had spontaneous food intake and had remained free from any reported acute or chronic disease (at the time of sampling). They had no known past history or pre treatment that was likely to modify their nutritional status in any way.

4.1: THE POPULATION

Six hundred and nine children were enrolled in the nutrition survey. Their age and gender distribution is highlighted in Tables 4.1 and 4.2.

TABLE 4.1: AGE AND SEX DISTRIBUTION OF ALL THE CHILDREN IN THE SURVEY

Total number of children	**609**
Sex(%of males)	53.7%
Mean age	37.2 months

TABLE 4. 2: AGE AND SEX DISTRIBUTION OF THE POPULATION STUDIED IN DETAIL (INCLUDING BIOCHEMICAL INDICES):

CHILDREN	NUMBER	MEAN AGE(months)	MEDIAN AGE(months)	MODE (months)
MALE	52	34.3	32.1	31.2
FEMALE	54	34.9	35.9	29.6

Age range (months) *MALES (6.1-65.3) FEMALES (5.78-71.7)*

Their origin (Village) is shown in Table 4.3

TABLE 4. 3: ORIGIN OF PATIENTS BY REGION

n=106	**ANABERG**	**KWANGA**	**BOGEN**	**BUNAPAS**
NUMBER	52	9	33	12
PERCENTAGE	49.1	8.5	31.1	11.3

4.2: INDICATORS OF VITAMIN A DEFICIENCY

4.2.1 FUNCTIONAL INDICATORS

HISTORY OF NIGHT BLINDNESS: In the larger group (n=609) the prevalence off night blindness was 1.1%, In the smaller subgroup where all biochemical parameters were studied, the results are outlined below:

TABLE 4.4: HISTORY OF NIGHT BLINDNESS (in children >24 months of age) n=74

Status	male	female
Normal	34	35
"night blind"	1	4

4.2.2 CLINICAL INDICATORS

OCULAR SIGNS OF XEROPHTHALMIA: No evidence of any of the ocular signs of Xerophthalmia was observed except in the one patient with true night blindness as described earlier. Almost all (98%) of the children had normal eyes on external examination. The following conditions were detected.

Table 4.5. OCULAR CONDITIONS

Ocular conditions	
Conjunctivitis	1
Nystagmus	1
corneal scars(trauma)	2

All findings were crosschecked by an ophthalmologist.

4.2.3 BIOCHEMICAL INDICATORS

SERUM RETINOL, β CAROTENE AND RETINOL BINDING PROTEIN

The mean serum Retinol level was 1.22µmol/L and *10.3% of the subjects had a serum retinol level of less than 0.70µmol/L.*

TABLE 4.6: SERUM RETINOL

REGION	OBSERVATIONS	MEAN (µmol/L)
ANABERG	47	0.97
KWANGA	8	1.83
BOGEN	33	1.52
BUNAPAS	12	0.92

TABLE 4.7: SERUM RETINOL IN BOYS (µmol/L) n= 47

Mean	Variance	Std dev	min	25% percentile	median	75% percentile	Maximum	Mode
1.15	.17	.41	.6	0.8	1.2	1.5	2.4	0.8

TABLE 4.8: SERUM RETINOL IN GIRLS (µmol/L) n=53

Mean	Variance	Std dev	Min	25% percentile	median	75% percentile	Maximum	Mode
1.27	0.28	0.53	0.4	0.9	1.2	1.7	3.2	0.9

TABLE 4.9: BETA CAROTENE LEVELS n=100

Mean	Variance	Std dev	Min	25% percentile	median	75% percentile	Maximum	Mode
0.50	0.09	0.31	.09	0.28	0.43	0.66	1.75	0.26

TABLE 4.10: RBP LEVELS

Mean	Std dev	Min	25% percentile	median	75% percentile	Maximum	Mode
19.23	6.02	9	16	18	22.5	48	21

4.2.4 HISTOLOGICAL INDICATORS: CONJUNCTIVAL IMPRESSION CYTOLOGY

Total smears studied: 101, Unsatisfactory smears: *36*

Table 4.11. KERATINISATION STATUS OF CELLS

Keratinisation status	N
>75%	20
50-75%	10
25-50%	8
<5%	27

Table 4.12 CELL POPULATION ON THE SLIDES

Cell population	%
Plenty	59
Moderate	6
Scanty	9
No cells	3

The study of the goblet cells was considered as unsatisfactory due to the thickness and staining of the smears. The cells were screened for with identification of vacuolation of the cytoplasm.

The slides were examined for the presence of normal conjunctival

cells and keratinised squamous cell population. They were screened for the presence of columnar, squamous, cuboidal and goblet cells. The cell population was classified as:

- plenty (>8- 10 cells/HPF) ,
- moderate (4-7 cells/HPF)
- scanty (0-3 cells /HPF)

The keratinisation of the squamous epithelial cells, a sign of VAD was classified in to four groups of *< 5%, <50%, 50- 75% and> 75%* after counting about 100 squamous cells. The smears were recorded as unsatisfactory if the cells could not be studied properly because of the paucity of the cells or poor staining or to folds in the filter paper. Smears with > 75% of the keratinised cell population were considered as having good evidence of deficiency.

4.3 BREAST FEEDING PATTERNS

A fairly large number (41.5%) of the children were still breast-feeding. The mean age of boys still breast-feeding was 20.4 months (n=26, 6.1-65 months) and girls (n=18, 5-53 months).

In the younger age group, 93.1% of children below 18 months of age were being breast fed and the mean age of stopping breast feeding was 22.2 months (median 24 months SD 11.09)

Solids were introduced at a mean age of 4.9 months (SD 2.76(median 4 months range 3-12 months)

4.4 DISEASE RATES

Diarrhoea was defined as the passage of six or more stools in 24 hours as reported by the parent or guardian.

The one week diarrhoea prevalence in the larger population (n=609) was 8.7%.

TABLE 4.13: ONE WEEK DIARRHOEA RATES (n=106)

DIARRHOEA	YES	NO	UNSURE
n	12	92	2
%	11.3%	86.8%	1.9%

The one-week fever prevalence in the larger population was 25%

TABLE 4.14: ONE WEEK FEVER RATES

FEVER	YES	NO
n	36	70
%	34	66

Of the children who had fever, cough and diarrhoea, 80% came from one region

TABLE 4.15: ONE WEEK COUGH RATES

COUGH	YES	NO
n	43	63
%	40.6	59.4

TABLE 4.16: IMMUNISATION STATUS

IMMUNISATION	Unknown	Incomplete	Complete
N	36	57	13
%	34	53	12

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TABLE 4.17: BCG VACCINATION

BCG	UNKNOWN	YES	NO
n	37	64	2
%	35.9	62.1	1.9

TABLE 4.18: HEPATITIS B VACCINATION

HEPATITIS B	NO DOSE	1 DOSE	2 DOSE	3 DOSE
N	67	13	8	15
%	65	12.6	7.8	14.6

TABLE 4.19: TRIPLE ANTIGEN

DOSES	NO DOSE	1 DOSE	2 DOSES	3 DOSES	TOTAL
n	32	9	11	51	103
%	31.1	8.7	10.7	49.5	100

TABLE 4.20: MEASLES VACCINATION

MEASLES	NO DOSE	1 DOSE	2 DOSE	3 DOSE	TOTAL
n	40	21	39	3	103
PERCENTAGE	38.8	20.4	37.9	2.9	100

None of the children between 12-23 months were fully immunised. They were incompletely immunised against measles.

TABLE 4.21: SABIN VACCINATION

SABIN	NO DOSE	1 DOSE	2 DOSES	3 DOSES	TOTAL
n	33	8	9	53	103
%	32	7.8	8.7	51.5	100

4.5 DIETARY PATTERNS

Tables in APPENDIX 3

4.6. ANTHROPOMETRIC DATA

(SEE APPENDIX 7 ALSO)

TABLE 4.22: WEIGHT FOR AGE

WEIGHT FOR AGE	FREQUENCY	PERCENTAGE	CUMULATIVE %
>100%	3	2.9	2.9
80-100%	38	36.5	39.4
60-80%	58	55.8	95.2
<60%	5	4.8	100
TOTAL	104	100	

TABLE 4.23: MID UPPER ARM CIRCUMFERENCE

MUAC	FREQUENCY	%	CUMULATIVE %
NOT KNOWN	3	2.9	2.9
>13.5 cm	73	69.5	72.4
12.5-13.5 cm	23	21.9	94.3
<12.5 cm	6	5.7	100
TOTAL	105	100	

(MEAN 14.26, RANGE 8-18cm)

TABLE 4.24: MUAC IN BOYS

MUAC	FREQUENCY	%	CUMULATIVE %
NOT KNOWN	3	5.8	5.8
>13.5 cm	34	65.4	71.2
12.5-13.5 cm	11	21.2	92.3
<12.5 cm	4	7.7	100
TOTAL	52	100	

TABLE 4.25: MUAC IN GIRLS

MUAC	FREQUENCY	%	CUMULATIVE %
>13.5 cm	39	73.6	73.6
12.5-13.5 cm	12	22.6	96.2
<12.5 cm	2	3.8	100
TOTAL	53	100	

MISCELLANEOUS DATA

TABLE4.26: SIZE OF SPLEEN

SPLEEN SIZE	FREQ.	%	CUMULATIVE %
NOT PALPABLE	76	71.7	71.7
1cm	14	13.2	84.9
2cm	8	7.5	92.5
3cm	2	1.9	94.3
4cm	4	3.8	98.1
5 cm	2	1.9	100
Total	106	100	

ENLARGED THYROID GLAND

None of the patients had an enlarged thyroid gland

PEDAL OEDEMA

None of the patients had pedal oedema

TABLE 4.27: ASSOCIATED CONDITIONS

CONDITION	FREQUENCY	%
NONE	73	79.3
RESPIRATORY TRACT INFECTION	2	2.2
**MALARIA(CLINICAL)	3	3.3
SKIN INFECTION/RASH	11	12
HELMINTHIASIS	1	1.1
OTHER	2	2.2
TOTAL	92	100

NB: **THE MALARIA SLIDES FOR THESE TWO PATIENTS WITH ”CLINICAL MALARIA” WERE NEGATIVE

TABLE 4.28: HAEMOGLOBIN (g/L)

Mean	Std dev	Min	25% percentile	Median	75% percentile	Maximum	mode
9.2	1.13	5	8.5	9	10	11.5	9

TABLE 4.29: MALARIA SLIDES

MALARIA	FREQ.	%	CUMULATIVE %
SLIDE NOT PROPER	5	5.2	5.2
POSITIVE	2	2.1	7.2
NEGATIVE	90	92.8	100

TABLE 4.30: RESULTS OF THE EYE EXAMINATION

EYE EXAM	FREQ.	%	CUMULATIVE %
NORMAL	104	98.1	98.1
CONJUNCTIVITIS	1	0.9	99.1
TRAUMA	1	0.9	100

4.7: OTHER BIOCHEMICAL PARAMETERS

TABLE 4.31: VITAMIN E LEVELS (µmol/L)

n=100	Mean	SD	Median	Min-max	Mode
	11.97	6.46	10.4	2.1-31	10.4

TABLE 4.32: PREALBUMIN RESULTS (g/L)

Mean	Variance	Std dev	min	25% percentile	Median	75% percentile	maximum	mode
137.2	1315	36.3	55	115	137	156	295	137

TABLE 4.33: TOTAL PROTEIN RESULTS (g/L)

Mean	Std dev	Min	25% percentile	Median	75% percentile	maximum	mode
70.4	7.9	46	68	71	75	89	70

TABLE4.34: CHOLESTEROL LEVELS (µmol/L)

Mean	Std dev	Min	25% percentile	Median	75% percentile	maximum	mode
2.78	0.94	1.2	2	2.7	3.4	6.1	2.2

TABLE 4.35: TRIGLYCERIDE LEVELS (µmol/L)

Mean	Variance	Std dev	min	25% percentile	Median	75% percentile	maximum	Mode
0.98	0.3	0.55	0.26	0.6	0.9	1.3	3.45	0.4

TABLE 4.36:C REACTIVE PROTEIN LEVELS (mg/L)

CRP LEVELS	FREQ.	%
ZERO	56	58.9
ELEVATED	39	41.1
	95	100

CHAPTER 5:

DISCUSSION OF THE RESULTS

This study was intended to be a pilot project to establish whether Vitamin A deficiency exists in a remote and rural area in the Madang province of PNG. This was conducted in one visit, as a one off study, because of the difficulties of accommodation, transport and the costs involved.

5.1: THE AREA

The justification for choosing this area for the pilot study is outlined in the Chapter3 on “How this study was done”.

5.2 STUDY BIAS

There may be a bias in the study in that only the children who presented themselves for examination and were easiest to locate were included. Individuals who resided in more remote locations would have been missed out. These constitute a small proportion of the total population.

Accessibility to rural and remote populations in PNG is a well-known problem, since most of the villages in the study area can only be easily reached by boat or air. Besides making such surveys an expensive affair, there are the additional issues of accommodation and storage of blood samples. The limited outlay on health expenditure does not allow money to be spent on such studies. Although costly and time-consuming, assessment is far less expensive than intervention itself, and may indicate that the problem is much more limited or widespread than was originally thought, and could also identify the reasons for the

existence of the problem. . Fortunately, the mobility of these populations is fairly low. In the future, they can be followed up if required and longitudinal data can be gathered. Intervention strategies can then be specifically tailored to achieve maximum efficiency and effectiveness.

Local control populations are not available, as similar surveys in PNG are very few and sample sizes small. Most previous studies have been carried out in selected populations attending health care facilities and data from a National sample is not available. Surveys from small areas may provide a biased prevalence estimate, especially if they are performed in areas known to have a high prevalence of VAD, and may not represent the situation in the entire country. The present study area that was chosen is in the middle of the spectrum of published health indicators. The accuracy and techniques of laboratory procedures performed in different surveys, the comparability of the cross-survey assessments, and the methods employed are problems encountered when comparing different studies, both local and international.

The time of the survey was chosen dependent on the navigability of the Ramu river. This is one of the major rivers in PNG and is tidal its level is too low for navigation by barge for the full length of the river in the dry season. Variations in nutrition and Vitamin A status according to season were not studied, as this was a one off survey. Generally, Vitamin A status is known to vary according to season because of the availability of food supplies. PNG being a tropical country does not have much variation in its climate and the same food supplies are available through the year.

The population studied is small as this is intended to be a pilot study and the confidence intervals are large for interpretation of prevalence.

Different approaches have been used in the design of surveys and the selection of samples to ensure the greatest degree of representation. For cross-sectional surveys, such as this one, stratified sampling techniques with sample sites being selected to provide a representative impression of a population, have advantages.

Furthermore, since in most developing countries, VAD tends to occur in clusters rather than being equally distributed throughout populations (homogenous), specific survey sampling designs are required so that variance estimates are not miscalculated and confidence intervals misrepresented.

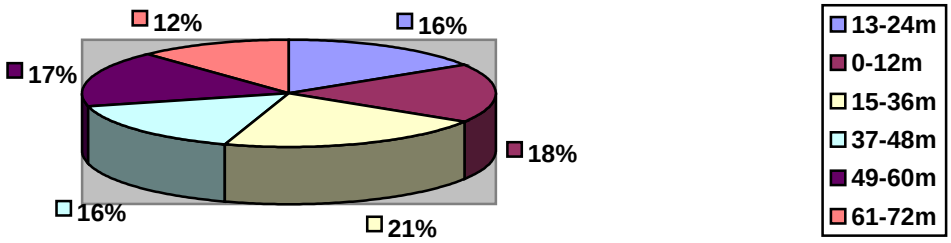
The cut off values that have been used are from the WHO publication: “Indicators for assessing Vitamin A deficiency and their application in monitoring and evaluating intervention programs" (1996). Global application of these cut off values may not be appropriate since each ethnic group and country may have their own peculiarities and specific cut off values.

5.3. THE POPULATION

5.3.1 AGE

The mean age of the population studied was 34.3 months (boys) and 34.9 years (girls).

FIGURE 5.1:AGE DISTRIBUTION OF CHILDREN



5.3.2 GENDER

Females were slightly better represented than males. This is in contrast to the rest of the country where males predominate and could reflect the fact that girls stay with the mother and help in household chores whereas boys have no definite role to play until they are capable of doing physical tasks such as hunting and fishing. It is quite likely that this is the reason since girls accompanied their mothers to the interview.

The national average is 111.4 males per 100 females. This is one of the highest sex ratios in the world (DOH 1996).

5.3.3 OTHER FEATURES

Anaberg had the largest population in the region and is therefore represented accordingly in the sample size (49.1%).

None of the children were visibly ill or had obvious fever at the time when the study was undertaken and blood samples collected. Acute infections are known to lower the Serum Retinol and increase the requirement of Vitamin A.

All the children were born in the village and were “normal deliveries”. None were adopted and for almost all of them (98.1%) the main caretaker was the mother with the grandmother looking after the other two (one was the first child and the other the 11th).

The birth order of the children is shown in the graph. Most of the children were first born in the family (mean 3.1)

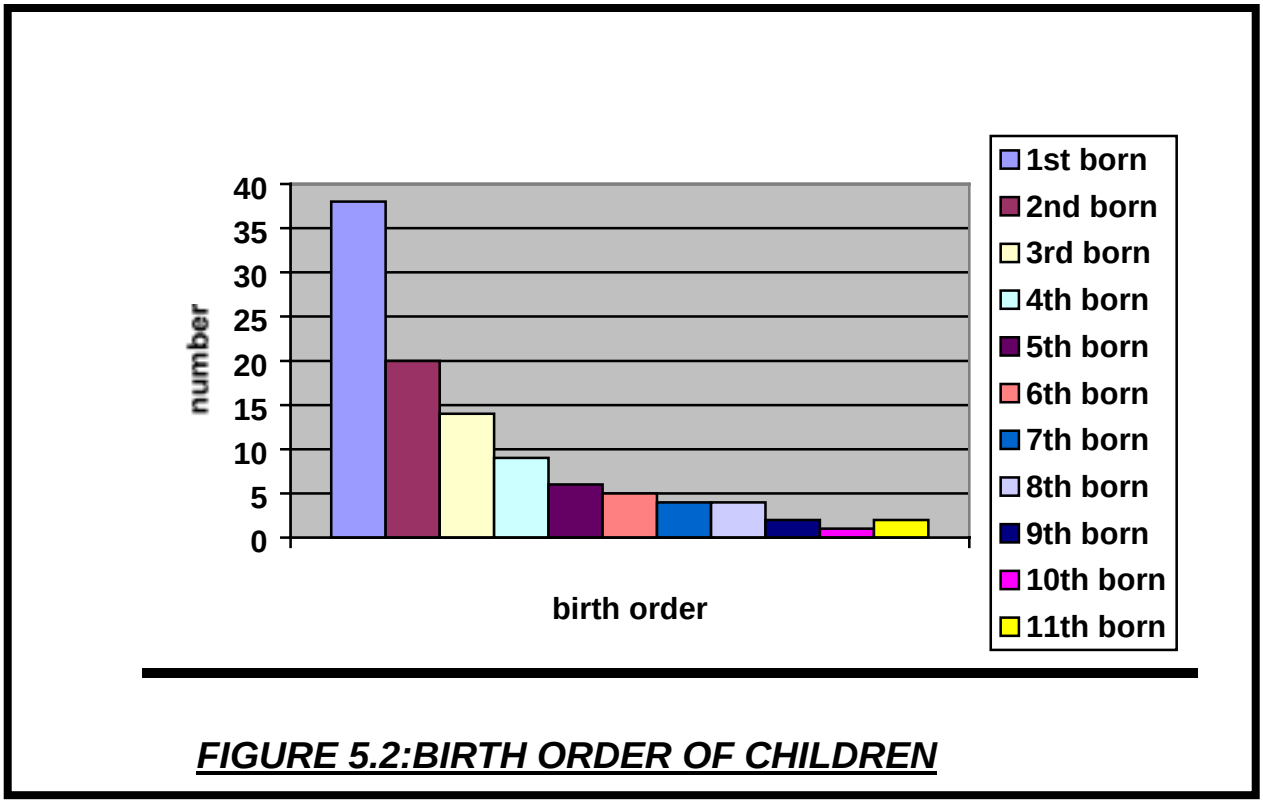


FIGURE 5.2:BIRTH ORDER OF CHILDREN

Since there is minimal movement of the population (migration), the sample is a reasonably true representation of the region.

5.3.4 CHILDREN PER HOUSEHOLD

The household survey showed that the mean number of children per household was 3 with at least 1 between 6 and 72 months of age. This indicates that most of the families were young and is in keeping with the findings at the national level. The average number of live births for woman in rural PNG is 6 as compared to 4 for her urban counterpart. The child–woman ratio in PNG is 685/1000, which is one of the highest in the world (DOH 1992). Large families in the lower socioeconomic group have an increased risk of VAD since breast feeding is stopped earlier due to pregnancy, weaning practices are less than desirable, food supplementation is a drain on resources and there is reduced parental attention (Sommer 1982)

5.4. INDICATORS OF VAD

5.4.1 CLINICAL INDICATORS

Xerophthalmia

No children with definite clinical eye signs of VAD were seen. [98% of the children had normal eyes on external examination. 1.3% of them had purulent conjunctivitis. One child had nystagmus and 2 had corneal scars due to previous trauma]. These were crosschecked and validated by an ophthalmologist.

In PNG, Xerophthalmia was seen in hospital settings only in children with debilitating illnesses.

5.4.2: FUNCTIONAL INDICATORS

Night Blindness (XN)

Night blindness is the inability of the eye to see under low levels of illumination such as early dawn or dusk or in a poorly illuminated room. This was the classically recognised sign of VAD.

Acquired night blindness in children living in developing countries is almost always due to VAD. This occurs at all ages and as is well known, results from a prolonged regeneration time of the outer segments of rods due to rhodopsin depletion. This is made worse if the level of photic stress has been high during the day such as if the child has been flying a kite or in the context of rural PNG, simply playing outside the house.

There are various newer ways of testing for night blindness but as yet none of them are practical under field situations. A history of night blindness is recognised as a valid parameter by the WHO for assessing VAD status in a population where a specific expression to describe night blindness exists (Sommer 1996).

The Pidgin expression for Night Blindness is “ai tutak long nait”(eye too dark in the night) is well established in Papua New Guinea and understood in most villages.

History taking has the limitation that it cannot be used in assessing VAD in children below 2 years of age because malnourished children below this age are usually not very mobile after dusk so that night blindness could go unnoticed. Another

reason could be that many of them are unlikely to have VAD since they are still breast-feeding. Breast feeding patterns in the surveyed population are presented later.

In the larger group studied (n=609), a total of four cases of possible night blindness were seen in 397 children aged more than 24 months (1.1%). These four children had no evidence of a fundus abnormality or a positive family history of the disease. (Table 4.4)

The algorithm suggested by the WHO (1996) which is outlined below was used with good results:

- Can your child see in the daytime?
- Can your child see at night?

If 2 are "yes", is your child different from other children in the village?

- Does your child have " ai tutak long nait?"

Further study of the children with a positive history of night blindness revealed that they were all females.

Further analysis indicated that only one of them had a really "low" serum retinol

The Serum retinol levels of the five patients were as follows:

TABLE 5.1 SERUM RETINOL IN PATIENTS WITH POSSIBLE NIGHT BLINDNESS

Serum Retinol(μmol/lit)	0.4	1.2
Number	1	3
Sex	Female*	Female

*This five-year-old child had a β Carotene level of 0.71μmol/L and an RBP of 12.
The CRP was 7.8 indicating that the child had been ill or had an infection. The other children had a reasonably "good level" of serum retinol although this does not preclude them from having vitamin A related night blindness.

The relationship between nyctalopia and serum Retinol is not all that binding since 20% of children in a study with nyctalopia had a serum retinol of greater than 0.7

μmol/lit which is used by the WHO as a “cut off” level for defining populations which have VAD (Sommer et al 1980). Carefully controlled depletion studies by Hume and Sauberlich indicate that impaired dark adaptation occurs at Vitamin A levels between 20 and 30 μg/dL (0.7 and 1.05 μmol/L).

Another point of note is that when an expression for night blindness exists in the local dialect (as it does in PNG) one can assume that VAD has been endemic there for many years.

Using WHO cut off values, a prevalence of 1.1% of Night Blindness in the population indicates a <u>mild</u> VAD in the population.

