STUDIES ON PROTEIN-ENERGY MALNUTRITION AMONG PRE-SCHOOL CHILDREN IN KEBBI STATE (NIGERIA)

BY

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A Dissertation submitted to the Postgraduate School
Ahmadu Ballo University, Zaria, in partial fulfillment
for the degree of
DOCTOR OF PHILOSOPHY

BIOCHEMISTRY

Department of Biochemistry,
Faculty of Science,
Ahmadu Bello University, Zaria

1997

DEDICATION.

Oh Lord! You know those who deserve works to be dedicated to them. I humbly dedicate this work to them, my subjects (the pre-school children of Kebbi state) and all those afflicted by malnutrition.

DECLARATION.

I declare that this thesis was produced by me in its entirety. It is original and no part of it was ever presented for an application in respect of a higher degree before now. References made to other works have all been duly acknowledged.

Mal.D.A.Almustafa

Signature.....

Date 06-04-98

CERTIFICATION.

This thesis entitled, STUDIES ON PROTEIN-ENERGY MALNUTRITION AMONG PRE-SCHOOL CHILDREN IN KEBBI STATE OF NIGERIA by D.A.Almustafa meets the requirements governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University,Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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ACKNOWLEDGEMENT.

If I was not created and endowed with the faculties that make life worth living, this study would not have merited a mention. I therefore thank the almighty God, who in His infinite mercy made it all possible. Also, in appreciation of the fact that the work required much cooperation from various parties; some academic, others technical, while others administrative, and yet others financial and so on. I wish to express my gratitude to all.

It is impossible for me to individually thank every person or organisation that assisted me during the study. I therefore wish to first of all thank everybody collectively. May God bless you and reward all of you immensely. In addition to the general gratitude I wish to specially state my inestimable appreciation of the tremendous academic, financial and logistic support accorded to me by my major supervisor -Dr. J.A. Elegbede. He, amongst other things, provided all the important materials for the biochemical aspects of the study. These would have cost thousands of naira even by the 1994 prices. Also, despite all his busy schedules, disruptions by strikes, and a sabbatical leave in the U.S.A., he has always remained in touch by mail, hand messages or telephone to maintain that vital supervisory link.

Also deserving a special mention is Dr. J. N. Andrew who played a critical role by thoroughly reading through the draft thesis and made many inportant observations and gave

very helpful suggestions during the internal defense. He also supervised the corrections that were recommended after the internal defence. Thank you ever so much.

I am also indebted to Dr. I.I. Achoba who has always maintained a brotherly attitude towards me. He served as a tireless advisor and a resource person whose connections generated both fresh literature as well as funds to forge ahead when things were seemingly deadlocked. Dr. D.A. Omotola, under whose wonderful care I was assigned by my supervisor as he left for the U.S., contributed markedly by assisting during the proposal seminar and reading and giving valuable advice during the drafting stage of the thesis. My special regards also go to the head of department, Dr. D.A. Ameh, who was also the postgraduate coordinator when I started the programme. I thank you very much for encouraging me to start the write up, and also for the constructive criticisms during the internal defense.

Dr. Sani Ibrahim, the present postgraduate coodinator, who arranged all the examinations and also participated actively at each stage is indeed a person who has earned my sincere appreciation. You have done so much not only for me, but for many others who have come your way. May God reward all of you. Also, in addition, I would want to thank all the other members of the biochemistry department at Ahmadu Bello University, Zaria. My special regards to Dr. (Mrs.) Obagaiye, malam Nasir and all the other staff who assisted in many ways.

In Sokoto, I am particularly thankful to all my colleagues in the biochemistry department at Uthman Danfodio University, Sokoto. Deserving particular mention are, Malam Mansur Lawal, Dr. M.K. Abubakar, and Malam M.J. Ladan. At the teaching hospital, my sincere gratitude goes to the chairman of the medical advisory committee -Dr. Hamid Ahmad and the head of the Chemical Pathology Laboratory Mr. S.S. Sunday. I am also grateful to the Chairmen, Directors of Health, and the medical personnel assigned to assist me in the six local government areas. Their assistance is to be ever cherished. The subjects and their parents, the local chiefs and their representatives and all the others who have escaped my feeble memory are saluted with utmost regard. I conclude my acknowledgment with salutations to my entire family and friends. I know they will not mind if I do not mention how they assisted, so I will simply list a few names that readily come to mind. They are -Saa and Saa, Wonkwai, Kasimu, M.J. Haruna, Adamu Augie, D.M. Gomawa, Dr. Umar T. Muhammad, Malam Isiaka Muhammad, A. Roko, Suleiman Isah, Bashir Ghandi, Yahaya Maiyama, D.D. Mungadi, B.K. Yeboah, and Dr. A.A. Zuru. Those who are not mentioned here are by no means regarded as unimportant contributors.