5.4.3 BIOCHEMICAL INDICATORS

<u>SERUM RETINOL</u>

The mean Serum Retinol level was 1.22μmol/l (σ = 0.481) and 15% of the children had a serum retinol <u>≤</u> 0.70μmol/l. ***Using the WHO suggested cut off values; the population can be categorised as one where a <u>moderate</u> level of VAD exists.*** *The largest number of children with low serum retinol were in Anaberg which had the largest representation in the total sample (49.1%)*

There was no statistically significant difference in the Serum retinol levels of boys (1.15μmol/L) and girls (1.27μmol/L)[*p value 0.21, t value 1.25*]

There was a difference in the mean serum retinol between the four regions as depicted in Table 5.2.

TABLE 5.2 SERUM RETINOL IN THE FOUR REGIONS

Region	S retinol (μmol/lit)			n	
Anaberg	0.97			47	
Kwanga	1.83.			8	
Inapang	1.52			33	
Bunapas	0.92			12	
Variation	**SS**	**df**	**MS**	**F statistic**	**P value**
Between	9.92	3	3.31	24.53	0.0000
Within	12.94	96	0.14		
Total	22.861	99			

The reason for this variance is not clear since there was no difference in socioeconomic status of the villages. In fact, the local health authorities as a neglected area pointed out Inapang. The mean serum retinol there was higher than. *Anaberg and Bunapas. (Table 5.2)*

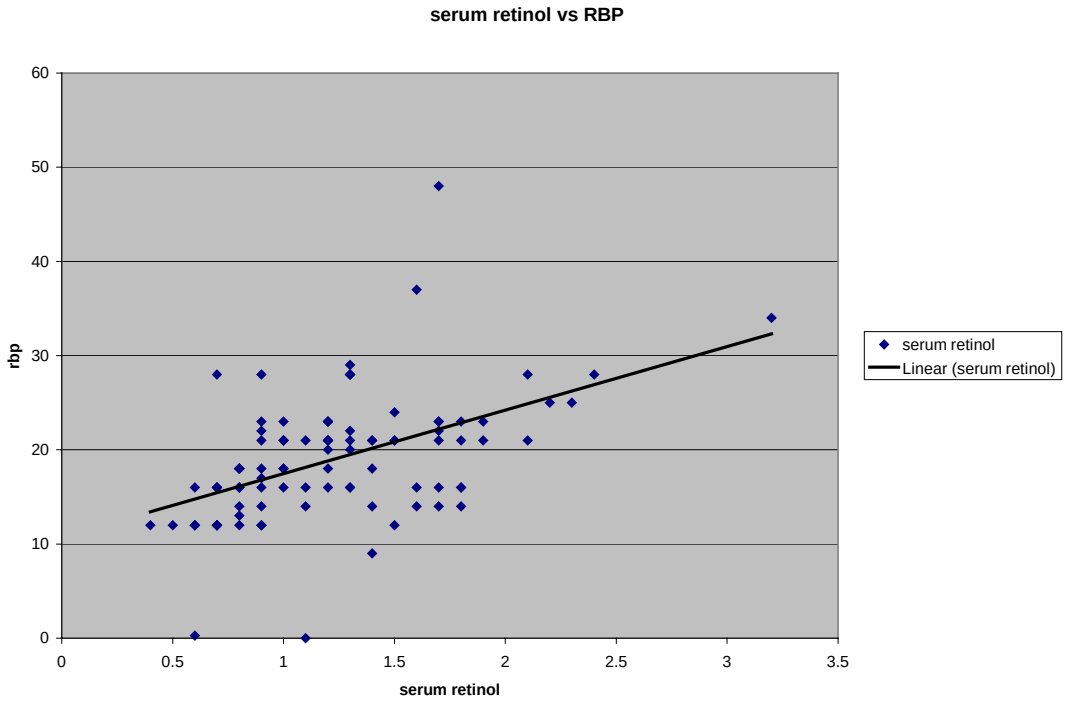
Clustering exists because of common practices and beliefs. Studies by Katz et al in Asia and Africa have shown that children living in villages where one other child has xerophthalmia are at 1.2-2.3 times higher risk of developing xerophthalmia as compared to children living in villages where no other cases exist.

There was a positive correlation between serum retinol and RBP(r=0.51, r^2=. 26 95% C.I. 0.07 and 0.43) as is also evident from the graph (Figure 5.3)

TABLE 5.3 SERUM RETINOL AND RBP

Source	df	SS	MS	F statistic
Regression	1	5.93	5.93	34.33
Residuals	98	16.93	0.17	
Total	99	22.86		

FIGURE 5.3:SERUM RETINOL AND RETINOL BINDING PROTEIN



There was no significant correlation of Serum retinol with age (Correlation coefficient r=-0.20 r^2=0.04(95% C.I. -0.4>r^2<0.48)[Figure 5.4].

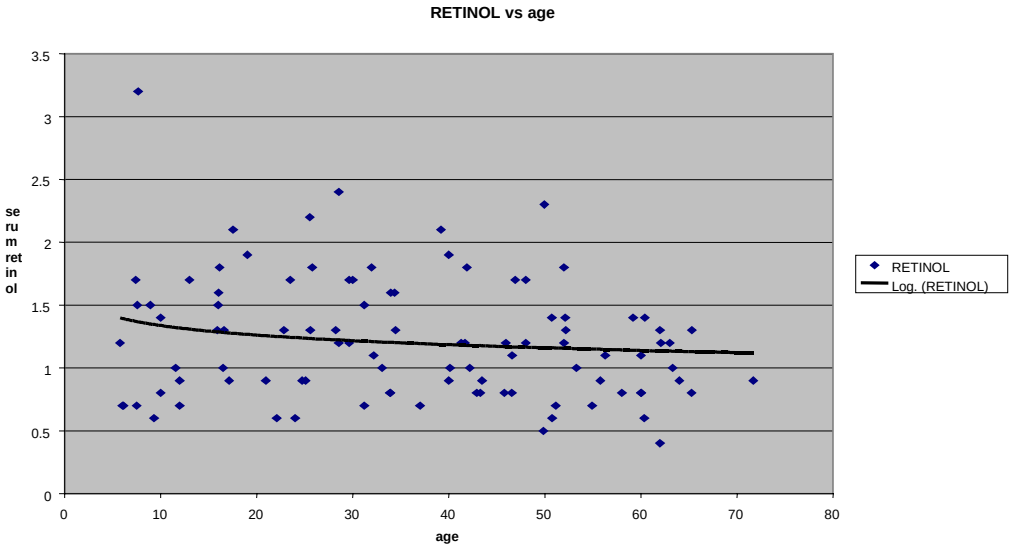


FIGURE 5.4:SERUM RETINOL versus AGE

TABLE 5.4 SERUM RETINOL AND AGE

Source	df	SS	MS	F statistic
Regression	1	0.89	0.89	4.00
Residuals	98	21.97	0.22	
Total	99	22.86		

The reduction in serum retinol (which decreased slightly with age) was less in boys (r= -0.11(r^2=0.01 95%CI -0.53-0.55). than girls(r=-0.26 r^2=0.07 95% C.I. -0.45 -0.58). This could be related to breast feeding patterns in PNG where which boys are weaned later than girls. In general, however, these results are in agreement with many studies (Sommer et. al 1982,Hennig et. al 1991,Tarwotjo et. al 1982) that have shown

that the risk of xerophthalmia in children increases with age through the preschool years.

Attention to the 7 children who had had a serum retinol below 0 .7μmol/l [mean 0.56 σ = .079, median = 0.6, range = 0.4- 0.6] revealed that all had elevated CRP levels indicating an acute infection. This is shown in Table 5.5.

TABLE 5.5: SERUM RETINOL IN PATIENTS WITH ELEVATED CRP

CRP->	5.2	7.8	10.9	22.8	25.6	31	53	Total
RETINOL(μmol/lit)								
0.4	0	1	0	0	0	0	0	1
0.5	0	0	1	0	0	0	0	1
0.6	1	0	0	1	1	1	1	5
Total	1	1	1	1	1	1	1	7

Two of these patients had a positive malaria slide.

These patients also had a lower mean β carotene level of 0.34 μmol/L (min 0.11 - max 0.71) as opposed to the whole group which was 0.502μmol/L.

None of the patients with a Serum retinol of > 0.7μmol/L had an elevated CRP.

Sommer (1996) has suggested that *a prevalence of >40% serum retinol <0.7μmol/lit be taken as a cut off point* as this encompasses a >5% prevalence of serum retinol values <0.35μmol/L and requires a sample size that is eight times smaller than when attempting to work with the 5%, (0.35μmol/L) definition to define populations that are severely deficient. **This fits in with our observations using the 0.7μmol/L cut off for defining this population as *moderately* deficient.**

This approach is also useful in assessing the effects of vitamin A supplementation in intervention programs.

A number of factors are responsible for alteration of serum retinol levels. One of them is the presence of malaria .A study by Genton et al (1994) have shown that 50% of preschool children in PNG where malaria is endemic had a serum retinol <10μg/dl

without any accompanying clinical signs of VAD. Filteau et al (1993) have estimated that a reduction of malaria in Ghana could influence the Serum Retinol regardless of Vitamin A status or liver reserves. This is certainly important in PNG where malaria is endemic and is a future direction for research.

In our study however, the two patients who had a positive malaria slide had serum retinol levels $\geq$0.7µmol/L

There was no correlation between the serum retinol and the anthropometric parameters.

Other factors that are known to influence the serum retinol levels by altering the amount of RBP available to carry it in the blood stream to target organs are the protein status (Muhilal et. al 1974), liver function (Nyberg et. al 1988), other organ disease (Smith et. al 1971), micronutrients (Carney and Underwood 1976), infection and other metabolic insults (Filteau et al, 1993). The relationship of these factors with RBP levels and Serum retinol is discussed in the following section.

The problems in using serum retinol as a parameter to identify populations with VAD and comparing the results with other studies are many and include:

- Variability in sample processing, handling and storage
- Variability between results from different laboratories even if they are all using HPLC for estimation.
- Numerous factors which can alter the amount of circulating retinol.
- Complicated relationship between Vitamin A Status and body reserves of Vitamin A

Despite all these problems, when one considers the variability of the other parameters, serum retinol levels remain an important index of Vitamin A status of a population. It is very obvious that high serum retinol precludes low liver reserves of Vitamin A. Amongst populations, however, a frequency distribution can be very informative. The value of serum retinol estimations in monitoring the efficacy of intervention programs is obvious.

TABLE 5.6: COMPARISON WITH OTHER STUDIES

Median => (`age Range)	Retinol	B carotene µg/l	Cholesterol g/l	Tocopherol	Prealbumin (mg/lit)	AT /CT	RBP (mg/lit)	Retinol/ RBP ratio
Present (6-72 months)	1.22 µmol/L	0.50	2.78	11.97	137.32	4.71	19.23	0.87
Looker '89 (HHANES) 48-60 months.				18.0µ mol/L*				
				15.2µ mol/L**				
Karr 1997` Sydney 9-62 months.	1.29	0.30		18.9	186.2		25.5	1.1 (1,08-1.12)
Genton PNG 1993	Mean							
(6-180)	0.41							
(6-72)	0.31							
(72-180)	0.44							

*Mexican American
** Puerto Rican
Further comparisons can be obtained from the MDIS tables (Global)

The use of the Relative Dose Response Assay and the Modified Relative Dose Response Assay (Tanumihardjo et. al 1987) are useful in assessing body reserves of Vitamin A but were not carried out in this pilot study.

SERUM CAROTENOIDS

Carotenoids function in many ways in nature. One of the well known established functions in the body is formation of Vitamin A. Six major carotenoids have been reported in studies done on American residents. The common ones are lycophne, lutein plus zeaxanthin and β Carotene. The percentage of provitamin A carotenoids is about 40-50% There are many other carotenoids which have lower levels and are "steady state" compounds and play an important role in nutrition and function.

Only a fraction of carotenoids that are found in nature serve a provitamin molecules. Besides their well-known function of conversion to Vitamin A, the carotenoids have an important antioxidant function. Along with α Tocopherol (AT) and Ascorbic acid, they form a part of the antioxidant network within cells. Carotenoids are more effective than Vitamin A in this function. They have been shown to exert a positive effect in the protection against many diseases including cancer.

The serum carotenoid levels are partially dependent upon dietary intake.

β CAROTENE.

The plasma carotenoids in adults have been fairly well studied but data from children is limited.

In this study the mean β Carotene levels were 0.502μmol/L (range 0.09-1.75). These levels were lower (0.340μmol/L) in the population with a low serum retinol (<0.7

μmol/L) than in the rest of the population (0.502μmol/L). There was a very mild correlation (r=0.25) between β Carotene and retinol levels (Table 5.7). This is in keeping with the findings of Solomons et. al (1993,1994) who found that the evidence that the absorption of provitamin A carotenoids from fruits and vegetables is sufficient to improve vitamin A status, is surprisingly weak.

TABLE 5.7 BETA-CAROTENE AND RETINOL

Source	Df	SS	MS	F statistic
Regression	1	1.46	1.46	6.67
Residuals	98	21.40	0.22	
Total	99	22.86		

TABLE 5.8: MEAN SERUM CAROTENOID VALUES: A COMPARISON

	Madang	Senegal	Sydney	Michigan	France
Age group (month)	6-72 m	24-48	12-36 36-72	24m-14y	12-36 36-72
Nutritional status	PEM	POOR	HEALTHY	GOOD	GOOD
Mean level(μ mol/l)	0.502	0.16	0.32 0.29	0.20	0.43 0.50
n =	100	271	467	10	

There are only few reports of β Carotene levels in humans (Table5.8). The mean levels found in our study population were significantly higher than those reported in 2-14 year old children in Michigan (0.20μmol/L) by Homnick et al (1993), 2-4 year old Senegalese children with poor nutritional state (0.16μmol/L) by Rankins et al (1993) and Sydney children aged 9-62 months (0.27-0.34 μmol/L) by Karrr et al. They were

similar to levels in healthy French children as reported by Malvy et al in 1988[0.43μmol/L in 1-3 year olds n=10 and 0.50μmol/L in 3-6 year olds]. The numbers in our study are considerably higher. The relatively higher β Carotene levels in PNG children could be related to the high intake of DGLV by the study population (mean 5.6 days/week) and the fact that most homes have their own garden in which they grow DGLV and yellow fruits such as pawpaw, sweet potato and pineapples. The pattern of prolonged breast feeding in this as compared to other populations may also be significant.

DePee et al in Indonesia have shown that there is little impact on circulating Vitamin A levels of consuming provitamin A carotenoids (such as DGLV, carrots) in populations with marginal to adequate Vitamin A status. This is in contrast to populations with deficient to marginal status. This could be related to the amount of dietary fat, intestinal helminthiasis, inadequate duration of intake of vegetables, poor digestibility and bioavailability of vegetable carotenes. Chronic protein restriction may also be expected to reduce absorption of carotenoids in animals (Kamath 1972).

These results and the nutritional data indicate that the access to and consumption of pro vitamin A carotenoids is adequate. This would be important in times of illness or starvation in terms of developing VAD.

OTHER BIOCHEMICAL PARAMETERS AND THEIR INTERACTIONS WITH SERUM RETINOL

RETINOL BINDING PROTEIN (RBP)

The mean RBP levels were 19.23 mg/L (17.87 in boys and 19.62 in girls χ^2 =20.17, df =18 and p=0.328) which is higher than the reference value of 18mg

/L)[Table 5.9]. The difference with gender was not statistically different. The normal values for RBP lie between 18-45 mg/L. In the study by Karr, Mira et al (1997) there was a variation of RBP with age although there was no correlation between the two.

There was a good correlation between serum retinol and RBP levels(r=0.51 r^2=0.26 95%CI 0.07 and 0.43) since they form a 1:4 complex. This is in keeping with the findings of other authors (James et al 1984, Raz, Shiratory and Goodman 1969 and Wolde-Gebriel et. al 1992).

TABLE 5.9 RBP LEVELS IN THE STUDY POPULATION IN mg/L (n=100)

Mean	Variance	std dev	Min	25% percentile	Median	75% percentile	Maximum	Mode
19.23	36.26	6.02	9	16	18	22.5	48	21

TABLE 5.10: SERUM RETINOL AND RBP

Source	Df	SS	MS	F Statistic
Regression	1	5.93	5.93	34.33
Residuals	98	16.93	0.17	
Total	99	22.86		

There was a mild negative correlation with age (r=-0.21 r^2=0.04 95% C.I. -0.39 and 0.49). This is similar to the findings of Karr, Mira et al (1997). This is similar to the association of Serum retinol with age (Table 5.11).

TABLE 5.11: RBP AND AGE

Source	Df	SS	MS	F statistic
Regression	1	155.70	155.70	4.44
Residuals	98	3434.14	35.04	
Total	99	3589.71		

There was a significant correlation between RBP and prealbumin (r=0.54, r2=0.29 95% C.I. 0.10 and 0.46) as is shown in Table 5.12.

TABLE 5.12: RBP AND PREALBUMIN

Source	Df	SS	MS	F Statistic
Regression	1	1028.73	1028.73	39.37
Residuals	98	2560.98	26.13	
Total	99			

This was also more marked in female(r=0.57) as compared to male children(r= 0.44). This correlation is strong because within the plasma, the holo RBP circulates as a 1:1 complex with transthyretin (prealbumin) which specifically binds one thyroxine molecule per tetramer. There was no correlation between RBP and total protein.

RBP is an acute phase protein and we found a mild negative correlation between CRP and RBP(r =-. 25 r^2 =0.06 95% C.I. -0.37 to 0.51)

TABLE 5.13: CRP AND RBP.

Source	Df	SS	MS	F statistic
Regression	1	233.62	223.62	
Residuals	98	3307.61	35.57	
Total	99	3531.22		

The problem of RBP assays is that its synthesis and storage is dependent upon liver functions, Zinc metabolism and PEM. Further, the value of isolated RBP measurements in assessing the Vitamin A status of a population is not established. There seems to be a role in measurement of changes in RBP concentrations (ΔRBP) in VLBW infants after acute administration of Vitamin A (Plasma RBP response test) as

an alternative to the RDR test which has value in assessing liver stores of Vitamin A. RBP assays are cheaper than serum retinol estimations and therefore this test may have a place in future surveys. The new blood spot test offers great promise (Ma Y. Shi, et al 1994)

The correlation coefficients between Serum Retinol and the other biochemical parameters are shown in Table 5.14 (95% Confidence levels)

TABLE 5.14 RETINOL AND OTHER BIOCHEMICAL INDICES

	Vit E	Chol	At/ct	RBP	tgl	Retinol	Total protein	Ret/RBP	Prealbumin
Beta carotene	19	17		11	1	25	13		21
Vitamin E		28		31	34	22	-10		5
Cholesterol				25	10	12	28		45
AT/CT									
RBP					12	51	9		54
Triglycerides						22	42		1
Retinol							18		48
Total protein									23

(Correlation coefficients are x100)

α TOCOPHEROL

The serum αTocopherol level in our population was 11.97 μmol/L, which is lower than the values reported by other authors. It is still higher than the cut off values as suggested in the HHANES study by Looker, Underwood et al (1988 -11.6 μmol/L) it was noted that 57% had an α Tocopherol level of less than 11.6 μmol/L. A comparison of 4-5 year olds in the study revealed that the mean serum αTocopherol was 10.17μmol/L as compared to 18.0 for Mexican American and 15.2 μmol/L for Puerto

Rican children (Looker and Underwood 1989). Sixty three percent of the children had levels below the cut off (11.6μmol/L). These values were also lower than those reported by Karr, Mira, Causer Earl, et al (1997) in preschool children in Sydney. (18.9 μmol/L)

There was a good correlation between α Tocopherol and Triglycerides (r=0.34) and cholesterol(r=0.28).

TABLE 5.15 α TOCOPHEROL AND TRIGLYCERIDES

Source	df	SS	MS	F statistic
Regression	2	701.63	350.81	10.14
Residuals	92	3184.31	34.61	
Total	94	3885.94		

There was mild correlation between serum retinol and α Tocopherol(r=0.22) and a milder correlation with Beta Carotene(r=0.19)[Table 5.16]

TABLE 5.16: BETA-CAROTENE AND TOCOPHEROL

Source	df	SS	MS	F Statistic
Regression	2	269.20	134.60	3.38
Residuals	97	3863.62	39.83	
Total	99	4132.82		

The mean α Tocopherol/Cholesterol (AT/CT) ratio was 4.71

The mean α Tocopherol/Triglycerides (AT/TGL) ratio was 15.21

Unlike other studies there was a negative correlation between α Tocopherol and age(r= - 0.46) and these results are in agreement with those of Farrell et al (1978) who found no correlation in subjects aged 3 months -10 years but are not in agreement with the findings of McWhirter et. Al (1975) and Looker et al (1988).

TABLE 5.17 VITAMIN E AND AGE

Source	df	SS	MS	F Statistic
Regression	1	879.05	879.05	26.48
Residuals	98	3253.77	33.20	
Total	99	4132.82		

Vitamin E has a protective effect on Vitamin A by reducing its oxidation in the gut and possibly in storage globules in the liver and other organs. It also reduces the rate of hydrolysis of retinyl esters in the liver. Vitamin A deficient children have lower Vitamin E levels and lower ratios of plasma vitamin E levels to total lipid as has also been shown in this study. This could be related to poorer absorption of fat-soluble vitamins and related to low dietary fat intake, intestinal helminthiasis and PEM. This requires further studies

To the best of our knowledge, this is the first report on Vitamin E levels in Papua New Guinean children in literature.

5.5 HISTOLOGICAL INDICATORS

CONJUNCTIVAL IMPRESSION CYTOLOGY

Our experience with obtaining good samples of conjunctival cells for study has not been very good. . The films were too thick for a meaningful interpretation of the results in terms of goblet cell population. In 44.4% of samples > 75% of cells had undergone keratinisation, which is a non-specific change and can result from a variety of conditions.

We used the technique of Wittpen, Tseng and Sommer (1986) because

of its simplicity and ease of use in the field. The advantage of ICT over CIC is that a single staining solution is involved, while CIC requires more reagents and processing steps for fixing, staining and mounting specimens. Impression Cytology avoids the difficulty of obtaining an efficient transfer of cells of high quality from filter paper to slide.

Although our pre-field trials in a hospital setting provided satisfactory results when tested on 20 eyes, the slides obtained from children in the Ramu region were too thick for any meaningful analysis. A few pertinent observations are highlighted below.

The children accepted harvesting of cells using the filter paper technique generally. Acceptance was improved after the procedure was explained and demonstrated before hand, and the mother is reassured that there would be no damage to the eye or any negative consequence associated with obtaining a specimen. The specimens were taken by applying a disc of filter paper to the temporal portion of the bulbar conjunctiva. We have no experience with the disk applicator developed by Keenum et al (1990).

One does not realise that the specimens are unsatisfactory until the survey is over and the specimens are processed. It is extremely difficult to revisit the place of study for repeat samples. This is perhaps what happened in our case.

5.6 INDIRECT INDICATORS OF VAD

5.6.1:NUTRITIONAL STATUS AND DIET RELATED INDICATORS

BREAST FEEDING PATTERNS

Interviews of mothers during the survey showed that:

41.5% of the children were still breast-feeding.

- The mean age of boys still breast fed was 20.4 months (n=26, 61-65 months) and girls (n=18, 5-53 months).
- 93.1% of children below 18 months of age were being breast fed
- The mean age of stopping breast feeding was 22.2 months(median 24 months SD 11.09)
- Solids were introduced at a mean age of 4.9 months (SD 2.76(median 4 months range 3-12 months).

This data was rechecked by random repeat questioning.

However, maternal VAD results in lower breast milk levels and may not exert this protective effect. In such situations, the composition of the weaning diet becomes very important.(Mele and West 1991)

In PNG mothers are actively discouraged from bottle feeding their babies. It was the first country to enact legislation to restrict the use of bottles for feeding.Strict enforcement of this act has many obvious advantages .

WEANING

Details on *maternal malnutrition* in the Madang province are unavailable .In general the diet of many women in PNG seems to be inadequate .For many women the physical effects of a lifetime of under nutrition is a slow rate of growth, delayed age of menarche and shorter framed adults. Poor diets during pregnancy and lactation also mean that they pass on nutrients to their breast feeding children and follow the same feeding practices as they have followed in their childhood. Further their role in subsistence agriculture increases their dietary needs . The average weight of a woman without children aged 20-24 years in the Wosera district of East Sepik Province was 53 kg, one with one child 51 kg and those with 4-6 children was 47 kg(Gillet et. al).Malaria, pneumonia and Tuberculosis which are common also increase their needs but reduce their appetite and consequent intake.

Looking at breast feeding and weaning practices alone all children between the ages of 6 and 17 months were eating solid food in addition to breast milk intake. This is highlighted in the Table 5.18.

The quantitative intake of the above foods per day is difficult to estimate accurately and has not been done. This is because the size of a “serving “ is difficult to determine as it varies from village to village and varies with age. Such an estimation may be possible in an urban setting. Profound misclassification may occur when trying to estimate the intake of vitamin A of individuals and communities(West et. al 1993,Portocarrero et. al 1992).

TABLE 5.18 :WEANING FOODS

FOOD	DGLV	PAWPAW	SWEET POTATO	WHOLE FISH	COOKING BANANA	WHOLE MILK	YAM	MARGARINE/ OIL /DRIPPING	BREAST MILK	EATING BANANA
MEAN DAYS /WEEK	3.7	1.4	1.4	2.6	2.7	0.3	3.2	4.7	7.00	2.8

The risk of using this parameter alone in assigning the classification of a population at risk of VAD is obvious.

TABLE 5.19: WEEKLY FOOD INTAKE

FOOD	KUMU	PAWPAW	WHOLE FISH	MARGARINE/OIL/ DRIPPING	BREAST MILK	COOKING BANANA	KAUKAU	EATING BANANA
EATEN>3 DAYS/ WEEK	57.7 %	23.1%	32%	65.4%	96.2%	54.2	30.8%	46.2

These are the commonly consumed foods in villages in PNG and were therefore chosen in the study questionnaire. Clearly the number of children eating any of the above mentioned foods (except pawpaw) is greater than 25% and in light of the fact that 96.2% are breast fed, use of this parameter indicates that the population is possibly **not at risk of VAD.** It must be pointed out that it is not possible to estimate the quantity of these foods consumed /day. This would provide useful information and may be a direction for future studies.

5.6.2 PREVALENCE OF LOW BIRTH WEIGHT (LBW)

No data is available locally but as indicated earlier there is strong evidence of maternal under- and malnutrition in PNG as reported in the DOH report. This puts children at risk of VAD by reducing their stores of Vitamin A at birth and also by reducing the available Vitamin A in breast milk which is an important source of the Vitamin in children since most of the younger children in PNG are breast fed.

Corroborative evidence from available data for this indicator points to the fact that the population is at risk of VAD.

5.6.3 ANTHROPOMETRIC INDICATORS

The prevalence of stunting in our population (under 5 years of age n=92) was 35.2%(Z score < -2 SD for ht/age). A prevalence of stunting ≥30% in children under five years identifies an area/population at risk of VAD. (WHO 1996)

Studies have shown that children with clinical signs of xerophthalmia are almost always stunted a finding that correlates well with age and duration of VAD (Bloch 1921, Sommer 1982). The longer the duration of VAD, the greater the degree of stunting. This was seen in our study too where older children tended to have more negative z scores(r= -0.10) This may be seen as the result of a chronic state of mild VAD which is significant enough to cause increased susceptibility to infections rather than clinical xerophthalmia and therefore reduced linear growth. There was no correlation between serum retinol levels and HAZ, HAP or the HAM.

The relationship between stunting and the presence of Xerophthalmia, night blindness, abnormal CIC has been well documented by several authors. We did not

find any correlation between stunting and low serum retinol levels, prealbumin, total proteins cholesterol, haemoglobin or Triglycerides levels. There was no correlation with α Tocopherol, β carotene or RBP levels either.

It would be interesting to see the effects of Vitamin A supplementation to this population in terms of whether this leads to accelerated growth or not. Although it is felt that enhancement of the general nutritional, status may be more successful.

We found no correlation between Weight for Height (WHZ, WHM, WHP) and age, serum retinol, Vitamin E concentrations, Triglycerides, total protein, prealbumin, RBP, There was a negative correlation(r=-0.14) between CRP, WHZ and WHP indicating that in children prone to acute infections had some degree of wasting. There was a positive correlation between WHP, WHZ and the β Carotene(r=0.15) and Haemoglobin(r=0.15) levels.

WEIGHT FOR AGE

The Weight for age Z score does not differentiate between tall thin children from well-proportioned short children. In our study, 51.6% of under fives had a WAZ score of <-2 SD for wt/age. There was no correlation between weight for age (WAP, WAZ, WAM) and age, serum retinol, Vitamin E, RBP, total protein or Triglycerides.

There was a mild positive correlation between WAZ and prealbumin(r=0.13), cholesterol (r=0.26) and haemoglobin levels(r=0.16). There was a negative correlation between CRP and WAP(r=-0.17) and WAZ(r=-0.10)

Comparison of the study population with the national data available indicates that 99% of this population is below the 80th percentile of Weight for age (WAP). Previous studies have put this figure at 63.8%. Most of the under fives were below 60% weight for age (95.2%).

In population studies the prevalence of malnutrition is widely being assessed by nothing more than actual weight/ age in relation to an international standard such as that of NCHS (National Centre for Health Statistics) of the United States. This index is easy to measure but has some disadvantages (MacLaren et. al 1998).

The precise age of young children is not known in some communities.

Healthy children of the same age may have different weights, as a result of following different growth paths prior to being weighed. Genetics, intra-uterine growth retardation, or recent illness may be responsible for low weight.

Weight is much more labile than height and, being to some extent a reflection of body composition, weight gain may occur from tissue fluid increase as well as from muscle or fat.

TABLE 5.20: WEIGHT FOR AGE

WEIGHT FOR AGE	FREQUENCY	PERCENTAGE	CUMULATIVE %
>100%	3	2.9	2.9
80-100%	38	36.5	39.4
60-80%	58	55.8	95.2
<60%	5	4.8	100
TOTAL	104	100	

MID UPPER ARM CIRCUMFERENCE

The advantage of this test is that it can be applied simply to all age groups and can be used as an indicator for present under and over nutrition. The reproducibility of this test is fair and the observer error is <0.5 cm. There are no limits for over nutrition although this is of little relevance in this study. Measurements done in the course of the study indicate that the MUAC indicated a "normal" nutritional status in 72.4% of the children (Table 5.21).

TABLE 5.21: MID UPPER ARM CIRCUMFERENCE

(MEAN 14.3 (RANGE 8-18 cm)

MUAC	FREQUENCY	PERCENTAGE	CUMULATIVE %
NOT KNOWN	3	2.9	2.9
>13.5 cm	73	69.5	72.4
12.5-13.5 cm	23	21.9	94.3
<12.5 cm	6	5.7	100
TOTAL	105	100	

A single measurement is of less value than serial measurements in assessing the nutritional status of a child. It measures the achievement till date or the cumulative growth (McLaren et. al 1988). It does not tell us whether growth is proceeding or not. In this study all measurements were single and it is hoped that if future studies were done in which the somatic measurements were repeated it would be possible to estimate the linear growth of this population.

Although it has been stated that well nourished children of different ethnicity differ by about 3% in their height and about 6% in their weight. Those in the lower socioeconomic group in developing countries average 12% less in height and 30% less

in weight than their upper class peers. The place of genetics seems to be less important than environment and nutrition in determining growth and therefore "Western Charts" may be used to assess growth (McLaren and Burman). The description of nutritional status in the PNG community is extremely difficult. This is because there is a gap in knowledge about the optimal growth from this race that has the distinction of living in isolation for many thousand years. There may be a difference in the amount of subcutaneous fat and skeletal mass that make interpretation of other indices such as BMI very difficult.

In the absence of local reference data, and for the sake of uniformity and comparison, the use of the NCHS reference data seems to be the best alternative at this point of time.

The height for age is a more accurate indicator of socioeconomic conditions in a community (WHO 1986). This index is slow to change over time and therefore the effect of any future interventions may be difficult to assess. All the graphs in Appendix 7 clearly indicate that the population suffers from significant PEM

The PEM is possibly not due to food shortage. PNG is a fertile country and is not prone to famine and drought like many other places. An analysis of food consumption patterns can be found in the next section.

Using the cut off values suggested by the WHO, the prevalence of low anthropometric values (<-2 SD) in the study population is estimated **as high/very high thereby defining the population as one at risk of VAD**

In present population, it would be interesting to see the effects of Vitamin A supplementation programs on the anthropometric indices since the population suffers from a significant degree of PEM but only moderate VAD.

5.6.4 MARKET AND HOUSEHOLD FOOD AVAILABILITY

The average family in rural PNG has access to land and is engaged in subsistence farming (98%). From the interviews, it was apparent that few of them purchase all their food directly from the market. Rather than focus on market food availability, the pattern of food grown/collected locally will be discussed. Only 2% of the people depended on food obtained from the market. Many Vitamin A containing foods were noted to be high in the list of things grown in the family garden.

More than 75% had kumu (DGLV) and bananas growing in their garden. More than 60% had corn, sweet potato, beans and pumpkins in their garden.

In many villages in PNG some fruit trees are "common property" and mothers collect fruit for their household consumption. Pawpaw and Bananas were available to more than 80% of households on a regular basis.

Fish is plentiful in the rivers and creeks and in addition tinned fish, canned meats, cooking oils are available in the store in the village. Hunting for wild pigs, wallabies and birds provides extra meat on the table but is not a part of the daily diet.

This survey at the household level used focus groups of women and elders to generate a list of important foods available in homes whether from the home garden, hunting and gathering, or sources outside the community. Seasonal availability of food is not as important issue in PNG as it is in South East Asia and Africa because of the fact that drought is not a regular problem in the country. The usual quantity eaten by the family was difficult to estimate since children had access to the foods the whole day in their own garden and all around the village. A lot of them simply plucked the fruit/ vegetable and ate them when they were hungry. The weekly frequency of use presented in the next section may therefore be an underestimate.

Some studies have shown the beneficial effects of encouraging home gardens in VAD prone areas (Vijayraghavan). In addition, they could provide a potential source of income although in rural PNG the barter system is well in place. In any case most families grow the same things and staple diet sago, grows wild too.

The WHO guidelines indicate that a community is at high risk when vitamin A and carotene-rich foods become scarce in the market and cost to meet the recommended dietary intake by eating them nears the cost of obtaining vitamin A from animal sources. A low risk exists when vitamin A-rich foods are available in the home >3-times per week for >75% of households. In addition, adequate amounts of staples and fat/oil should be consumed. The risk of VAD is greater when consumption of foods of animal origin does not regularly occur.

Using this indicator, the risk of developing VAD in this community is low.

5.6.5 DIETARY PATTERNS OF VULNERABLE GROUPS: SEMI-QUANTITATIVE AND QUALITATIVE MEASURES OF FOOD CONSUMPTION

An assessment of the dietary patterns in children below 6 years of age by individual and household assessment revealed that 69.8% consumed DGLV (kumu) every day of the week. The mean number of days/week that kumu was eaten was 5.6 and less than 14.2% of children consumed DGLV less than 3 days /week. DGLV is a well-recognised source of pro vitamin A carotenoids. The mean serum retinol in children consuming DGLV > three days/ week was 1.033 μmol/L which is a good source of vitamin A.

The usual way in which kumu is prepared is by boiling which is known to break down plant cell wall complexes thereby increasing the presentation of vitamin

A to the digestive system. The loss of vitamin A activity by boiling is less than 20%.

Whole fish was consumed by 51.5% of children ≥ 3 times /week. (Mean 3.2). Fish is easy to obtain because most villages in the region are located next to the river.

Carrots were not consumed by any of the children, as they are more commonly grown in higher altitude areas in the country.

Sweet potatoes were not so commonly eaten (28.3% ≥ 3 days/week) as would have been expected considering that most households had "kaukau"(sweet potatoes) growing in their garden. This is the same situation with pawpaw consumption (2.6%> 3-days/ week mean 1.5) which grows commonly in the region.

Mangoes were eaten only in season and therefore are not a regular source of the vitamin throughout the year. Only 4 children had eaten a mango in the week preceding the study.

Cooking banana, (which is a good source of provitamin A carotenoids) was a commonly consumed cooked vegetable (70.2% ≥ 3 days/week. mean 4.5 days/week).

Eating banana was consumed by 55.7% of children ≥ 3 days/week; mean 3.3 days)

Tomatoes, Chinese cabbage, pumpkin, pandanus, pineapples, guava, shellfish, avocado pears, whole milk and eggs were consumed infrequently or not at all,

As mentioned before, these children have access to many yellow fruits growing in the village and possibly pluck them directly from the tree and eat them whenever they are hungry rather than depending on the mother to collect them formally for home consumption. This would result in an underestimation of Vitamin A intake.

The above data is probably more accurate when considering things like cooking banana, DGLV and the tubers, as they have to be cooked. Regular food consumption patterns during pregnancy and lactation, complementary feeding or infants are not available. This data would have been useful and could be collected in the future.

According to the WHO guidelines an adequate dietary pattern among vulnerable groups means consumption of vitamin A-rich foods three or more times per week together with the use of sufficient staples, fats and some foods of animal origin in >75% of the population. At-risk groups include pregnant and lactating women, infants and children during the period of complementary feeding and fully weaned children through 5 years of age.

A semi quantitative assessment of dietary Vitamin A intake as suggested by Underwood et al could not be done since the children ate varying amounts (age 6-72 months) and the sample size was rather small for a meaningful outcome.

Using this cut off value and keeping in mind the breast feeding patterns prevalent in the community, the population can be described as being at low risk of developing VAD

5.6.6 ILLNESS RELATED INDICATORS

IMMUNISATION COVERAGE RATES

The immunisation rates in children between 12-23 months were generally poor and none of them were fully immunised against measles.

The BCG vaccination coverage was slightly better with 62.1% being completely immunised. This is probably because one dose is enough for completing the schedule. This reflects a break down of the primary health services in the region.

Vaccine preventable diseases are still common in PNG, as vaccination coverage for all antigens except BCG has generally been below 70 per cent since 1991. Papua New Guinea has not yet been able to achieve the high coverage of immunisation needed to protect children against the major diseases.

In case of an epidemic of measles, chicken pox or Tuberculosis, the danger of developing VAD is obvious.

Using the WHO guidelines, this puts the whole population at risk of developing VAD.

DISEASE PREVALENCE RATES

Communicable diseases such as measles, chicken pox, mumps, influenza, and skin diseases are quite common during the school age

years. The ability of a child to recover quickly from disease is greatly influenced by his or her nutritional health status. Under nutrition in school age children is a concern that has not been addressed adequately.

DIARRHOEA PREVALENCE RATES

The diarrhoea rates in the study population were 11.3%. Diarrhoea is a common cause of childhood illness and death in Papua New Guinea. In 1994, a total number of 66,308 children under five were treated for diarrhoeal diseases; and 4,705 children were admitted to health institutions for diarrhoea, which accounts for 24 per cent of all child admissions. A survey of Expanded Program of Immunisation (EPI) and Control of Diarrhoeal Diseases (CDD), conducted in the NCD and Central province in 1993, found that on average young children get three episodes of diarrhoea per child per year. Diarrhoeal diseases are also an important cause of malnutrition and low resistance to other childhood infections.

Diarrhoea is a disease that reflects sanitation and hygiene conditions. Only about a quarter of the population in PNG has access to safe water, while approximately 10% of people have adequate means of excreta disposal. High rainfall and the mountainous terrain make ideal conditions for faecal contamination of surface water, which is the most common source of drinking water in many communities throughout Papua New Guinea.

The mean Serum retinol in the patients with diarrhoea was

1.2μmol/L (n=10). No conclusion can be drawn, as the numbers are very small.

While assessment of DD incidence in a region may be helpful in identifying populations at high risk of VAD, its prime usefulness lies in applying such information for disease targeting of vitamin A control programs, and for monitoring and evaluating control strategies that promote breast-feeding and healthy complementary feeding practices. The available data suggest that providing vitamin A supplements may not influence the severity of a diarrhoeal episode although vitamin A supplementation has been shown to reduce diarrhoea specific mortality. Many cross sectional studies have established the link between diarrhoea and impaired vitamin A status (Brilliant et. al 1988, Gujral et. al 1993,Sommer et. al 1982 and others). However, contact with the medical system for a current episode could permit the administration of a vitamin A supplement that will improve the subject's vitamin A status and decrease the severity of the next episode.

Data collected by interview on the incidence and period-prevalence of DD, although obtained in most cross-sectional health surveys, are not always reliable given the inverse relationship between accuracy and period of recall (WHO 1996).

Quantitative information on DD episodes, duration, frequency of stooling, and consistency of stools can be used to determine prevalence of persistent and severe diarrhoea. A two-week period prevalence of DD >20% in the selected population may be used to identify populations at risk of VAD.

However, this criterion should be further validated by field studies that more directly measure vitamin A status among populations with different period-prevalence rates (WHO 1996).

Using this indicator, the population is not at risk of VAD

FEVER AND HELMINTHIC RATES

The fever prevalence rate was 34%. The mean serum retinol in this group was 1.3µmol/L and in 43.8% of these subjects, the CRP was not elevated. The mean RBP in this group was 19.23 mg/L. Helminthic infestation was not done because of the logistical problems of handling stool specimens in the village setting.

The CRP levels were elevated in 41% of the children. This indicates that many of them had underlying infections then or in the immediate past.

TABLE 5.22 CRP LEVELS

CRP LEVELS	FREQ.	%
ZERO	56	58.9
ELEVATED	39	41.1
	95	100

Using the WHO cut off values, the population studied is at risk of VAD.

OTHER INFECTIONS

The commonest infections encountered were those of the skin (superficial mycoses), upper respiratory tract (2.2%) and clinical malaria (3.3%). A positive malaria slide was encountered in 2.1% of the children.

MALARIA

In many areas of PNG, malaria is endemic and could, along with other factors, play a role in increasing the Vitamin A requirement. The exact relationship between the two is not clear. Malaria is also a major cause of infant and child mortality. Children between the ages of 3 months and five years of age are in the greatest danger of contracting malaria, as they have insufficient immunity.

Splenic enlargement was observed in 28.3% of the children. The commonest cause of splenic enlargement in PNG is chronic malaria.

Depression of Serum retinol in areas with endemic malaria has been shown by Filteau et al (1993) in Ghanaian children. In their article, the authors cite a personal communication by P Arthur in which he indicates that administration of Vitamin A made no difference to malaria parasitemia, density and only a slight difference to rate. The importance of malaria as a cause of low serum retinol in endemic areas such as parts of PNG and the impact of vector control programs on serum retinol requires further study. In

our study, only two children had a positive malaria slide. Their serum retinols were 0.7 and 0.8μmol/L respectively.

The magnitude and rapidity of fall and subsequent recovery of serum retinol levels in children with acute infections suggests direct interference with vitamin A release and transport. This is in addition to the depleting effects of impaired absorption and utilisation and excretion (Sommer 1996). The pre malaria serum retinol levels of these two children were unavailable and it is difficult to comment on the degree of serum retinol depression due to the malaria. Another aspect that needs to be studied is the difference in serum retinols in children with acute and chronic malaria.

PNEUMONIA

The living conditions throughout most of the country make children susceptible to catching pneumonia. The Highlands has the highest number of admissions and rate of death due to this disease. Prevention of respiratory infections needs more public health education programs aimed at improving housing to eliminate overcrowding and smoke-filled interiors, better nutrition so as to increase the child's general resistance to infections and ensuring that children are properly immunised.

5.6.7 SOCIOECONOMIC INDICATORS

Socioeconomic indicators are useful as pointers to a population's vulnerability to VAD and, as such, are useful in planning a

vitamin A intervention program, particularly when no clinical, biochemical or dietary surveys have been done. However, and despite their possible use for advocacy purposes, because these indicators lack both sensitivity and specificity they are of no use in monitoring and evaluating the impact of a vitamin A program. These indicators are most useful as supporting evidence of other, more specific, biologic and ecological indicators of vulnerability to VAD.

MATERNAL EDUCATION AND LITERACY

The survey showed that only a third (34%) of the mothers had not attended any school. Primary schools are present in most villages although there are problems in recruiting and retaining teachers. High schools are situated only in the larger villages and towns.

Sommer et al (1982), Tielsch et al (1984), Khatry et al (1995) and others have demonstrated that parents of cases of xerophthalmia are less educated and more likely to have one or more children die than control families. There is a consistent inverted relationship between VAD prevalence and maternal education and literacy.

No schooling or illiteracy in >50% of women I 5-44 years of age is associated with a high vulnerability to VAD when evaluated along with food availability and dietary patterns of preschool-aged children.

Using this indicator and the suggested cut off values, the study population is not at risk of VAD

INCOME/EMPLOYMENT

In many countries VAD, prevalence is closely correlated with poverty. Low-income families are unable to afford frequent consumption of foods of animal origin, the vegetables and fruits that are the main non-animal sources of dietary vitamin A or fat, which facilitates absorption of provitamin A sources. Low income, coupled with the usual lack of knowledge about VAD and the nutrient content of common foods, contribute to a very high risk of VAD.

In this study, 68% of households had a regular income most of which was earned by selling produce (78.8%) in the local market especially betelnut which grows in abundance in the area. The main buyers are the highlanders who purchase betelnut in bulk to sell in the highlands where they get a good price for it.

Reliable income data are difficult and costly to obtain and analyse, especially figures on the exact amount earned. This data has more relevance in the urban setting where money is used to buy food and subsistence farming less common. Regular employment in the villages is uncommon as most of the jobs are in the city. In the 50 households studied, only four households had a family member "employed".

The relationship between socioeconomic status and xerophthalmia has been studied in Aceh (Indonesia) by Mele, West et al (1990) and it was shown that the families of xerophthalmic children were from a lower socioeconomic

status as compared to non xerophthalmic families. To see how true this is for sub clinical VAD may be a direction for future surveys.

No suggestions can be made from this indicator since it is meant to assess urban populations. It is encouraging to note that the majority of families had access to cash, which is mainly used on education and clothing.

WATER SUPPLY AND SANITATION

Only 28% of the households studied had access to safe water. The rest of them relied on the rivers and streams (38%), bore holes (4%) and unprotected wells (24%) for their water supply.

National health authorities commonly collect these data on an annual or periodic basis, often with the support of external agencies including international and bilateral organisations.

There is a high probability of VAD if, in addition to being at risk based on diet and illness-related factors, <50% of households have a safe water supply.

Using this indicator, the study population is at risk of VAD.

ACCESS TO HEALTH CARE AND SOCIAL SERVICES

Populations physically remote from health and social services are often more prone to VAD, partly because of low socioeconomic status, but also because of frequent or severe infections due to low immunisation rates and

inadequate treatment. Some low-income urban/periurban households, which may make little use of health services, even when available, are likewise at risk

The use of this indicator is difficult since the situation keeps changing but overall, one can say that using the cut off values suggested by the WHO, **the population is not at high risk of VAD.**

ACCESS TO LAND

In many countries, in the rural areas absence of land ownership, or access to land, commonly means casual-labour livelihood and, as a consequence, poverty. Traditional practices may allow tenant farming to continue on unfavourable terms for the tenant but without the possibility of producing enough food to meet the family's direct consumption needs. This does not seem to be an issue in PNG where almost all people not only have access to arable land, but also its ownership.

This indicates that the study population is not at risk of VAD.

OTHER ASPECTS

HEALTH OF SCHOOL AGE CHILDREN

The National Health Plan aims to increase the proportion of school children screened and vaccinated to 80 per cent or more by the year

2000. In addition to annual visits from local health clinic staff, the strategy to be carried out includes the incorporation of health education into the curriculum of community and secondary schools, and for schools to provide first aid and health promotional activities

ANAEMIA

The mean Haemoglobin was 92 g/L, which is low and needs to be addressed. The causes for this could include PEM, mild VAD, and helminthiasis. The relationship between anaemia and VAD was demonstrated in the classic study by Hodges and his colleagues in the mid 1970's. The increase in mean Haemoglobin after vitamin A administration to Indonesian preschool children has been demonstrated (Muhilal et. al 1988) earlier. The dose of vitamin A required to increase the haemoglobin levels in anaemic children is close to the recommended daily intake and the action is based on a reduction in VAD rather than a pharmacological effect (FAO 1988). Taking care of the associated factors such as PEM and intestinal worms needs further study and perhaps a limited trial under controlled conditions.

There was a mild correlation between Serum retinol and Haemoglobin ($r=0.17$) in line with other studies (Mejia et. al 1979, Mohanram et. al 1977).