Best wishes and God bless!

Mal. D. A. Almustafa.

September,1997.

Abstract

Two thousand five hundred and thirty nine pre-school children randomly selected from urban and rural locations in Kebbi state were assessed for weights, heights, and arm-circumference and a sub-sample of 800 hundred were served socio-economic questionnaires and blood samples were collected from 192 of the 800. The major meals eaten by the subjects were sampled and analyzed for proximate composition iron and zinc. The filled questionnaires were analyzed for demographic, socio-economic and nutritional habits while the blood samples were analyzed for PCV, [HB), plasma albumin, globulins and total protein.

The results show that the prevalence PEM among the children was very high. Mild wasting was the most prevalent form of malnutrition (34.4% rural; 22.1% urban) whille mild underweight and stunting were about the same in occurence and were about half as prevalent as wasting in both sectors. The prevalence of the severe forms of PEM were relatively low, and ranged from one third to half of the prevalence of the mild forms in the respective sectors.

The biochemical assessments revealed that many of the children were also anaemic (17.2% rural; 10.0% urban). The prevalence of hypoalbuminaemia and hypoproteinaemia were 9.7% and 30.3% in rural sector and 3.7% and 24.7% in urban sector. The differences in the prevalence of the various forms of malnutrition between the two sectors was statistically significant ($p<0.05$).

Analysis of the anthropometric indices compared to the NCHS/WHO standars revealed that the NCHS/WHO standards required only a 5% scaling down for weights and arm-circumferences to be suitable for assessing Nigerian children. However the height standards did not require any correction. The major causes of malnutrition among the children in Kebbi state were poverty, large numbers of dependants, illiteracy, frequent infections and above all, poor quality diets.

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Abbreviations and Symbols.

Av	Average
BCG	Bromocresol Green
CDC	Center for Disease Control
cm	Centimeters
dl	Deciliters
et al	And others
eg	For example
etc	And so on
FAO	Food and Agriculture Organisation
FELS	Federal Educational and Life Sciencces (Institute).
g	Grammes
Hb	Haemoglobin
Fe	Iron
FGN	Federal Government of Nigeria
ICCIDD	International Council for the Control of Iodine Deficiency Diseases
ie	That is
I.U.	International Units
Kcal	Kilocalories
Kg	Kilogrammes
KJ	Kilojoules
M	Molar
mg	Milligrammes
ml	Milliliters
MPO	Master Plan of Operation
NDHS	National Demographic and Health Survey

NCHS	National Center for Health Statistics
Nig.	Nigeria
NPC	National Planing Commission
p	Probability
PCV	Packed Cell Volume
PEM	Protein-Energy Malnutrition
r	Correlation coefficient
RBP	Retinol Binding Protein
SD	Standard Deviation
T4	Tetraiodothyroxine
TSH	Thyroid Stimulating Hormone
UNICEF	United Nations' Childrens' Fund
vs	Versus
WHO	World Health Organisation
Wt	Weight
Zn	Zinc
>	Greater than
<	Less than
[]	Concentration
°C	Degrees Centigrade
%	Percentage

CHAPTER ONE

1.0 INTRODUCTION

1.1 About Kebbi State (general).

Kebbi state is one of the states of Nigeria created during the military regime of General Ibrahim Badamasi Babangida. The state was carved out of the the former Sokoto state in the northwestern part of Nigeria. It has national boarders with its mother state (Sokoto), Zamfara, Niger and Kwara states and shares international boundaries with the republics of Benin and Niger at its northern confines. The state is divided into twenty six local government areas and it has a total population of about 2.1 million people (Okoro, 1992).

The major urban settlements in the state are the cities of Birnin Kebbi (the state capital), Argungu, Yelwa-Yauri, Jega and Zuru. The main ethnic groups of Kebbi state are the Hausas, Fulanis and Dakarkari. The minority tribes in Kebbi state include the Zabarmawa, Dandawa, Kyangawa, and Kambari. Hausa language is the major language of communication and it is spoken by more than 90% of the population. With international boundaries, the boarder towns of t state such as Kamba, Dole Kaina, and Lolo enjoy a lot of commercial opportunities.

The state has waterways as well as national and local

roads for transportation. In the remote areas, animals such as donkeys, cows and camels are also used for transportation and farming. The climate and vegetation of Kebbi state is typical of the Sudan Savannah zone. Big trees are far apart while the majority of the open expanse is covered by shrubs and short grasses. The annual rainfall is about 35 inches and the temperature ranges from as low as 15°C during the harmattan season to a high of 35°C during the hot season (Audu *et al*, 1982).