TABLE 5.23 SERUM RETINOL AND HAEMOGLOBIN

Source	Df	SS	MS	F statistic
Regression	11	10.68	0.68	2.94
Residuals	996	22.08	0.23	
Total	997	22.76		

The mean haemoglobin levels in children with serum retinol<0.7µmol/L were 87.5 g/L (n=10). This could reflect the dietary habits, impact of infections or be a result of the lower vitamin A levels per se. There was a positive correlation of prealbumin and haemoglobin levels(r=0.35)

TABLE 5.24: SERUM RETINOL AND PREALBUMIN

ource	f	S	S	F statistic
egression	1	5.32	5.32	3.35
esiduals	96	10.15	.15	
otal	97	25.47		

There was no correlation of haemoglobin with total protein, Vitamin E, age, anthropometric indices or Triglycerides levels or sex.

The numbers are too small to draw any meaningful conclusions. Further studies to characterise the anaemia are needed.

IODINE DEFICIENCY DISORDERS

No cases of goitre were seen.

In June 1995, the Pure Foods Act was amended to prohibit the importation and/or sale of non-iodised salt. Nutritionists and DOH health inspectors have been trained in the detection of goitre as well as the testing of salt for iodine content.

These measures have been found to be partly successful since non-iodised salt was also being sold in the villages at cheaper prices than the iodised variety.

Though not directly related to VAD, it does reflect the breakdown of enforcement of important legislation by the Health Department in the rural and remote sector. This is where the bulk of Papua New Guinea's population lives. The situation that exists with respect to immunisation, staffing of remote health clinics and availability of medications needs to be addressed urgently.

RESULTS OF THE EYE EXAMINATION

Papua New Guineans are known to have good eyesight and do not suffer from many diseases that are common in western populations.

None of the children had any obvious defect. Purulent conjunctivitis and a posttraumatic corneal scar were seen in one child. Accidental instillation of lime, which is chewed along with betel nut, is a common cause of corneal opacity in children. Blinding Trachoma is also uncommon possibly because of the abundance of water in these villages, despite the presence of flies.

PREALBUMIN AND TOTAL PROTEIN

The mean prealbumin was 137.2 mg/L. This was much lower than preschool children in Sydney as reported by Karr in 1997 (186.2 mg/L). This may reflect the lower protein quality and intake by children in the Ramu region as shown by the data collected from the interviews. The only source of dietary protein seems to be breast milk and fish. Ingestion of red meat and poultry as well as bush meat was occasional. The relationship between prealbumin and the other biochemical parameters is presented earlier.

The mean total protein levels were 70.4 mg/L which is also low. Protein Energy Malnutrition affects vitamin A metabolism by reducing carotenoid cleavage and synthesis of RBP and receptors. On the other hand, by restraining growth, it retards the development of acute xerophthalmic signs of VAD. It has been shown that children deficient in protein, tend to be deficient in other nutrients as well (McCollum

1925,Graham 1921) This non causal relationship could explain this association between vitamin A and protein levels (Sommer 1982).

Common origins: the association of hygiene standards, dietary habits and the infection-malnutrition complex (Ahmed et. al 1993) could also explain this association.

The close relationship between serum retinol and protein levels demonstrated in this study is said to provide a reasonably sensitive and specific biochemical index for differentiating xerophthalmia patients of varying clinical severity-an index superior to either of its components alone (Sommer 1982).

This relationship is maintained in children without xerophthalmia (as in our population) but would be expected to break down in subjects with severe VAD or PEM with obvious xerophthalmia or corneal dissolution (Sommer 1982)

The danger of increased protein demand as in a growth spurt or recovery from PEM with an adequate diet may precipitate an increased demand for vitamin A and precipitate VAD (Gopalan et. al 1960, Bloch et. al 1924). This must be kept in mind when planning vitamin A supplementation in a background of low serum protein or vice versa and adds support to the suggestion that in PNG, a global improvement is necessary rather than focussing on one single micronutrient.

LIPIDS

Fat is essential for the effective intestinal absorption of Vitamin A. A daily fat intake of 10-20g/day is sufficient when concomitantly ingested with Vitamin A

After going through the questionnaire, it seemed that the obvious source of lipids in the diet seemed to be cooking oil (mean 5.4 days/week) or breast milk in the appropriate group.

A large number of experts have drawn attention to the fact that VAD could occur secondary to low fat ingestion (Erdman et. al 1988, Begum et. al 1977, Roels et. al 1958).

This needs to be kept in mind when planning dietary intervention programs.

Papua New Guinea has been classified as a country where clinical VAD exists based on a previous report from the East Sepik where 91% had a serum retinol of less than 0.7μmol/L. In addition, a hospital-based study in 9 provinces revealed that 0.59% of children had clinical VAD.

TABLE 5.24: SUMMARY OF INDICATORS

INDICATOR	CLASSIFICATION OF RAMU POPULATION
XEROPHTHALMIA	
NIGHT BLINDNESS	MILD
SERUM RETINOL	MODERATE
ICT	SPECIMENS INADEQUATE
BREAST FEEDING PATTERNS	NOT AT RISK
LOW BIRTH WEIGHT	AT RISK
ANTHROPOMETRIC INDICATORS	AT RISK
FOOD AVAILABILITY	NOT AT RISK
FEEDING PATTERNS	LOW RISK
IMMUNISATION COVERAGE	AT RISK
DIARRHOEA RATES	NOT AT RISK
FEVER RATES	AT RISK
INCOME EMPLOYMENT	
ACCESS TO LAND	NOT AT RISK
ACCESS TO HEALTH SERVICES	NOT AT HIGH RISK
WATER SUPPLY	RISK
MATERNAL EDUCATION AND LITERACY	NOT AT RISK

OUTCOMES

Other benefits that came out of the project were:

- The population in the region got long needed attention and access to medical care including immunisation

- Sixty-three cataract blind persons had their sight restored through surgery with Intra Ocular Lens implantation that was carried out in the village itself.

- On site training of para-medical and allied health staff.

- Increasing the awareness of the local and medical community about health care issues in remote and rural locations in PNG.

Although this is only a pilot study using a greater number of indicators in another region, Papua New Guinea perhaps needs to be reclassified as a country with children at moderate risk of VAD and steps to address this instituted accordingly.

CHAPTER 6:

WHAT NEEDS TO BE DONE

It is evident from this study that the Vitamin A deficiency is not a major problem in the area studied in PNG. Children in PNG do not figure in the global statistics of nutritional blindness. The classification of the WHO that PNG is a country with clinical VAD needs to be changed. This will allow the concerned Governmental and Non Governmental agencies to change their focus and concentrate on the real issues of an inadequate primary health care delivery, infections and malnutrition which afflicts the majority of rural children.

The association between stunting wasting, increased susceptibility to infections and mortality in Vitamin A deficient children is well known. (Sommer 1996). It is also clear that the risk of death is directly related to the severity of VAD.

Trials with Vitamin A supplementation indicate that improvement in Vitamin A status of preschool children resulted in a decrease in mortality (Beaton et. al, 1992)

SOME POSSIBLE CAUSES OF THE PROBLEM

The DOH is well aware of the lapses and inadequacies of various initiatives that it has put forward in the past years to try and improve the lot of children living and rural and remote areas of PNG.

Strengthening of primary health care delivery systems that deal with infectious diseases, immunisation, nutrition as well as maternal and child health is

the answer. The major obstacle in primary health care delivery is financial. Lack of funding often leads to closure of health care facilities. It is not uncommon to find rural nurses, aid post orderlies and community health workers have not been paid their salaries for long periods of time. In addition, lack of medications and vaccines are common. It is well known that working in the bush is a challenging task and many health care professionals suffer the usual associated problems of isolation, exhaustion, lack of educational and recreational facilities, accommodation problems and burn out. When these factors are compounded with the financial constraints alluded to earlier; many of them quit their jobs in frustration. Finding the person with the right ethnic background is also an issue since many clans and tribes do not get along well together. A lack of active support by the provincial health departments of the man out in the field is another problem. Funds for travel are often unavailable so that support and relief services do not find their way into the bush or even if they do, they are irregular and inadequate.

UNICEF is a potential source of funding and resources. Its thrust towards fortification of foods with Vitamin A is good but this measure will not work in isolation in the presence of PEM, poor immunisation status, lack of proper drinking water supply, rampant infections and so on. There is no doubt that Vitamin A administration has well demonstrated positive effects on growth and a variety of bodily and immune functions but this must be accompanied by improved nutritional status, provision of safe water supply, better vaccination coverage, etc. A multi faceted, multi disciplinary approach is the way to address the problem.

Availability and consumption of Vitamin A containing foods is not the predominant issue. The major problem seems to be the factors leading onto PEM which need to be addressed. The high incidence of DD and infectious diseases in a growing child is a problem.

Legislation banning the sale of feeding bottles and non-iodised salt are very good. Studies by Friesen (1995) and this one have shown that both these measures have not been totally successful on the ground

Education of mothers who are the primary caretakers of children in the use of better nutritional practices does not find a place in the school curriculum. The positive impact on VAD reduction by teaching Bangladeshi mothers better cooking techniques has been demonstrated (Rahman et al 1994) and there is no reason why it would not work in PNG. The problem is that such programs are personnel intensive and perhaps better communication ("Social Marketing") in an effort to create the demand for a better diet may be the way to go (Griffiths et. al 1994). PNG is fortunate to have schools in many of the villages and in addition many adult literacy programs are in place. Nutrition education could start from there.

The health workforce is inadequate as most of the medical staff are located in the provincial hospitals and are bogged down with managing acute problems. Their involvement in curative medicine leaves little scope for their input in preventive medicine. The department of Community and Preventive Medicine is very small and serves an academic function rather than playing an active role in devising and implementing appropriate programs in the bush.

The media (radio/TV and newspaper) is fairly well developed in PNG but the majority of people living in rural areas have no access to this aspect of development in the nation. At best some areas can receive radio transmissions. The additional problem of not using vernacular for broadcasts restricts the efficacy of this medium.

Information on health status of women and children is meagre and is based on hospital attendance and clinic statistics. Very few actual surveys at the village level exist. Many are focussed on the study of specific diseases such as malaria, Japanese encephalitis, STD and so on rather than on the overall health status of the individual.

A lot of Social development dollars that are supposedly to be used by many of the major mining and oil companies to improve the lot of villages in their region of operation are not being used effectively. This is partly due to a lack of cooperation and planning between the National and provincial DOH and the companies in terms of devising and implementing plans in primary health care.

Financial allocations by the DOH for primary health care are minimal. The bulk of the health budget goes on salaries and very little on operations. This has led to the creation of a large workforce with no money to carry out its job. A one off injection of money into a project without any allocation for maintenance, running costs and replacement of the equipment carries out many improvements.

The lack of political will by the duly elected representatives of the people to spend their EDF on health or education issues is obvious. Only a handful of

leaders actually use their money on education and health infrastructure development.

Communication and travel is a major impediment to health service delivery in PNG. The lack of roads means that travel is mainly by air or water, which is expensive.

The poor state of Maternal Health, high incidence of LBW babies, STD and the increase in HIV infections all have a negative impact on the health of children.

SOME POSSIBLE SOLUTIONS

INFORMATION, EDUCATION AND COMMUNICATION (IEC)

Information education and communication are relevant to all the issues discussed above. They play a key role in general health promotion, changing of eating habits, lifestyle and cultural behaviour that may be detrimental to the health of susceptible children. They encourage action at the local and governmental levels by increasing awareness. Some specific measures include:

- Increasing the coverage by TV and radio by installing additional transmitters in remote and rural locations
- Ensuring availability of health promotional literature publication and distribution in the local languages
- Introduction of health and nutrition in school curricula. Children are a powerful medium to send messages home to their parents.
- Regular production and distribution of appropriate posters and other display material.

- Improvement in maternal literacy is an important measure that is likely to have a positive impact on child rearing practices.

Closer cooperation between the Departments of Education and Health are necessary to make this work.

STRENGTHENING MATERNAL AND CHILD HEALTH PROGRAMS

This is a critical area and needs a lot of thought and action by the Government as it has been amply demonstrated time and again that the state of mothers and children in PNG is bad as evidenced by infant and maternal mortality statistics. A concerted effort to introduce better antenatal care, immunisation coverage, family planning and prophylaxis against STD should be the key thrust areas.

The Maternal and Child Health program that the DOH has recently initiated with the assistance of AUSAID is a positive step in the right direction.

FOOD SUPPLEMENTATION

There is no doubt that Vitamin A deficiency is a contributory factor in childhood morbidity and mortality. In fact in 1983, Sommer et al stated that "Our results suggest that the existence of even mild xerophthalmia in a community justifies vigorous intervention measures as much to reduce childhood mortality as to reduce blindness". This statement cannot be more apt when dealing with children in PNG. The only question is what strategies to adopt.

Sommer (1996) states that vegetables and fruits are not as effective in raising vitamin A status to optimal in populations that are no longer moderately or

severely deficient. In such populations an increase in dietary fat may be helpful. *The need of the hour is to shift the focus away from single micronutrient enhancement and to concentrate on a global improvement in nutrition.* A sustainable strategy needs to be adopted otherwise the fate of this program will be the same as many other vertical measures that are (historically) doomed to failure.

Although the degree of VAD and PEM encountered was not severe, the role that Vitamin A plays in reducing childhood mortality and enhancing child survival and growth is proven beyond doubt. In the rural setting, there is no dearth of Vitamin A containing foods. The problem seems to be the additional Protein Energy malnutrition that exists and that needs to be addressed urgently.

Ensuring that the intake of 180-450µg of retinol or Retinol Equivalents (RE) a day is not an issue as most Vitamin A containing foods are available throughout the year. This requirement increases in the presence of PEM and infections. There is decreased absorption, storage and utilisation in PEM, decreased absorption with gastrointestinal infections and increased demands during febrile infections.

It has been shown beyond doubt that subclinical Vitamin A deficiency contributes to increased mortality and morbidity (risk of dying increases by 23-30%) with childhood infections such as diarrhoea and measles. This reduced immunity is sometimes reversible with Vitamin A supplementation (Semba et al 1993)

Clearly this problem needs to be tackled differently in PNG where access to Vitamin A risk foods is not the primary problem. A measure to prevent infectious diseases in addition to improving general nutrition seems to be the correct approach. It is quite possible that if a larger study is done, pockets of clinical VAD may be identified where high dose Vitamin A supplementation may also be necessary.

In other places low dose supplementation may be the answer. Mothers of childbearing age need to be studied as far as their nutritional status is concerned and should be included in the program. This, however is a useful measure in the short term in high-risk populations.

The issues of improvement of potable water supplies and sanitation to the villages are self-evident.

The introduction of a school meal program is a possible way of ensuring that each child gets at least one balanced meal /day since there is enough anecdotal evidence that many children go to school hungry.

Education on how to prepare DGLV (lightly boiling, throwing away the water, cutting into small pieces and mixing with the staple diet) is important

Research is needed to develop technologies for the multiple nutrient fortification of foods that are used in PNG in ways that retain and or promote micronutrient balance and bioavailability. Research is needed to develop novel, household food preparation techniques that optimise the nutritional value of foods and reduce demands on women's time.

THE PROBLEM WITH SUPPLEMENTATION PROGRAMS is that since VAD coexists with other micronutrient deficiency, the program does often not address these. Children living in remote areas get left out anyway since they are difficult to reach. Moreover, most of these programs are limited by time and after the duration of the program, things return to as they were before. (Fawzi, 1993)

Food supplementation is another avenue using locally available resources.

Research is needed to increase cropping system diversification, including integrated crop-livestock (including birds, small mammals and fish) systems. Efforts should also emphasise the use of fruits and vegetables, and should include the development of appropriate technologies for preserving and storing foods.

Research is also needed to increase the use of edible indigenous plants and to enhance the dissemination of the results to other potential users (eg. farmers, communities, and policy-makers)

THE CASE FOR FISH MEAL AS A SUPPLEMENT

On way of making a cheap source of nutrients available is through fishmeal. Fish is plentiful in Papua New Guinea. Most of the fish caught globally is consumed by people in the more affluent countries and is of little help to the malnourished part of the world's population. About 30 % of the total world catch is used to produce fishmeal, an animal food, and not directly for human

consumption. In addition about 5 million tons of fish obtained during shrimp trawling are discarded for various reasons.

As a food, fish provides an excellent balance of nutrients. Although it is low in calories, it is high in good quality proteins, which are about 20 % of raw weight. Fish protein has a higher biological value than meat from land animals as well as having increased amounts of minerals, vitamins and unsaturated fatty acids. An added advantage is that the cost of producing animal proteins from the sea is significantly lower than producing them on the land.

Compared to animal fats, the fat of fish generally provides a higher proportion of unsaturated fatty acids. A large percentage of fish fat is made up of polyunsaturated fat (omega-3 fatty acids).

The calcium contained in the skeleton of fish is an important nutritional element. If the bones are softened by cooking and consumed with the flesh then the body takes in a substantial amount of calcium. The calcium content of shell and bone is not normally available to the body but if canned products are consumed, soluble calcium is available to the body. Fatty fish are usually a very valuable source of the fat-soluble vitamins, A, D. and E.

In addition, marine fish, shellfish and seaweed are a rich source of Iodine. There is an urgent need to start fish feeding programs in the regions of Papua New Guinea where protein deficiency diseases and other heart-related problems occur. In addition, the inland population consumes large quantities of fatty foods. This is evident from the statistics available on the amount of lamb flaps, which are very high in fat, being imported into the country. There is, therefore, an urgent need to conduct a nutritional awareness campaign to educate consumers. Despite the large quantity of canned fish imported into the country evidence shows a shift in consumer preference due to high price structure. There is a need to introduce cheaper fish products to fight against protein deficiencies. Initially this could be done with the assistance of international funding agencies and later, if it proves successful, by local production.

Fish protein concentrate (FPC) is a dry stable fish powder with a protein concentration much higher than in the original fish. This additive can be used during the normal cooking of vegetables and fights malnutrition where there is shortage of protein rich food. In Papua New Guinea about 18,000 tons of trash fish obtained during trawling is wasted for various reasons. If initial trials using imported FPC prove successful then it may be possible to convert all this trash fish to FPC for the fight against protein malnutrition and to build up a healthy population. There is increasing concern about upgrading the utilisation of these resources. The production FPC or fish powder with the taste and smell of fish seems to be a technologically and economically viable solution to the problem of exploiting these fish stocks for the production of human food products.

Using a small quantity of FPC as a daily supplement to a staple food such as cassava, sago, sweet potatoes and taro can provide extra protein, minerals vitamins and thus prevent malnutrition and disease. FPC can also be used **medically** for treatment of people who are sick or malnourished. In addition, FPC can be stored for periods up to one year in humid tropical conditions. Because of lower water, content FPC is also cheap to transport.

There is every indication that fisheries can provide protein food supplies to people of Papua New Guinea. Efforts are needed to make the optimum of the present fishery resources and to convert under-exploited fish resources into products, which fit the consumer's consumption habits and his pocket.

Other initiatives

The Village Livestock Development Project (VLDP)

Papua New Guinea relies very heavily on imported frozen and chilled meat to meet its meat requirements. In 1989, the Department of Agriculture and Livestock (DAL) estimated that the country imported 25,000 tons of sheep meat. These imports were consumed by the 20 % of the population living in the urban and pen-urban centres. The remaining 80 % who live in the rural areas depended either on canned protein, their own produce or on coming into towns to purchase and take back to the village. Two major constraints contribute to this high import level - small animal numbers and the non -availability of breeding animals in the country.

In the 1960s, government commenced various livestock stations (cattle, sheep, goat and poultry). In 1989 the government amalgamated several projects (sheep, goat, poultry, buffalo and bee keeping) into one project known as the Village Livestock Development Project (VLDP) (Tupper & Vano 1989)

The objectives of the project were -

- Create rural employment
- Improve rural nutrition
- Increase rural cash-earning opportunities
- Sustain rural agriculture.

To achieve these objectives the project performed the following functions -

- Produced and distributed appropriate livestock into rural areas
- Extension and training of farmers and provincial staff
- Investigated field problems and conducted experiments accelerate development of technologies.

Ten years ago sheep meat was not common in Papua New Guinean homes but today it is a common sight in many villages, either as cuts or whole carcasses. As readily available meat, it is also used extensively to satisfy social obligations. Although the current breeding population is insufficient to meet the country's demand, it does form a basis from which, through careful breeding policies; a contribution can be made to the overall demand for sheep meat. The fact that most sheep are in the villages means that sheep produced from these breeders will be consumed in the village thus helping to supplement the nutrition of the rural population.

Poultry

Hatching and distribution of suitable poultry for villages has been an ongoing government project since the late 1960s. However, it was not actively promoted, although village chickens have been a common sight in many coastal villages. Improved birds such as broilers and dual-purpose Australorp chickens were promoted and the broiler industry is now very well established meeting 80-90 percent of the country's frozen poultry requirement.

Although interested in promoting village hens, VLDP has been limited by lack of manpower and facilities.

Although production and distribution of poultry (dual-purpose chickens and ducks) has been an ongoing government project for some time, its impact on nutrition is not known. In the last decade or so, some 250,000 to one million chickens have been distributed to villages. There have also been increases in the production and distribution of broiler chickens, which are used largely for making quick money. Surveys carried out in 1990 in the Eastern and Western Highlands indicate that 100 percent of farmers interviewed reared broiler chickens with the intention to sell.

The VLDP should be encouraged and enhanced since it attempts to improve the nutrition in rural areas in the following ways -

- Through the introduction of non-traditional animal types capable of reproduction and management at the village level that can be used for either consumption or sale.
- Promoting sheep, goat, poultry, buffalo and honey production from its stations

throughout the country. More programs of this nature need to be introduced and existing ones strengthened, as they will have long lasting impact on the nutritional status of mothers and children in rural PNG.

VITAMIN A ADMINISTRATION IN PNG IN SPECIAL SITUATIONS

Children suffering from measles, meningitis, diarrhoea and dysentery should be targeted to receive Vitamin A supplements when they are sick. There is enough evidence to prove that this results in a reduction of mortality due to these infections. Vitamin administration should be a part of the therapy of measles.

The beneficial effects of Vitamin A supplementation seem to be limited to persistent diarrhoea rather than acute self-limited diarrhoea. Both the length of the diarrhoeal episode as well as associated mortality decreases. The risk of developing diarrhoea is independent of anthropometric status and seems to depend more on Vitamin A status. The most beneficial effect of Vitamin A supplementation on reducing the mortality in diarrhoea cases in Brazil may be due to a reduction of the severity of the diarrhoea (Baretto et. al 1994)

The beneficial effects of prophylactic administration of Vitamin A versus treating measles are similar. There could be a case for Vitamin A supplementation along with the EPI program as long as there are no permanent health facilities in the villages and the measles CFR remains high.

HUMAN RESOURCE DEVELOPMENT

The development of a focussed primary health delivery workforce is a must. There exists Department of Primary Health Care services within the DOH but that alone cannot ensure that services are delivered at the ground level.

Involvement of the tertiary or curative services in planning primary health care services is important since all levels of health care are part of the health pyramid. Involvement of specialists in teaching and the production and constant updating of training materials is important Some specialities already do this but an integrated, multi-disciplinary approach is essential for a meaningful long-term result. Ante-, peri- and postnatal care needs to be strengthened.

MULTI-SKILLING OF HEALTH PERSONNEL

There needs to be a move away from creating vertical programs and much needs to be done in terms of strengthening health care delivery through broad-based horizontal programs. The seriousness of the problem as well as dietary and other solutions needs to be stressed in training programs for all health personnel.

INTER-SECTORIAL COLLABORATION AND THE ROLE OF NON GOVERNMENTAL ORGANISATIONS

Using an integrated plan for strengthening MCH coverage will allow various NGO's to join in and look after specific parts of the plan. This will also prevent small programs to sprout up wasting resources and often working at cross purposes with the bigger plan. Important participants in the plan are UNICEF, WHO, the oil and mining companies, and for implementation purposes, the Church which has a strong presence and influence in rural PNG.

Initiatives such as the RAM (Rotary against malaria), Susu Mamas need further penetration into the rural areas.

The Scout Association's initiatives in control of Diarrhoeal Diseases (DD) are another step in the right direction but lacks continuity and persistence.

STRENGTHENING INFRASTRUCTURE

Strengthening the intermediate and tertiary level facilities should accompany support of primary health care initiatives. The provision of adequate facilities, medication and vaccines, transport and communication are important in establishing a strong foundation for preventive and promotional activities at the village level. No country program can hope to survive in the long run if its base is not strong and there is no pyramidal structure of facilities and personnel in place.

Issues such as maintenance of the cold chain while executing the EPI program are as important as having the vaccine itself.

EVALUATION

Evaluation is an integral part of the management of any program. Emphasis should be placed on the functionality, cost effectiveness and efficiency of any program. Very often programs in PNG are started and end without any evaluation being carried out. Lack of funds are often cited as the cause although this could be obviated if initial budgeting included funds for evaluation.

Independent assessments as well as reporting systems need to be built into all programs which strive to improve the lot of the children and their mothers in PNG.

RESEARCH

This is just a pilot study but it illustrates the need for epidemiological and operational research. Medical, anthropological and behavioural research could form the basis for appropriately targeted social marketing and IEC efforts

VITAMIN A SUPPLEMENTATION TRIAL

There is a place for a trial to assess the impact of food supplements such as FPC on vitamin A levels and anthropometric indicators in preschool children in areas where IMR are high and immunisation coverage, low. The lack of health facilities is a further reason for this step. It seems that the best approach is to institute low dose supplementation initially and carry out studies like the one outlined above. The practice of giving high doses of vitamin A to patients with measles should be extended to those with life threatening infections and chronic diarrhoea. It is likely that malaria; anaemia and tuberculosis patients would also benefit.

A limited trial with Vitamin A supplementation on the background incidence and prevalence of diseases such as diarrhoea and respiratory infections as well as the associated mortality would provide additional data. It is quite obvious that conditions in PNG are special in terms of food availability and differs from the "standard" African or South East Asian third world child. Again, these need to be tested out in rural and urban settlement settings, as the two populations are different.

The exact number of deaths attributable directly to VAD is not known. There is overwhelming evidence that Vitamin A supplementation in mildly VAD populations can also reduce mortality and therefore this adds more weight to the need for a similar trial in PNG.

On the long term, however, some of the measures outlined above should be instituted without delay so as to have a long lasting permanent impact on reduction of maternal and childhood mortality which continues to be one of the highest in the world.

CHAPTER 7:

DIRECTIONS FOR FUTURE RESEARCH

This is only a pilot study and adequately outlines the fact that in preschool children in rural PNG there is generalised malnutrition rather than singular micronutrient or Vitamin A deficiency. This study also demonstrates that the methodology used in the survey worked well and that future studies could use a similar format.

Future studies need to be done and should be aimed at:

- Assessing the status of urban preschool children living in settlements since this is a population that is potentially at risk of VAD. They have a low -socioeconomic status and also have no access to gardens
- Assessing the liver stores of Vitamin A using the MRDR and SRDR tests
- Assessing the Vitamin A and Nutritional status of mothers
- Assessing the pattern of water borne diseases
- Enhancement of knowledge and skills of Primary health care workers
- Assessing the EPI program and its efficacy
- KAP about food and nutrition in the population
- Improving the utilisation of ORT at the village level
- Looking at methods for dietary supplementation using locally available foods and resources

Some of the newer techniques such as Tear fluid retinol analysis, which is minimally invasive, rapid dark adaptation time, Vision restoration time or the spot retinol test can be used once they have been standardised and cut off values defined.

When VAD ceased to be a problem in wealthier countries, only a handful of people have continued their crusade against the devastating effects of deficiency of this micronutrient on a global basis. But yet the number of children who go blind due to VAD or the number that die due to subclinical deficiency runs in the millions.

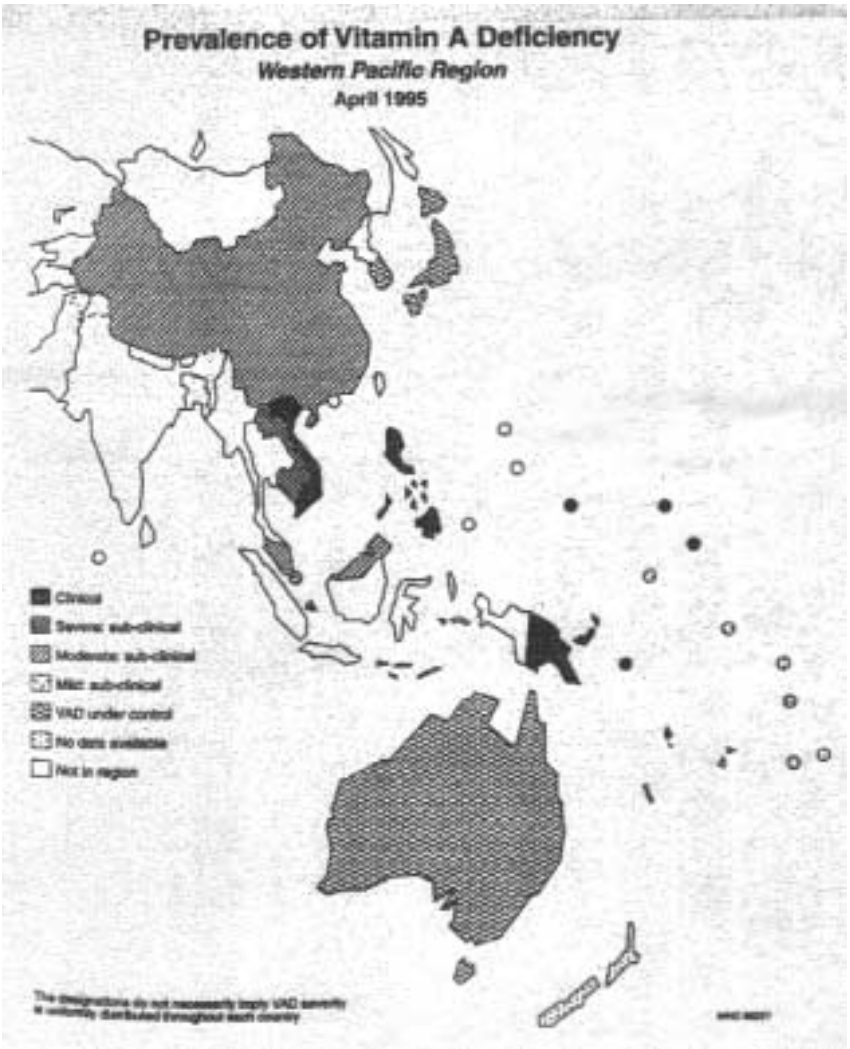
The problem with the state of present knowledge is the fact that the effects of subclinical deficiency are difficult to quantify and the cut off values of indicators are not well established. While it is well known that children with keratomalacia have serum retinol levels below 0.35μmol/L similar cut off values are not established with regard to clinically significant epithelial metaplasia that may make a child prone to pneumonia or urinary tract infection

The answer to what should be done with populations that have mild and moderate vitamin A deficiency using biochemical indicators especially when there is associated PEM still remains elusive. Simple supplementation with Vitamin A is possibly not the singular solution and improvement in sanitation, living standards and the general status of women and children seems to be the solution. Further observational and interventional studies are necessary in this regard

CHAPTER 8: APPENDICES

APPENDIX 1: MAPS OF STUDY AREAS

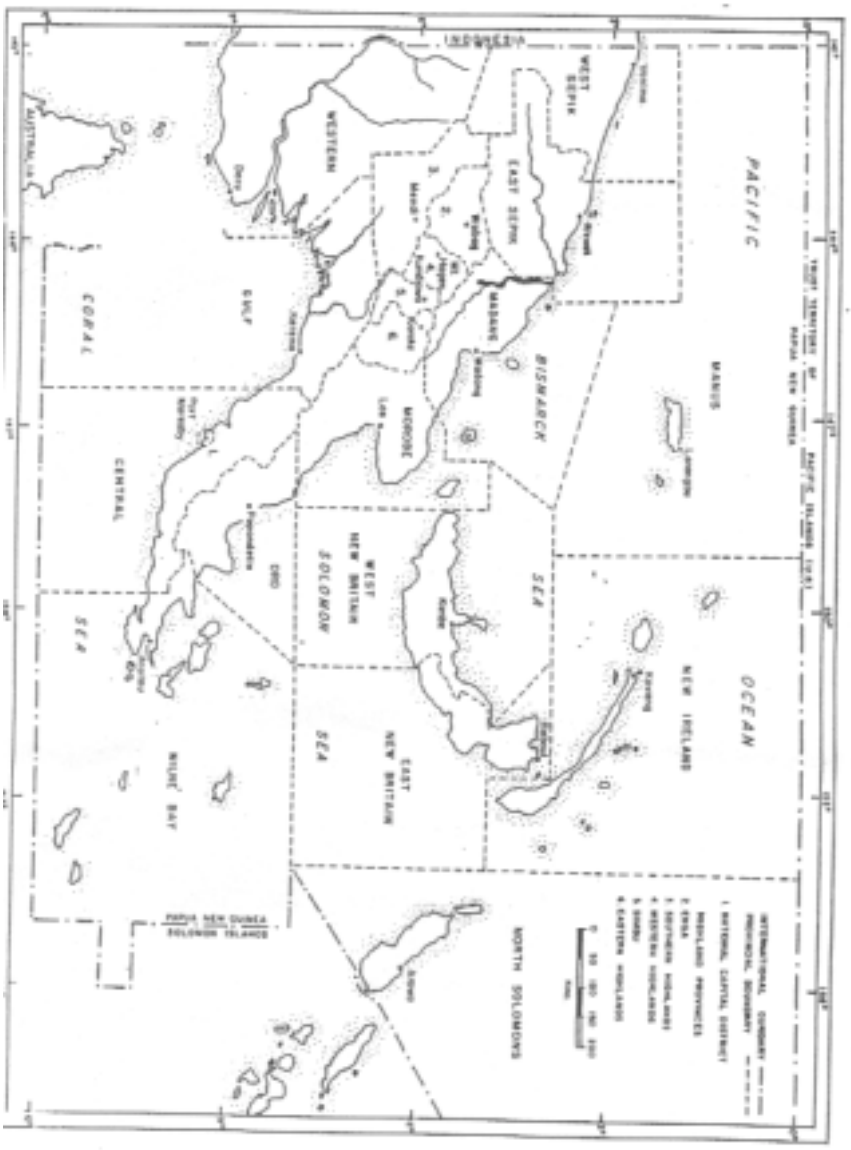
MAP1:VAD IN WPR(WHO)



MAP2: SURVEY AREA AND SURROUNDS

MAP3:RTHE RAMU REGION AND ADJACENT PROVINCES.

MAP 4: PAPUA NEW GUINEA



APPENDIX 2:

SURVEY FORMS AND QUESTIONNAIRES

VITAMIN A STUDY-- HOUSEHOLD INFORMATION FORM

Information to be collected from the mother/head of household

Date:

Name of health worker:

Code

1.Name of mother/ head of household: .....

2.Name of the village:

3.List all children born alive to the mother, including those ones who have died after birth:

	Name	Age	Sex	D.O.B	alive/dead	If dead, Cause of death
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

3a. Number of children between 6 months and 6 years in the household:

3b. Number of children died before the age of 5 years in the household:

4. Does anybody in the family earn cash

no	[1]
yes, from what source	[2]
business (pmv, store)	[31
selling produce	[41
teacher	[51
administrator / clerk	[6]
other, specify	[7]

5. What is the educational level of the mother:

no formal education	[11
up to grade 3	[2]
grade 4 to 6	[31
high school (gr 7-10)	[41
vocational training	[5]
tertiary education	[61
not known	[7]

6. Which of the following items are owned by the household:

radio		[Y] [NI
motorcycle		[Y][N]
bicycle		[Y] [NI
sewing machine		[Y] [N]
outboard motor boat	[Y] [N]	
car / truck	[Y] [N]	

7.- What is the main source of water for the household:

protected well/piped-water	[1]	- ------
unprotected well / spring		[2]
river / stream		[31
swamp		[4]
lake		[51
bore holes		[61
other, specify		[7]

8. What is the walking distance to the main water source:

within the compound	[1]	
less than 5 minutes		[2]
5-20 minutes		[31
more than 20 minutes	[4]	

9. What is the main staple food for the household:

sago	[1]
rice	[21
kaukau	[3]
cooking banana	[41
taro	[5]

other, specify [6]

10. What does the family usually eat with the main staple:

green vegetables	[1]
peanuts	[2]
beans	[3]
peas	[4]
meat	[5]
fish	[6]
other, specify	[7]

.....

11. What did the family eat yesterday evening:

12. Did the family eat something yesterday when they

got up in the morning:
if yes, specify:

if no, continue to question 13

13- Did the family eat something yesterday during the day,

when at work or in the garden: [Y] [N]
if yes, specify:
if no, continue to question 14

14. Does the family have a garden:

[Y] [N]

15. Where does the mother obtain most of the food for

household consumption:

family garden	[1]
market	[2]
other, specify	[3]

16. What is currently growing in the garden of the household:
(do not answer this question if question 14 was "no")

cassava	[Y] [N]
yam	[Y] [N]
aibika / kumu	[Y] [N]
peanuts	[Y] [N]
winged bean	[Y] [N]
legumes	[Y] [N]
corn	[Y] [N]
pumpkin	[Y][N]
snake bean	[Y][N]
other, specify [Y]	

17. What fruits has the mother collected for the family in the last week:

none	[011
pawpaws	[02]
mangoes	[031
guava	[04]
pineapple	[051
passion fruit	[061
oranges	[07]
mandarines	[081
eating bananas	[091
2 of the above	[10]
3 or more	[111
other, specify	[121

.....

VITAMIN A STUDY: VILLAGE INFORMATION FORM

Information to be collected from village chief or elders

Date:

Name of health worker:

Code

1. Name of the village:

2. Estimated total number of people living in the village

3. What is the main source of income for the villagers:
   .....

4. What is the major access to the village:

foothpath	1
motorable track	2
road only in dry season	3
all weather road	4
never	5
by air	6

5. Is public transport available:

no	1
yes, on daily basis	2
yes, twice weekly	3
yes, once weekly	4
yes, less than weekly	5

6. How far is the nearest health centre aid post:

less than 15 minutes walking distance	1
15 - 60 minutes walking distance	2
1 - 3 hours walking distance	3
more than 3 hours walking distance	4

7. Which of the following services are provided at the health centre/aid post:

   Immunisations: yes = 1 no = 2

   Family planning: yes = 1 no = 2

Antenatal care: yes = 1 no = 2

Delivery care: yes= 1 / no= 2

Oral rehydration therapy: yes = 1 / no = 2

others, specify yes= 1 /no=2

8. How far is the nearest primary school:
   - less than 15 minutes walking distance 1
   - 15 - 60 minutes walking distance 2
   - 1 - 3 hours walking distance 3
   - more than 3 hours walking distance 4

9. How far is the nearest trading centre or market:
   - less than 15 minutes walking distance 1
   - 15 - 60 minutes walking distance 2
   - 1 - 3 hours walking distance 3
   - more than 3 hours walking distance 4

10. Is there a shop in the village:

    yes =1 no=2

11. If there is a shop in the village, are the following items sold:

    a. sugar: yes = 1 no = 2

    b. salt: yes=1 no =2

    c. bread: yes = 1 no = 2

    d. rice: yes = 1 no = 2

    e. tinned fish: yes = 1 no 2

12. What is the main source of water in the village?

    - protected well / spring 1
    - rain water tanks 2
    - river 3
    - swamp 4

13. How far is the water source from the village?
    - water source in the village 1
    - less than 15 minutes walking distance 2
    - 15 - 60 minutes wamng distance 3
    - 1 - 3 hours walking distance 4
    - more than 3 hours walking distance 5

14. Are there 5 or more man o trees in the village:
yes =1 no 2

15. Are there rubbish- collection places in the village:

none
few (3 or less)
many (more than 3)

16. Are any traditional medicines used for sore eyes?

yes = 1 no = 2

17. If traditional medicines are used for sore eyes, which type of medicine for which problem:

Eye problem. Medicine:

18. Any other relevant information: (describe briefly)

SUMMARY

19. Number of households visited:

20. Total number of children between 6 months and 72 months in these households:

21. Number of complete child information forms:

22. Number of blood samples taken:

24. Number of breast milk samples collected:

CHILD INFORMATION FORM

Information to be collected from the mother/ guardian of the child

GENERAL INFORMATION

Date:// Name of health worker:

1 Name of the child: Study number

2. Name of the village:

3 Name of head of household:

4. Is a clinic book available? yes =1 no = 2

5. What is the age of the child in months?

6. Sex of the child: male 1 female 2 male

7. Is the child adopted? Yes=1 no 2

8. What is the birth order of the child?

9. Who is the main care taker of the child?

Mother	1
grandmother	2
aunty	3
older sibling	4
other	5

10. Has the child had diarrhoea in the last 7days? yes=l no=2

11. Has the child had fever in the last 7 days? yes= 1 no=2

12. Has the child had a cough in the last 7 days? Yes= 1 no= 2

13. What is the immunisation status of the child?

Vaccine	**Number of doses**
BCG	
Triple antigen	
Sabin	
Measles	
Other	

14. Has the child ever had measles?
yes = 1 no = 2

if "Yes", at what age:

15. Is the child still breast feeding?

yes = 1 no = 2

16. If the child is not breast feeding, at what age in months did the child stop completely?

17. At what age, in months, were solids introduced?

18. What was the child fed after breast feeding?

Name of food	**In past week, number of days an average helping of foods was eaten by the family**							
Sweet potato	0	1	2	3	4	5	6	7
Mango	0	1	2	3	4	5	6	7
Cooking banana 0	1	2	3	4	*5*	6	7	
Sweet banana	0	1	2	3	4	5	6	7
Chinese cabbage	0	1	2	3	4	5	6	7
Pumpkin	0	1	2	3	4	*5*	6	7
Tomato	0	1	2	3	4	5	.,6	7
Pawpaw	0	1	2	3	4	5	6	7
Pandanus	0	1	2	3	4	*5*	6	7
Dark green leafy 0 vegetables	1	2	3	4	5	6	7	
Pineapple	0	1	2	3	4	5	6	7
Eggs (hen/turtle) 0	1	2	@3	4	5	6	7	
Guava	0	1	2	3	4	5	6	7

Taro	0	1	2	3	4	5	6	7
Clams/Mussels	0	1	2	3	4	5	6	7
Whole fish (+liver)	0	1	2	3	4	5	6	7
Other liver	0	1	2		4	5	6	7
Carrot	0	1	2		4	5	6	7
Avocado	0	1	2	3	4	*5*	6	.7
Yam	0	1	2		4	5	6	7
Whole milk	0	1	2	3	4	5	6	7
Food cooked with oil / coconut cream / margarine	0	1	2	3	4	5	6	7

VITAMIN A STUDY - CHILD INFORMATION FORM

OCULAR EXAMINATION OF THE CHIILD

Name of the examiner:..... Code

1 Name of the child:.....

OD OS

2. Lids: entropion
trichlasis
inflamed

3. Conjunctiva: injection
phlyctenule
non-purulent discharge
purulent discharge

xerosis:
temporal
nasal
other
"foam' or "cheese": temporal
nasal
other

4. Cornea:
xerosis
erosion

ulcer

Indicate location of abnormalities

xerosis
erosion

ulcer

OD OS

keratomalacia: clear
opaque
perforation

keratomalacia
keratomalacia with perforation

Corneal scar: macula / nebula
leukoma
adherent leukoma

Historical data on corneal scars and destruction, if corneal scars **or** destruction is present

5. Historian: reliable
possibly reliable
unreliable or unavailable

6. Age at which lesion occurred:
0 = less than 1 month
1 = 1-6 months
2 = 7-12 months
3 = 1 year completed
4 =2 years completed
5 = 3 years completed
6 = 4 years completed
7 = 5-6 years completed
8 = over 6 years completed
9 = unknown

7. Other events 4 weeks or less before lesion occurred: OD OS

Eye trauma
Measles
Purulent infection

Marked diarrhoea
Marked malnutrition
Marked cough

8. Medicine was applied before corneal lesion appeared: 0 = no 1 =yes

Conclusion, needs to be completed **for** all **children:**

9. Diagnosis based on clinical examination and history:
1 = trauma
2 = measles
3 = purulent eye infection
4 = congenital
5 = keratomalacia
6 = other

7 = uncertain

APPENDIX 3:

RESULTS: NUTRITIONAL INDICATORS

DIETARY INTAKE TABLES

TABLE 4.37: FOOD COOKED IN OIL DAYS/WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	7	6.6	6.6
1	3	2.8	9.4
2	7	6.6	16
3	5	4.7	20.8
4	8	7.5	28.3
5	11	10.4	38.7
6	3	2.8	41.5
7	62	58.5	100
TOTAL	106	100	

TABLE 4.38: INTAKE OF DGLV (KUMU)

NO OF DAYS/WEEK	NUMBER	PERCENTAGE
0 days	11	10.4
1 day	1	.9
2 day	3	2.8
3 day	7	6.6
4 day	7	6.6
5 day	3	2.8
6 day	0	0
7 day	74	69.8

TABLE 4.39: PAWPAW EATEN DAYS /WEEK

DAYS	NUMBER	%	CUMULATIVE %
0	40	37.7	37.7
1	23	21.7	59.4
2	19	17.9	77.4
3	11	10.4	87.7
4	9	8.5	96.2
5	1	0.9	97.2
7	3	2.8	100

TABLE 4.40: INTAKE OF DGLV. CHINESE CABBAGE DAYS/WEEK

CHINESE CABBAGE	FREQ.	%	CUMULATIVE %
0	103	97.2	97.2
1	1	0.9	98.1
3	2	1.9	100

TABLE 4.41: PUMPKIN EATEN (DAYS/WEEK)

DAYS	FREQUENCY	%	CUMULATIVE %
0	70	66	66
1	13	12.3	78.3
2	13	12.3	90.6
3	4	3.8	94.3
4	2	1.9	96.2
5	2	1.9	98.1
7	2	1.9	100

TABLE 4.42: BANANA EATEN (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUM FREQ.
0	11	10.4	10.4
1	16	15.1	25.5
2	20	18.9	443
3	25	23.6	67.9
4	7	6.6	74.5
5	1	0.9	75.5
7	26	24.5	100

TABLE 4.43: USE OF COOKING BANANA DAYS /WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	10	9.6	9.6
1	6	5.8	15.4
2	15	14.4	29.8
3	5	4.8	34.6
4	13	12.5	47.1
5	10	9.6	56.7
6	1	1.0	57.7
7	44	42.3	100

TABLE 4.44: TOMATOES EATEN (DAYS /WEEK)

TOMATO DAYS/WEEK	FREQ.	%	CUMULATIVE
0	105	99.1	99.1
1	1	0.9	100

TABLE 4.45: MANGOES EATEN (DAYS/WEEK)

MANGO	FREQ.	%	CUMULATIVE
0	102	96.2	96.2
1	4	3.8	100
TOTAL	106	100	

TABLE 4.46: SWEET POTATO EATEN (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	44	41.5	41.5
1	12	11.3	52.8
2	20	18.9	71.7
3	17	16	87.7
4	4	3.8	91.5
5	2	1.9	93.4
7	7	6.6	100
TOTAL	106	100	

TABLE 4.47: GUAVA EATEN (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	77	72.6	72.6
1	13	12.3	84.9
2	4	3.8	88.7
3	7	6.6	95.3
4	2	1.9	97.2
5	1	0.9	98.1
7	2	1.9	100
TOTAL	106	100	

TABLE 4.48: TARO EATEN DAYS/WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	62	58.5	58.5
1	9	8.5	67
2	15	14.2	81.1
3	7	6.6	87.7
4	5	4.7	92.5
5	2	1.9	94.3
7	6	5.7	100
TOTAL	106	100	

TABLE 4.49: CLAMS/MUSSELS EATEN DAYS/WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	103	97.2	97.2
1	1	.9	98.1
5	1	.9	99.1
7	1	.9	100
TOTAL	106	100	

TABLE 4.50: WHOLE FISH EATEN (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	32	30.5	30.5
1	8	7.6	38.1
2	12	11.4	49.5
3	9	8.6	58.1
4	6	5.7	63.8
5	7	6.7	70.5
6	3	2.9	73.3
7	28	26.7	100
TOTAL	105	100	

TABLE 4.51: LIVER EATEN DAYS/WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	102	96.2	96.2
1	2	1.9	98.1
2	2	1.9	100
TOTAL	106	100	

TABLE 4.52: CARROTS EATEN (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	106	100	100

TABLE 4.53: AVOCADO EATEN DAYS/WEEK

DAYS/WEEK	FREQ.	5	CUMULATIVE
0	0	100	100
TOTAL	106	100	

TABLE 4.54: YAM EATEN DAYS/WEEK

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	22	20.8	20.8
1	2	1.9	22.6
2	8	7.5	30.2
3	18	17.0	47.2
4	7	6.6	53.8
5	6	5.7	59.4
6	1	0.9	60.4
7	42	39.6	100
TOTAL	106	100	

TABLE 4.55: WHOLE MILK CONSUMED (DAYS/WEEK)

DAYS/WEEK	FREQ.	%	CUMULATIVE
0	96	90.6	90.6
1	3	2.8	93.4
2	1	.9	94.3
4	1	.9	95.3
6	1	.89	96.2
7	4	3.8	100
TOTAL	106	100	

APPENDIX 4:RESULTS

FOOD RELATED DATA

TABLE H-10: MAIN STAPLE FOOD

STAPLE FOOD	FREQ.	%	CUMULATIVE
SAGO	49	98	98
RICE	1	2	100

TABLE H-11: WHAT THE FAMILY ATE TODAY

KUMU	PEANUTS	BEANS	PEAS	MEAT	FISH	OTHER
45	1	2	2	17	32	1

TABLE H-12: WHAT THE FAMILY ATE YESTERDAY EVENING n=35(70%)

TARO	KUMU	FISH	BANANA	KAUKAU	PAWPAW	WATER MELON	YAM	PINE APPLE	CORN
2	16	27	18	1		1	5	5	1

TABLE H-13: FOOD EATEN YESTERDAY EVENING (n=29) 58%

SAGO	KUMU	FISH	BANANA	KAUKAU
21	9	2	33	4

TABLE H-14: WHAT THE FAMILY ATE YESTERDAY (DURING THE DAY) n=10

FISH	BANANA	KAUKAU	PAWPAW	WATER MELON	YAM	PINEAPPLE	CORN	TARO
1	14	1	7	2	1	3	1	3

DOES THE FAMILY HAVE A GARDEN? 98% YES

WHERE DOES THE MOTHER OBTAIN FOOD:
GARDEN 98% MARKET 2%

TABLE H-15: WHAT GROWS IN THE GARDEN?

KAUKAU	TARO	BAN ANA	CASSA VA	YAM	KUMU	PEANU TS	BEAN	CORN	PUMPK IN	SNAKE BEAN	OTHER S
38	41	49	30	42	48	15	30	30	32	14	22

TABLE H 16: FRUIT COLLECTED BY MOTHER IN THE PAST WEEK

NONE	PAW PAW	MANGO	GUAVA	PINE APPLE	PASSION FRUIT	BANANA
3	40	6	20	17	3	43

APPENDIX 5:

RESULTS OF HOUSEHOLD SURVEYS

TABLE H-1 DISTRIBUTION OF HOUSEHOLDS BY VILLAGE

VILLAGE	NO OF HOUSEHOLDS	PERCENTAGE
ANABERG	26	52
KWANGA	14	28
INAPANG	10	20

TABLE H-2: CHILDREN/HOUSEHOLD

VILLAGE	1	2	3	4	5	6	7	8	9	TOTAL
ANABERG	5	7	5	2	3	1	1	1	1	26
KWANGA	3	7	0	1	1	0	2	0	0	14
INAPANG	2	5	1	1	0	1	0	0	0	10
TOTAL	10	19	6	4	4	2	3	1	1	50

TABLE H-3 OVERALL NUMBER OF CHILDREN/HOUSEHOLD

MEAN	STD DEV	STD ERR	MIN	25 PERCENTILE	MEDIAN	75 PERCENTILE	MAX
3.04	2.05	0.290	1	2	2	4	9

TABLE H-4: NUMBER OF CHILDREN BETWEEN 6-72 MONTHS

MEAN	VARIANCE	STD DEV	STD ERROR	MIN	25 %TILE	MEDIAN	75% TILE	MAX	MODE
1.82	0.56	0.75	0.11	1	1	2	2	4	2

TABLE H-5: HOUSEHOLD CASH INCOME

CASH INCOME	FREQUENCY	%	CUMULATIVE %
YES	34	68	68
NO	16	32	100
TOTAL	50	100	

TABLE H-6: SOURCE OF INCOME

INCOME FROM	FREQ.	%	CUMULATIVE
WAGES	4	11.8	11.8
BUSINESS	1	2.9	14.7
SELLING PRODUCE	27	79.4	94.1
OTHERS	2	5.9	100
TOTAL	34	100	

TABLE H-7: EDUCATION LEVEL OF THE MOTHER

EDUCATION LEVEL	FREQUENCY	PERCENTAGE	CUMULATIVE
NO EDUCATION	17	34	34
UPTO GRADE 3	4	8	42
GRADE 4-6	21	42	84
HIGH SCHOOL(7-10)	8	16	100
TOTAL	50	100	

TABLE H-8: MAIN SOURCE OF WATER FOR THE HOUSEHOLD

WATER SOURCE	FREQUENCY	%	CUMULATIVE
PROTECTED(WELL/PIPE)	14	28	28
UNPROTECTED WELL/SPRING	12	24	52
RIVER/STREAM	19	38	90
BORE HOLES	3	6	96
OTHERS	2	4	100
TOTAL	50	100	

TABLE H-9: DISTANCE OF WATER SOURCE FROM HOUSE

DISTANCE(MINUTES WALK)	FREQ.	%	CUMULATIVE
IN COMPOUND	19	38	38
<5 MIN	27	54	92
5-20 MIN	3	6	98
>20 MIN	1	2	100
TOTAL	50	100	

APPENDIX 6:

COMMON HOUSEHOLD MEASURES FOR FOOD IN PAPUA NEW GUINEA

Food	Common Household Measure	Weight of Edible Portion
CARBOHYDRATES		
Staples		
Breadfruit	1 small portion/piece	130 g
Cassava (tapioca)	2-cm slice (very small piece)	30 g
Cooking Banana (unpeeled, short)	1 short	130 g
Cooking Banana	1 long	130 g
Rice, boiled	1 cup	240 g
Rice, uncooked	1 cup	200 g
Sago, dry mixed in various recipes)	1/2 cup, dry (pressed firmly in cup)	100 g
Sweet Potato		130 g
Taro, Singapore	1 small	130 g
Taro Tru	1 small	130 g
	1 small	
HIGH ENERGY		
Cooking Oil	1 eating spoon	10 g

Food	Common Household Measure	Weight of Edible Portion
FRUIT		
Avocado	1 medium	200 g
Banana. Sweet	1 large	85 g
Guava	1 average	57 g
Mango (flesh only)	1 medium	130 g
Pawpaw	1/2 cup chopped	142 g
Pineapple	1 cup or 1 slice 1 cm thick	85 g

APPENDIX 7:

ANTHROPOMETRIC INDICATORS

FIGURE A1: WEIGHT HEIGHT Z SCORES

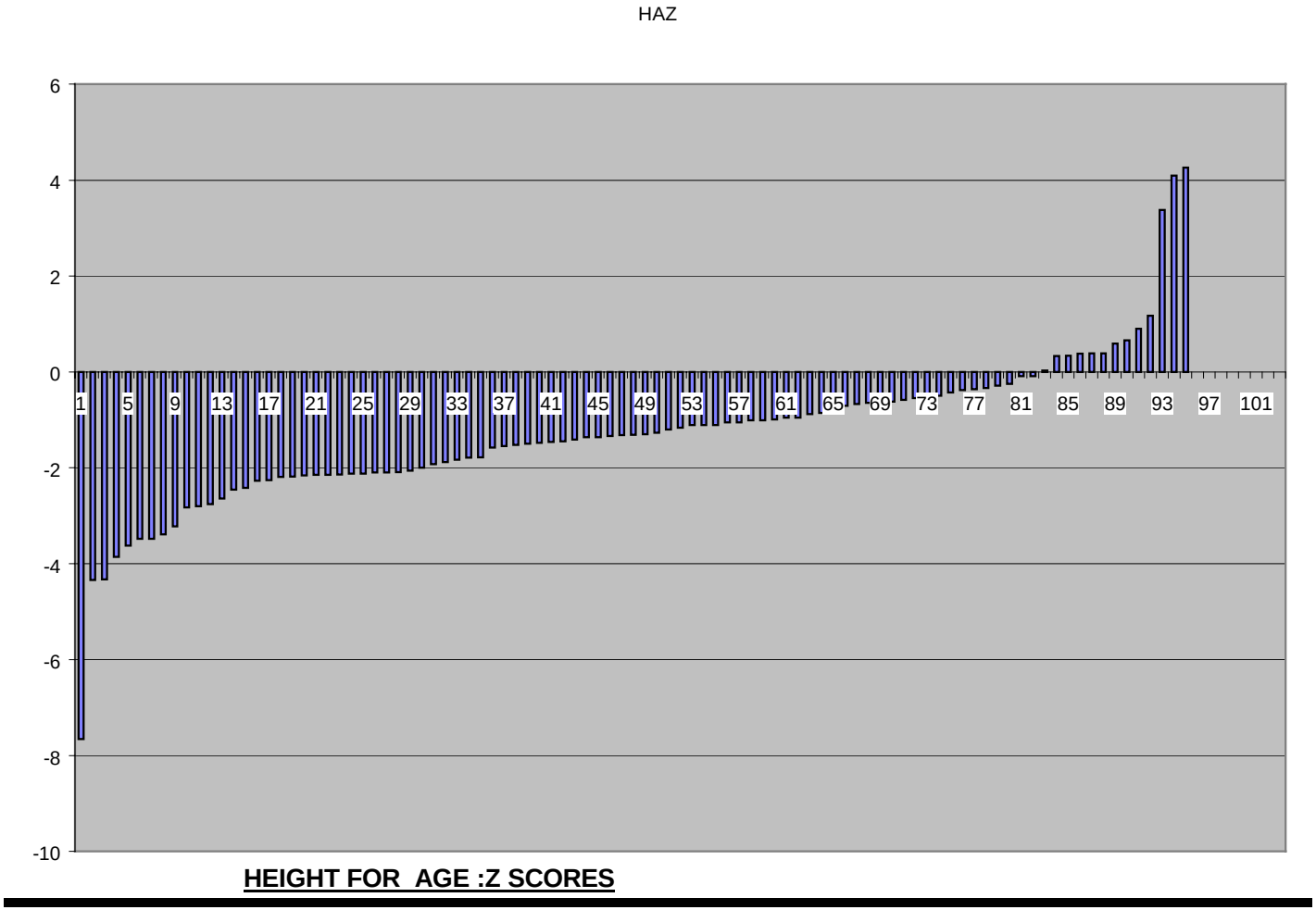


FIGURE A2: HEIGHT FOR AGE: Z SCORES

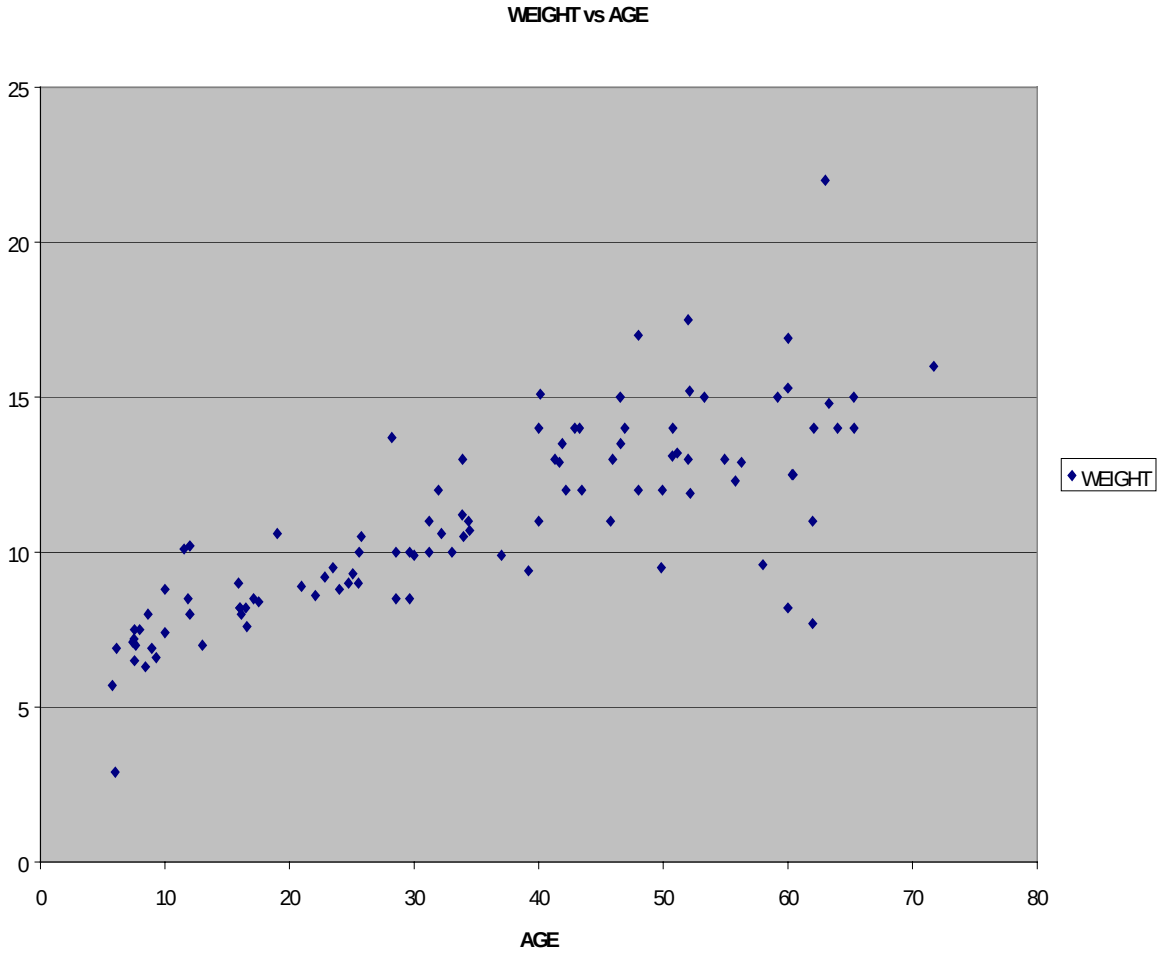


FIGURE A3: WEIGHT vs AGE

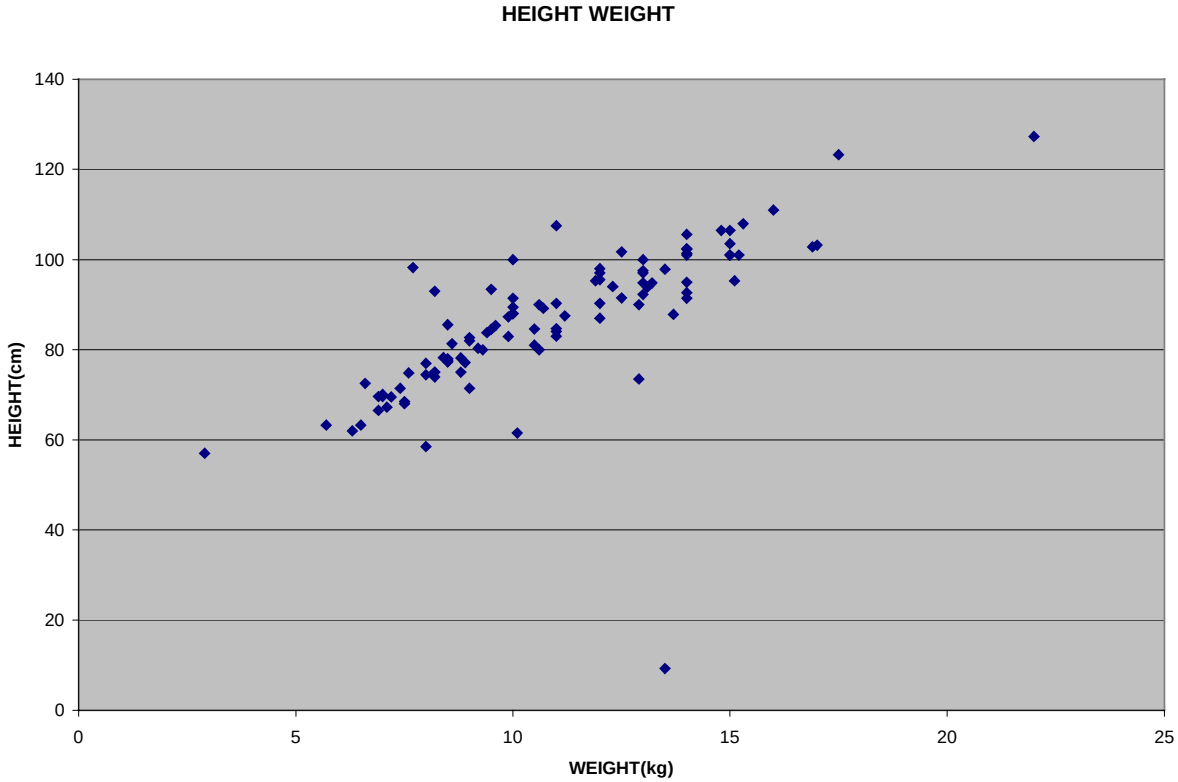


FIGURE A4: HEIGHT vs WEIGHT

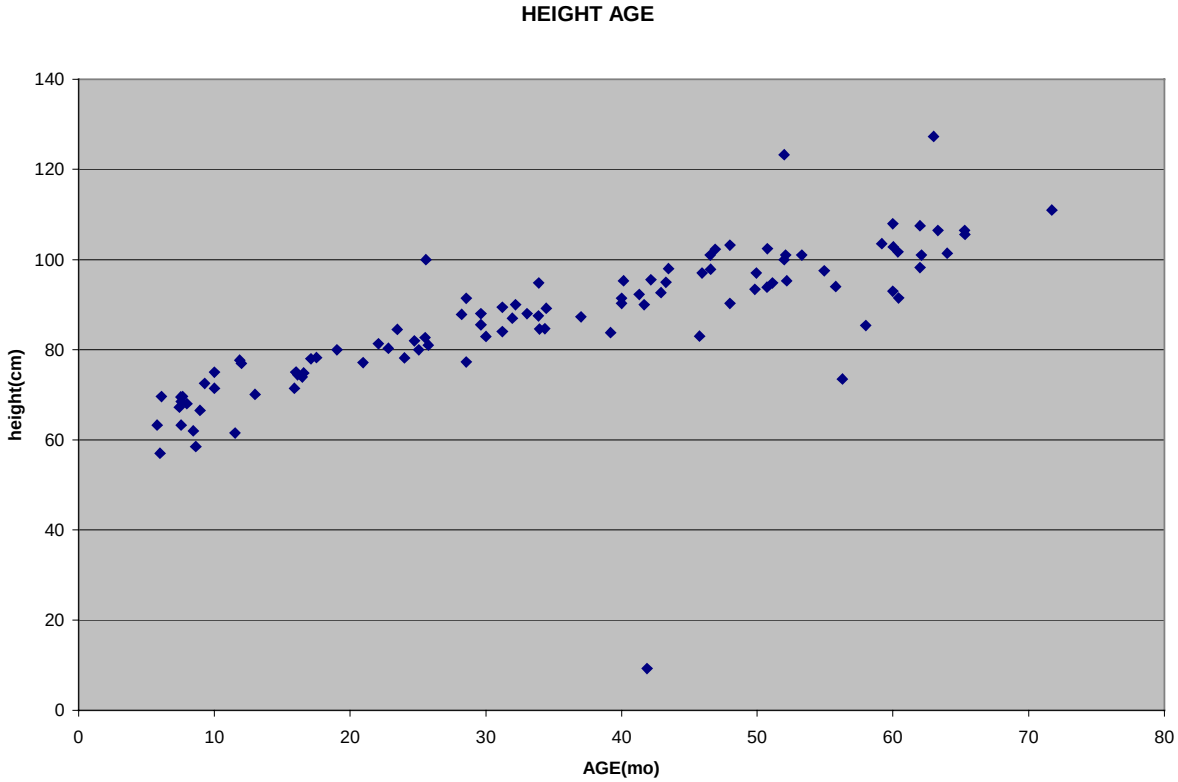


FIGURE A5: HEIGHT vs AGE

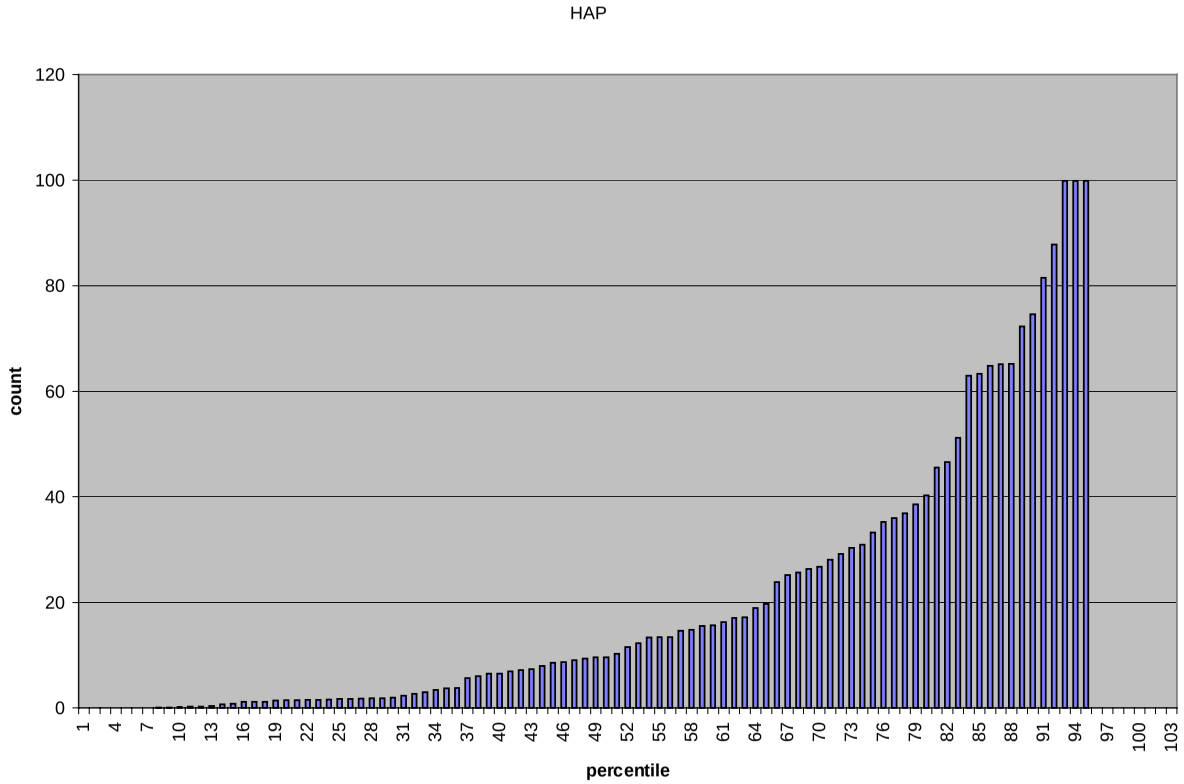


FIGURE A6: HEIGHT FOR AGE PERCENTILE

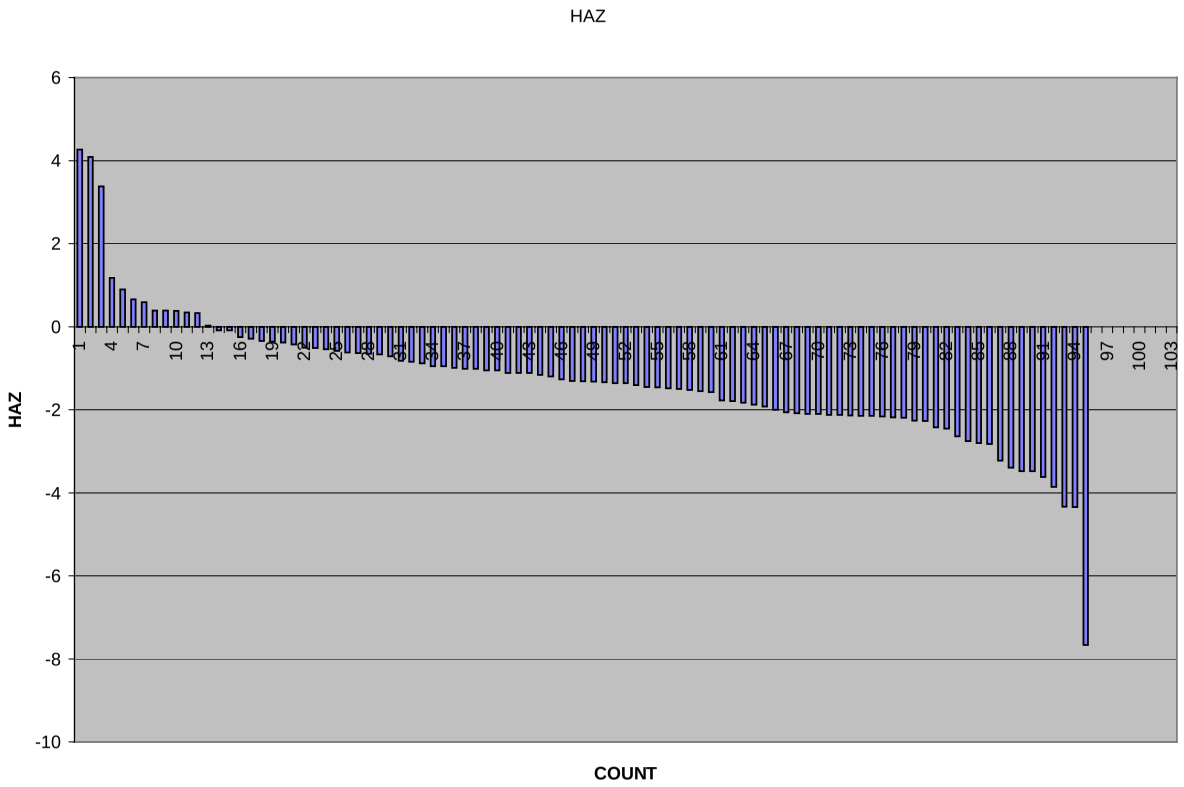


FIGURE A7: HEIGHT FOR AGE Z SCORES

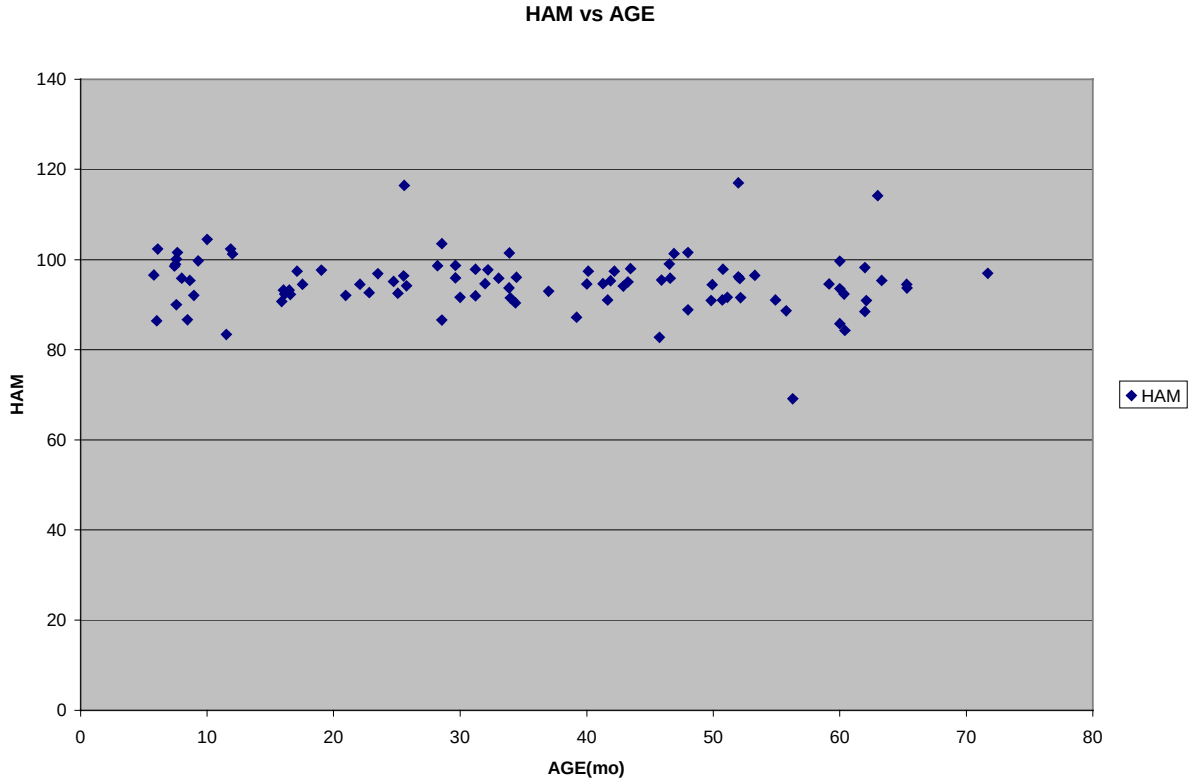


FIGURE A8: HEIGHT FOR AGE MEDIAN vs AGE

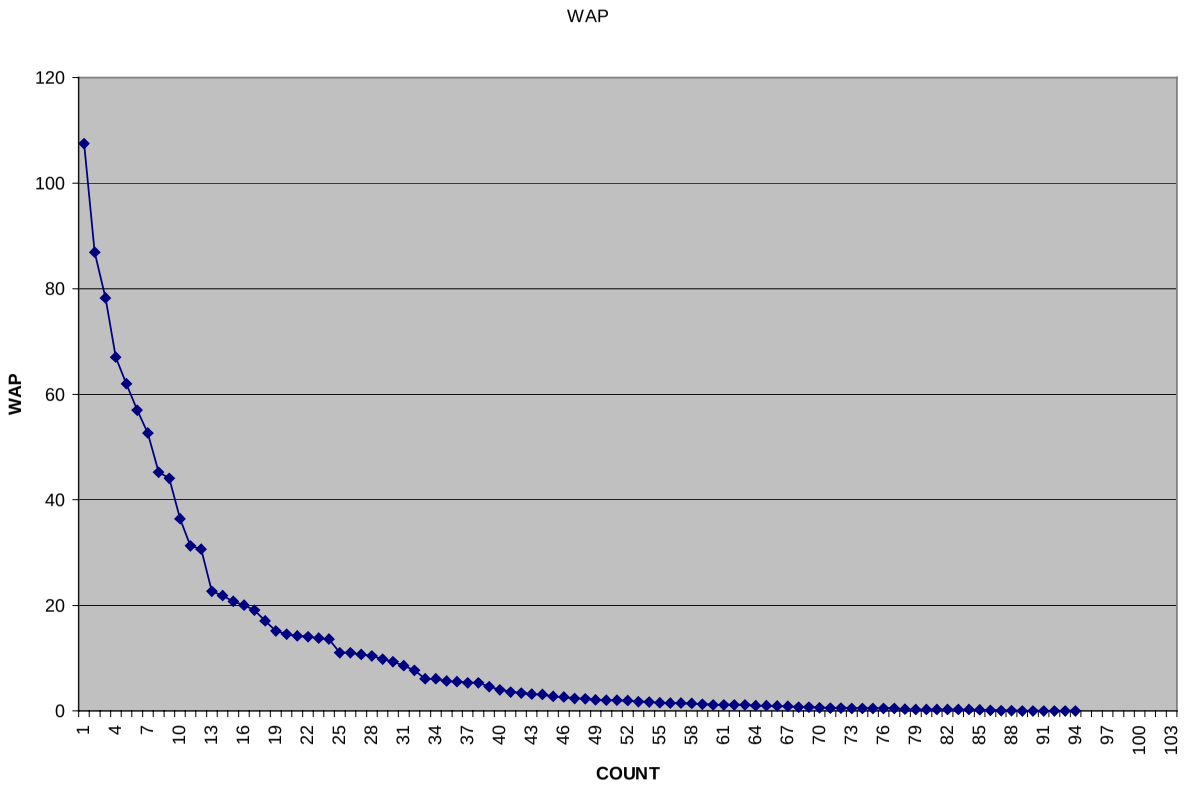


FIGURE A9: WEIGHT FOR AGE PERCENTILES

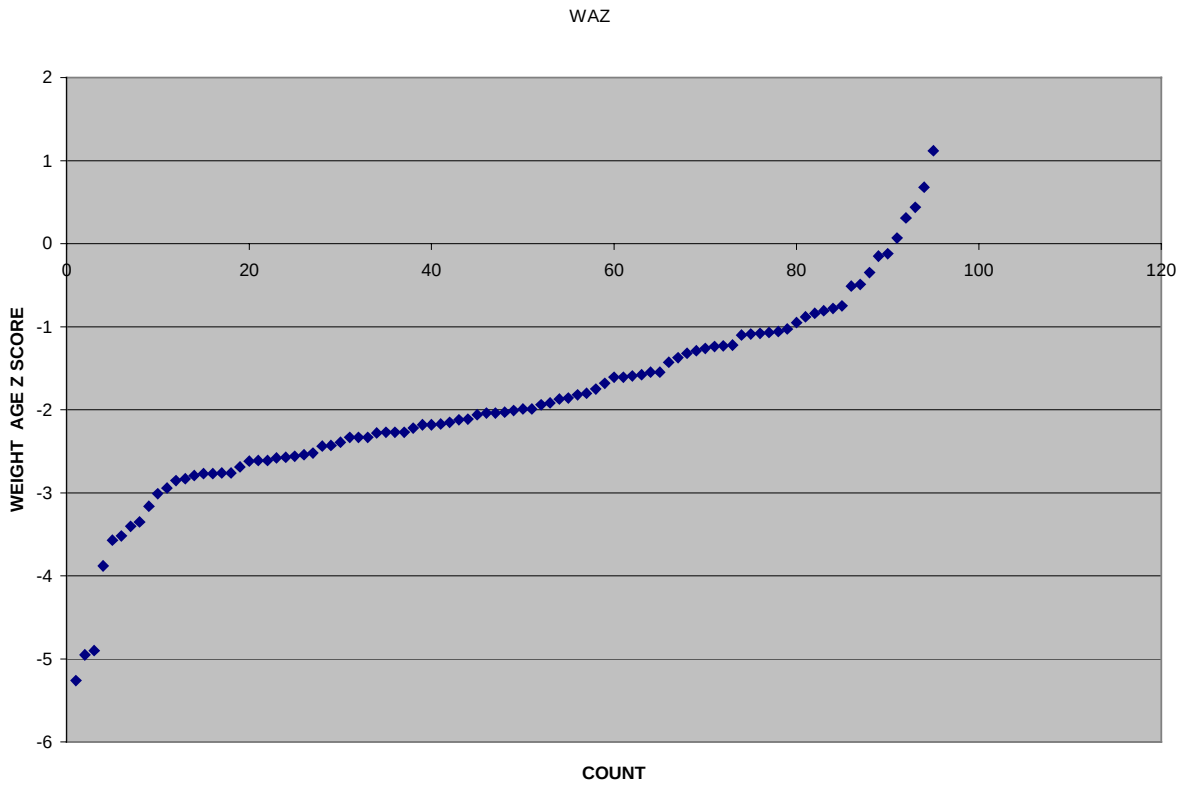


FIGURE A 10:WEIGHT FOR AGE Z SCORES

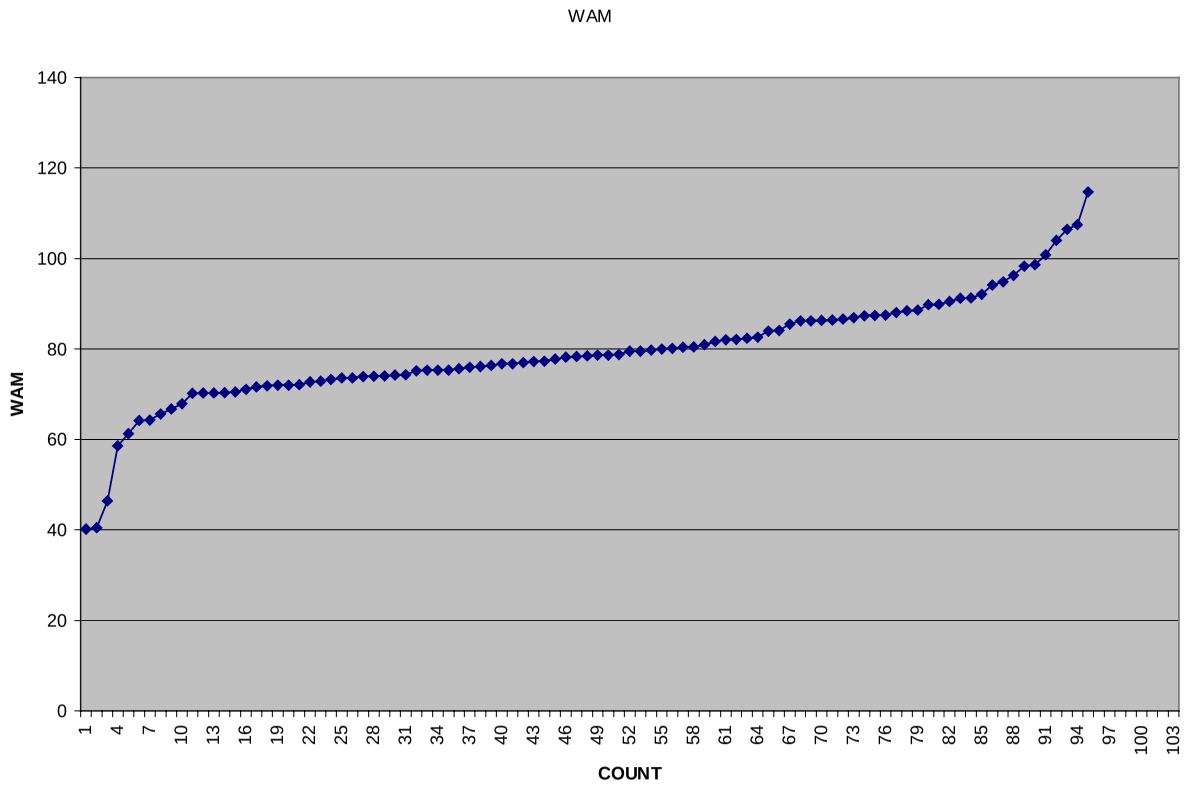


FIGURE A 11: WEIGHT FOR AGE MEDIAN

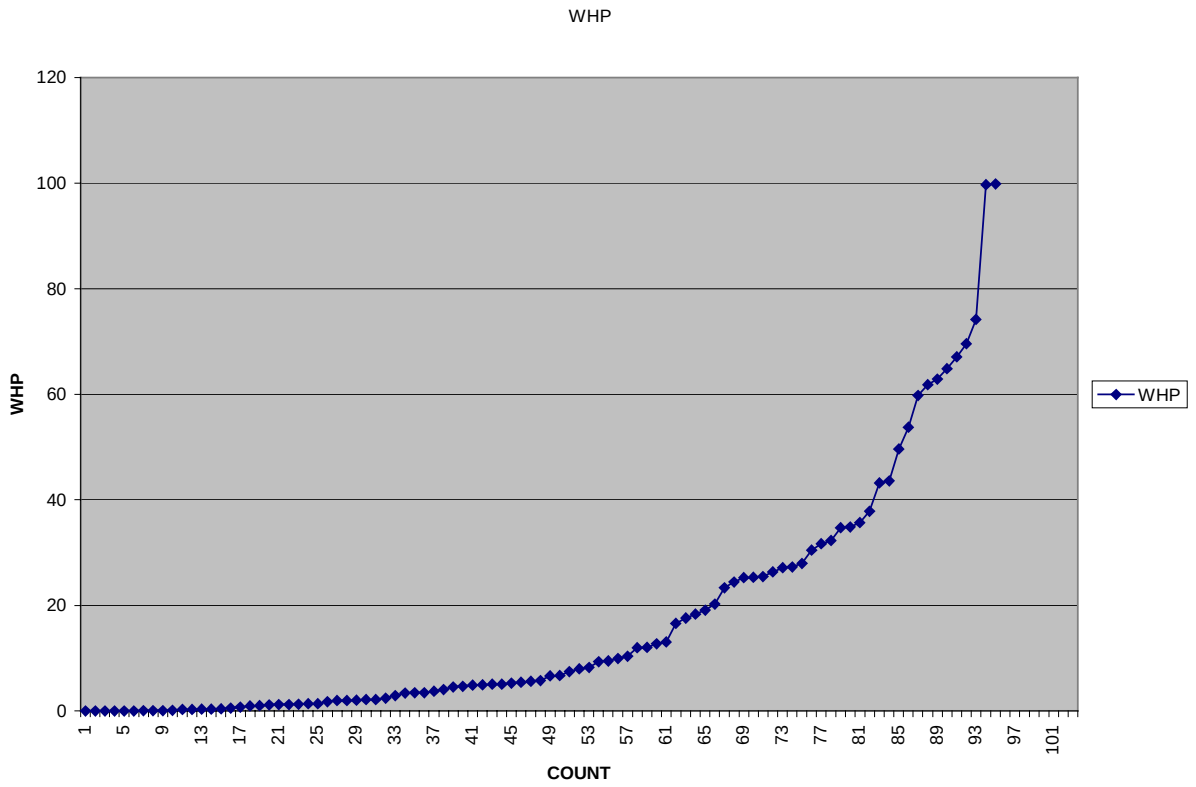


FIGURE A 12:WEIGHT FOR HEIGHT PERCENTILES

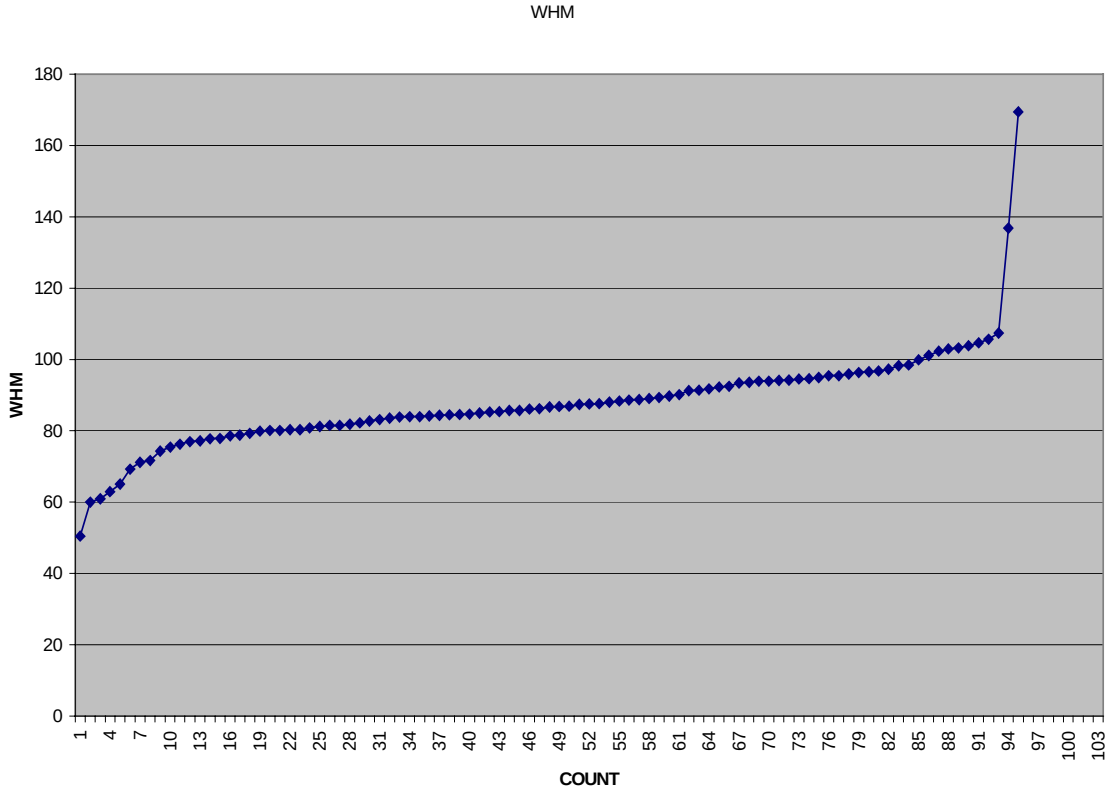


FIGURE A13: WEIGHT FOR HEIGHT MEDIANS

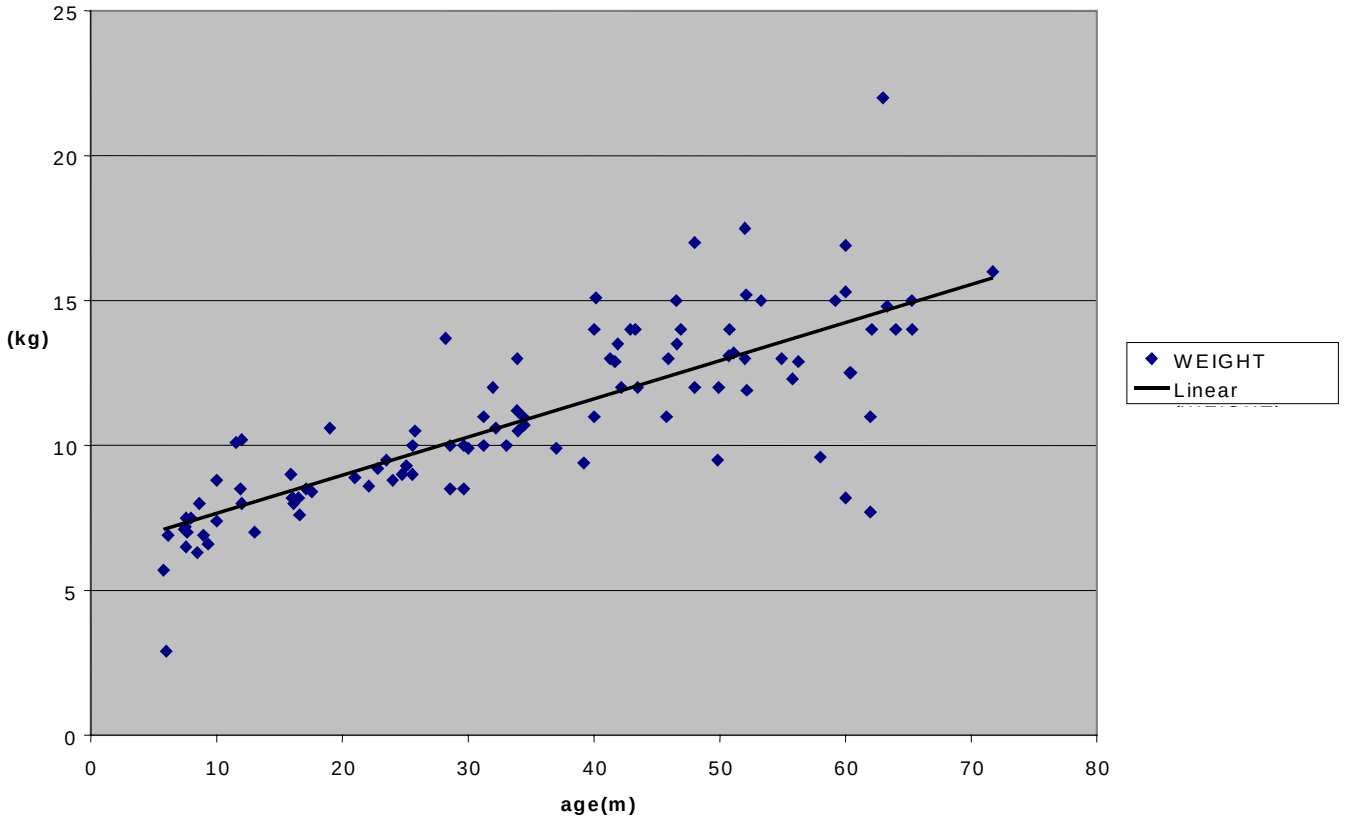


FIGURE A 14: WEIGHT vs HEIGHT

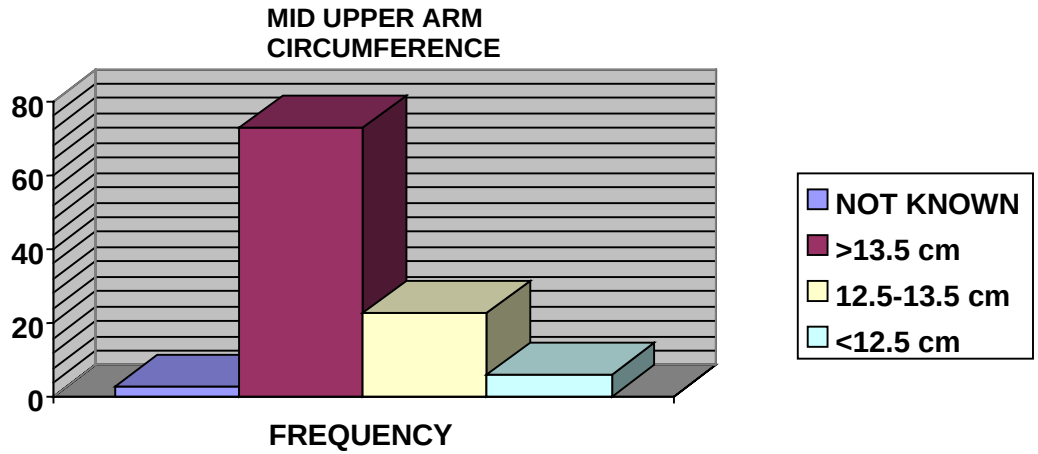


FIGURE A 15: MID UPPER ARM CIRCUMFERENCE. FREQUENCY

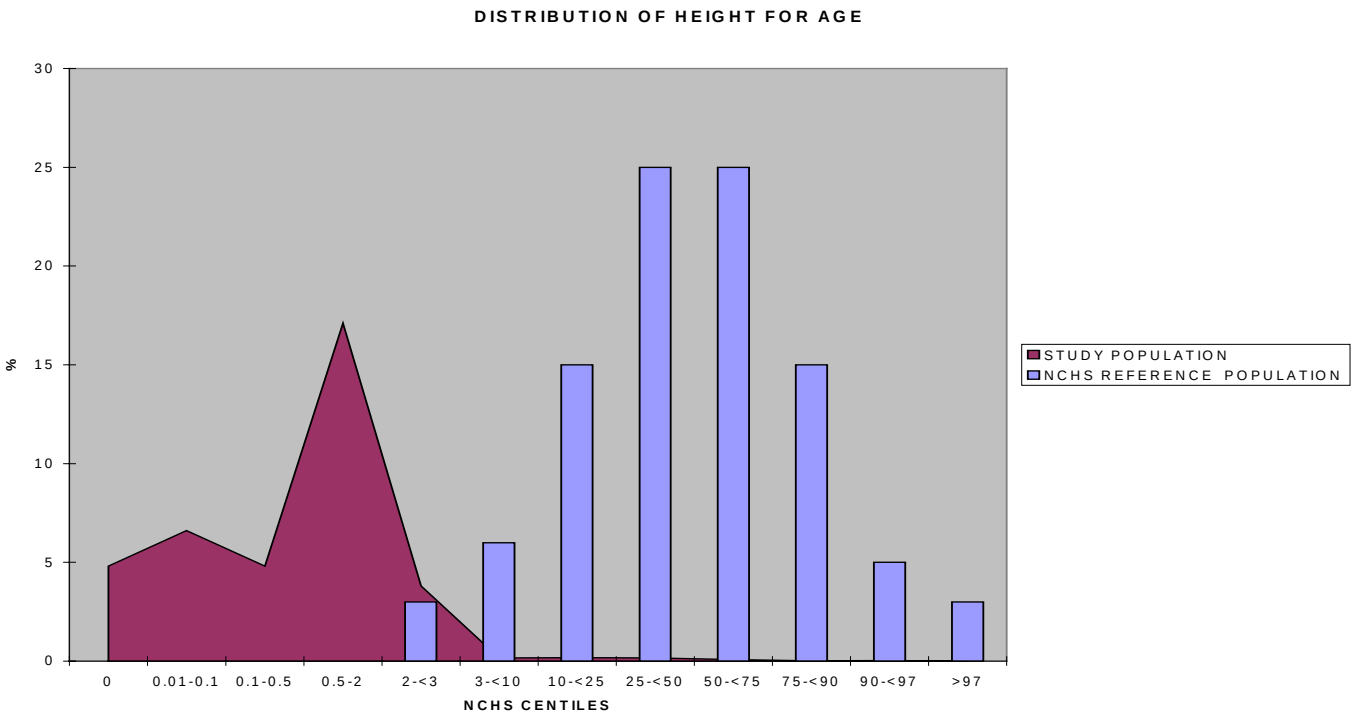


FIGURE A 16: COMPARISON OF HEIGHT FOR AGE.

STUDY POPULATION vs NCHS CENTILES

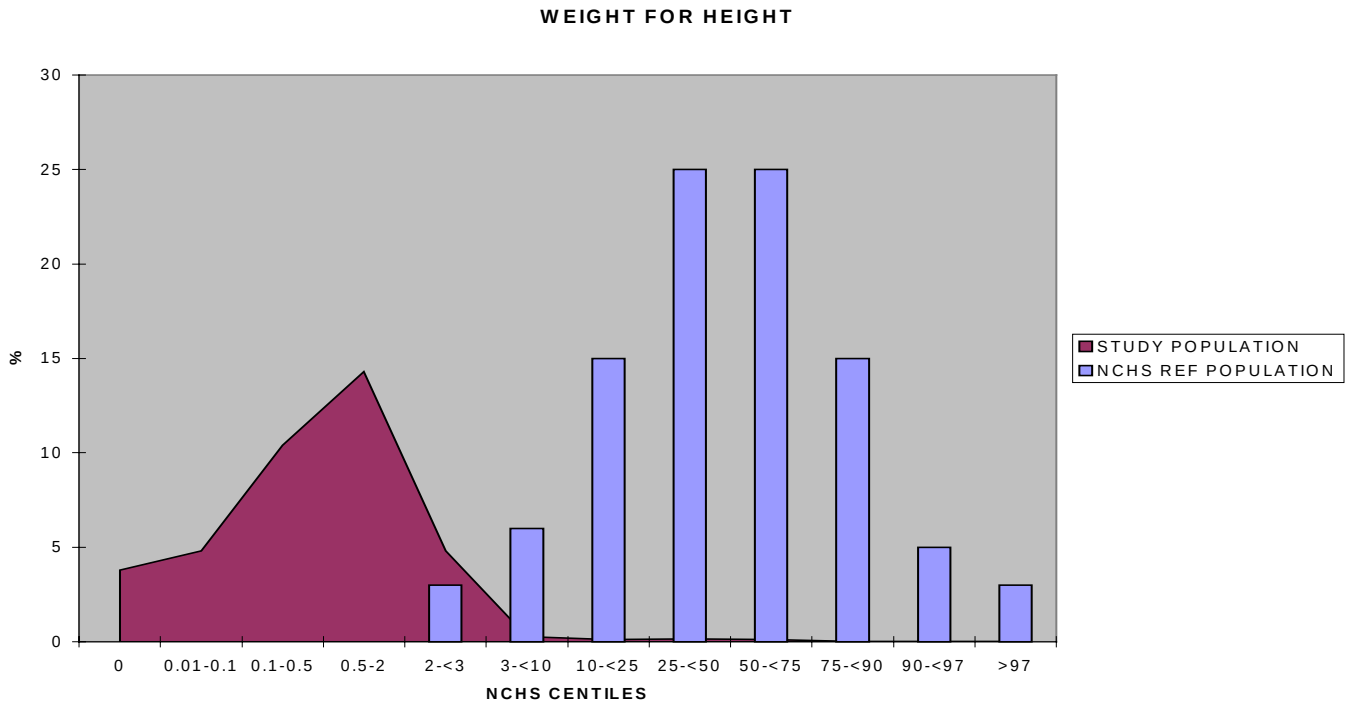


FIGURE A 17:WEIGHT FOR HEIGHT OF STUDY POPULATION vs NCHS CENTILES

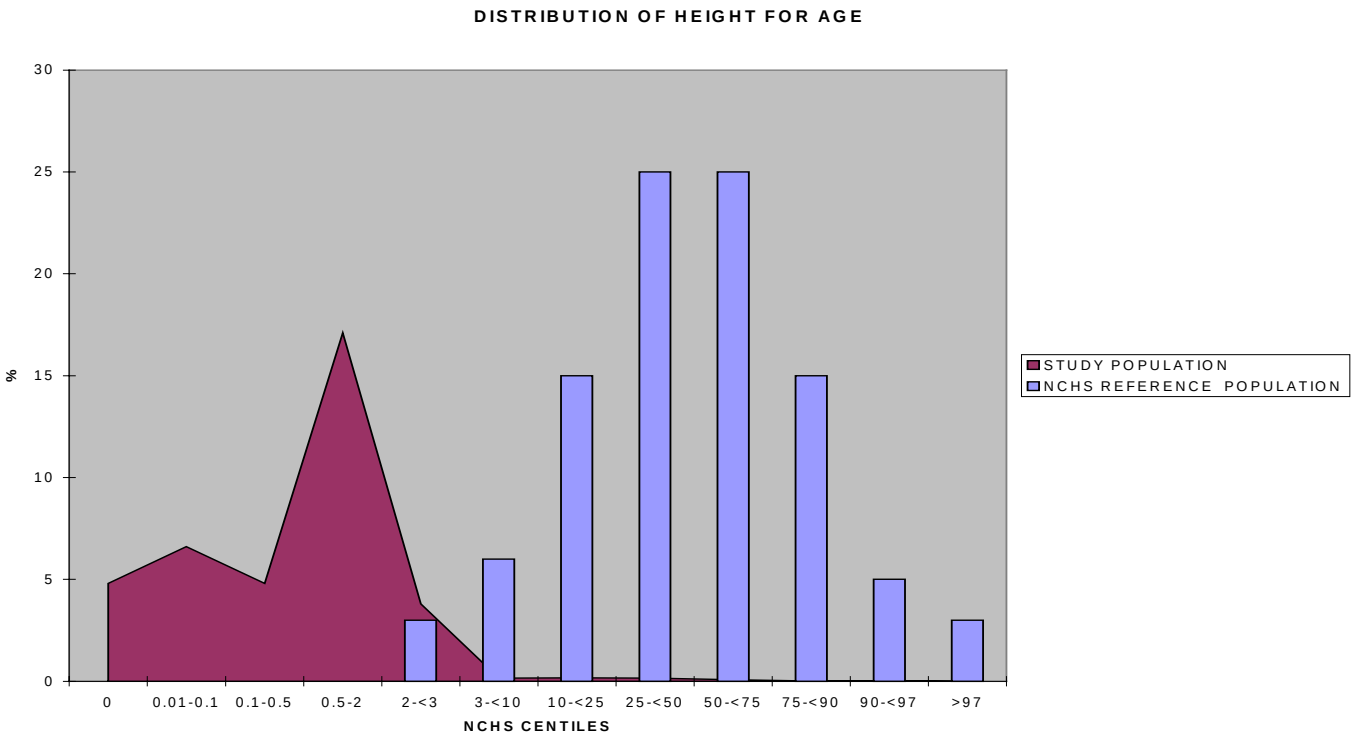


FIGURE A 18: HEIGHT FOR AGE OF STUDY POPULATIONS vs NCHS CENTILES

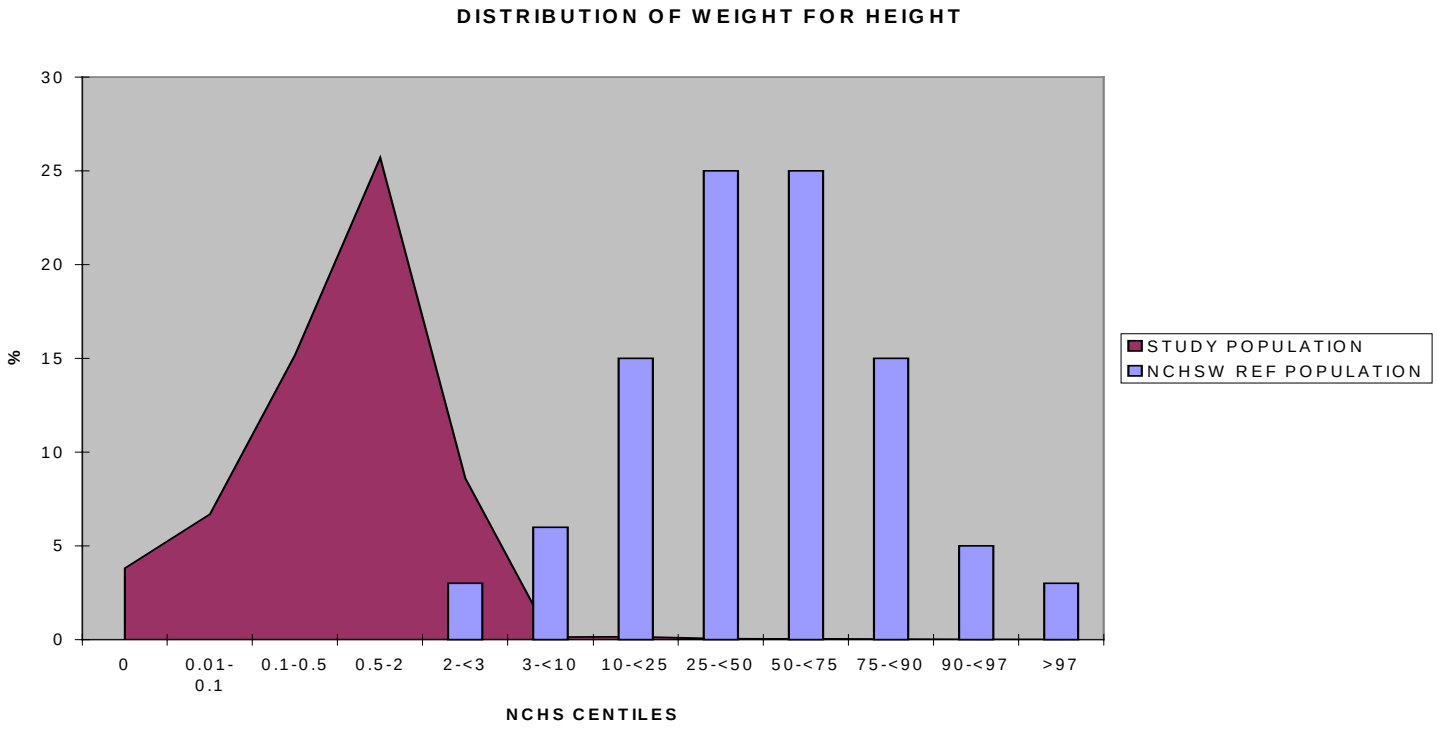


FIGURE A 19: WEIGHT FOR HEIGHT OF STUDY POPULATION vs NCHS CENTILES

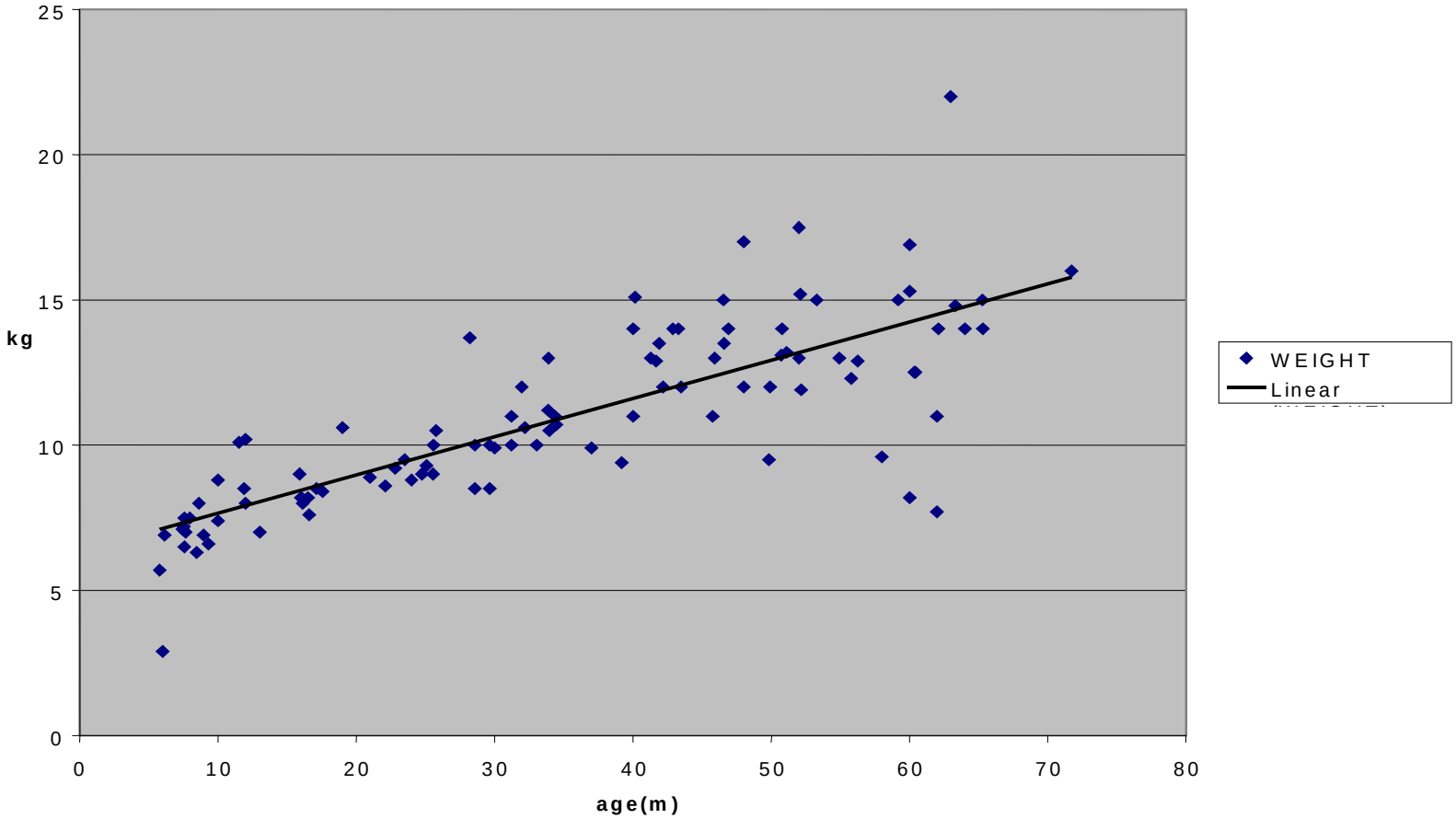


FIGURE A 20: WEIGHT FOR AGE OF STUDY POPULATION

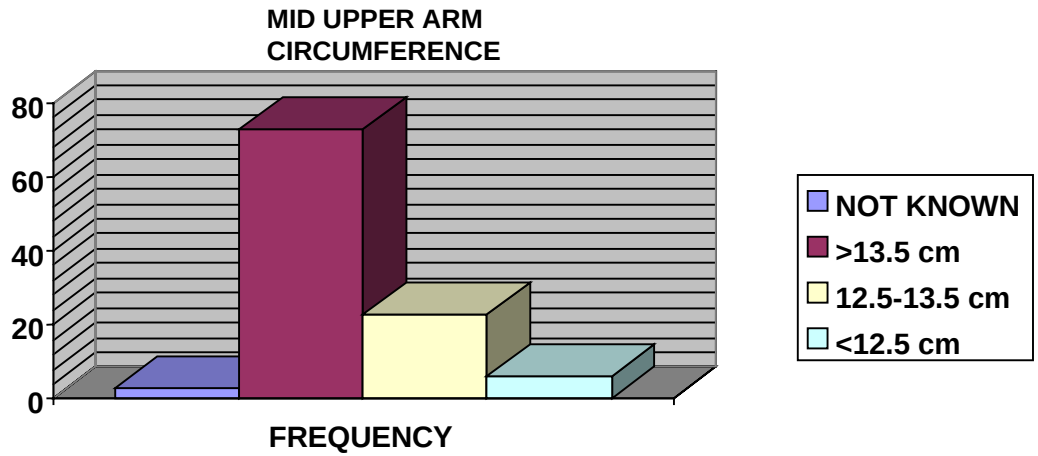


FIGURE A 21 MID UPPER ARM CIRCUMFERENCE

APPENDIX 8:

STAFFING DETAILS

STAFFING

Dental Section

Leo Ambura
Damarius Tavul
Megu Samrage

Ophthalmology

Dr Nitin Verma
Dr Ramesh
Prof Billson
Dr Demok
Joel Jacob
Jacob Harry Wulas

Paediatric

Dr Hanny Friesen
Dr Bill Lagani
Dr Uka Api
Mr Simeon Laia
Sr Pesi Madi
Sr Carol Wokias

Sr Diane Liriope

Pathology

Barbara Sambrey
Samson Maurip

APPENDIX 9:

EQUIPMENT AND CONSUMABLES

Questionnaires:
30 Village information forms
500 household information forms
1,500 Individual child information forms

Stationery
pens, pencils: 25 each
stapler and staples: 4
Sticky tape 8 rolls (2 for each team)
files: 40 (2 for each team member)
plastic covers: 40

Equipment for physical examination:
Salter weighing scales: 4 (1 for each team)
standing weighing scales: 4 (1 *for* each team)
measuring Boards: 4 (1 for each team)
tape measures: 20 (for each team member)
stethoscope: 4 (1 for each paediatrician)
otoscope: 4 (1 for each team)
torch: 4 (1 for each team)
ophthalmoscope: 4 (1 for each team)
blood pressure machine: 4 (1 for each team)
loupe(X2) 1 for each team

Equipment for blood drawing:
needles: 1000 butterflies and
1000 hypodermic needles
syringes: 2000,
5 cc blood containers for Haemoglobin:
150 blood containers for serum retinol:
200 blood slides:
20 vaccine carriers to keep blood samples cool:
8 rolls aluminium foil to keep samples in dark:
icepacks for the vaccine carriers:
alcohol swabs

Laboratory equipment:
microscope 1
stain for malaria .parasites:.
test materials for haemoglobin in the field

Medicines for curative services:
Chloroquine 5,000 tablets
Paracetamol suspension 200 bottles

ORS 3000 sachets
Amoxyl tablets 10,000 tablets
Septrin tablets 5000 tablets
Albendazole 2000 tablets
crystalline Penicillin 1000 vials
grille lotion 2000 tubes
Gentian violet 2000 bottles
Fansidar 2000 tablets
Primaquine 2000 tablets
Doxycycline 3000 tablets
Antibiotic eye ointment. 500 tubes
scalpel blades 500
infant Camoquine
Paracetamol tablets
Amoxyl suspension
Septrin suspension
scabies lotion
Tinidazole
Quinine injection
vitamin A capsules
Quinine tablets
Chloramphenicol suspension 500 bottles
Chloramphenicol inj. 1000 vials
Antiseptic cream 5000 tubes
Bandaids

<u>Requirements for immunisation during the survey:</u>
Estimated population to be immunised:
children below 5 years: 15% of total population: approximately
7500 pregnant women: 5% of total population: approximately 2500
calculate for 10.000 children and 3500 women
clinic books 10,000

Vaccines: 10,000 doses of BCG; 10 doses per vial; 10 vial per box;
40,000 doses of Hepatitis B; 1 dose per vial;
10,000 doses of Sabin;
10,000 doses of triple antigen
10,000 doses o measles
3500 doses of tetanus toxoid

diluent for BCG, Measles
droppers for Sabin
12 vaccine carriers
12 thermometers for each vaccine carrier

cool boxes and thermometers for each cool box

PATHOLOGY

1. COLORIMETER - CORNING 252
   FILTER - GREEN
   CUVETTE - 5ML
   540M

2. ALTERNATIVE COLORIMETER
   - AO HAEMOGLOBINOMETER (AO SPENCER HAEMOGLOBIN METER)

3. MICROSCOPE (BINOCULAR) X 1 - POWER LIGHT MICROSCOPE X 1 - LIGHT

4. EDTA PLASTIC - 5ML CONTAINERS, DISPOSABLE - 1,500 BOTTLES.

5. AMMONIA 5L

6. GLASS SLIDES 50 X 50 BOXES

7. BLOOD LANCETS. 200 X 7 BOXES

8. 10% GIEMSA - 1L (MALARIA)

9. HAIR DRIER - 1 (MALARIA)

*10. SKIN SWABS - STETRETS DISPOSABLE 200 X 7 B9XES 70% ISOPROPYL ALCOHOL

11. COTTON WOOL = 3 ROLLS

12. GLASS SLIDE BOXES STORAGE 100 X 12

13. METHANOL - 2.5L (FIXATIVE)

14. BUFFER SOLUTION pH 7.2 = 5L

15. MEASURING CYLINDERS lOml, 500M13, 1OOML

16. STRAINING TROUGHS X 10

17. COPLIN JARS X 5

18. PASTEUR PIPETTES - SOME

19. RUBBER TEAT X S

20. ANISOLE/OIL MERSIN - 2OOMLS

21. LENS TISSUE - 3 PKT

22. TONER X 1

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