Farming is a common occupation of the people. The climate of Kebbi state permits the cultivation of cereals such as millet, sorghum, maize, rice and wheat; stem and root tubers such as cassava, sweet potatoes, yams and cocoa yam; and pulses including different varieties of beans groundnuts and bambra groundnut. The major vegetables cultivated in the state are spinach, amaranths, lettuce, okra, tomatoes, peppers and onions. Fruits such as bananas, guava, papaw, cashew and many wild varieties like the sheanut fruit and the African locust bean are also available at different seasons of the year.

The vast grasslands of Kebbi state supports animal rearing which is undertaken by the nomadic Fulani. Fishing is a major occupation which is often practiced as a sole source of income for those who live in riverine areas. Poultry farming is practiced mainly in the rural areas as a domestic and small scale venture.

Petty trading is common among both the men and women especially during the dry season but mostly fold up during the farming season. Marketing cooked or raw farm produce is the major form of trade for women and young females of school age. With the current upward trend in the proportion and level of literacy among women however, a number of women now work as civil servants. The greater proportion of women in the state are still poorly educated and are mostly full-time housewives. In the urban areas, civil service is a major occupation for both men and women but the men out-number their female counterparts by a ratio of about four to one.

1.2 Background of the Study.

The nutritional status of an individual is an indication of how well the body's requirements for nutrients have been met at different stages of development, and under varying conditions preceding the time an assessment is made. The genetic make up of every individual determines his/her characteristics in terms of size, shape, color, and less obvious aspects such as the metabolism within the tissues, etc. But environmental conditions play a critical role in determining how much of the inherited genetic potentials are fully realized by the individual. Although there are many environmental factors that are very important in determining the general well being of a

person, nutrition and infection play key roles and occupy a central position. Therefore, anything that directly or indirectly affects them invariably affects the person's nutrition and hence health status.

A child born without any metabolic or anatomical abnormalities, given optimum environmental conditions including adequate nutrition, protection against infections and general care should attain its full developmental potential. Such a child will have a normal physique and mental alertness and could be considered healthy. Since nutrition is one of the key factors that modulate the attainment of this 'healthy' status, it is apparent that the nutritional status of the person will indeed have a high positive correlation with the status of health. That is, a good nutritional intake enhances good health whereas a poor nutritional intake precipitates poor health. The assessment of nutritional status is therefore very important in every community as it gives an insight to health problems.

Malnutrition (poor nutritional status) is a major public health problem in most developing nations where the majority of the people cannot afford enough to eat and the sanitary conditions of their environments are very poor. Under such circumstances, young children who have high nutritional needs and weak immune defenses easily fall victims to malnutrition and or infections. Those who

receive prompt medical care may recover fully while the less fortunate may sustain permanent developmental setbacks or fail to survive. As a result, millions of children die before the age of five years while many more suffer one form of morbidity or the other.

A healthy populace is essential for any country in order to be productive and hence develop. It is therefore the paramount duty of every nation to monitor and care for the health of her populace. International agencies like the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) are among those that assist nations in this crucial service, which many countries abandon or fail to give adequate attention. This has given rise to the paucity of data on nutritional assessments in many countries. The Federal government of Nigeria has acknowledged the importance of monitoring and caring for the health of her people and has pledged health for all by the year 2,000 (Master Plan of Operation -MPO, 1991). There has been many reports on the nutritional status of school age and pre-school children in Nigeria (Oduntan, 1972; Oomen, 1974; Nnanyelugo, 1980 and 1982; Alexander and Atinmo, 1982; Addo, 1984; Nigeria Demographic and Household Survey -NDHS, 1990). The data available are however mostly for the southern part of Nigeria, with many areas in the north virtually uninvestigated. Another shortcoming is that most of the reports are based on anthropometric findings

alone, which makes them open to more criticism. The level of malnutrition among Nigerian pre-school children is quite alarming. The latest comprehensive study (NDHS, 1990) reported the rates of chronic malnutrition (stunting) in different regions of Nigeria as 36.0% in the southwest, 37.0% in the southeast, and 50.0 and 52.0% in the northeast and northwest respectively.

An independent study in the northwest region at about the same time as the NDHS study, conducted by Almustafa (1992), on Hausa and Fulani school children in Sokoto and Kebbi states also reported the prevalence of underweight among them as 54%. This is the only reported work in these two states. Because of the alarming findings of NDHS (1990) in respect of the pre-school children in the region, and the high prevalence of underweght among school children in the two states, it became necessary to undertake a comprehensive study to assess the prevalence of these indices of malnutrition among the pre-school children of at least one of the states. The importance of such a study lies in the fact that pre-school children are nutritionally very vulnerable (Davidson *et al*, 1979 ; Guthrie, 1989) and therefore, if nutritonal problems among them are not detected and arrested early, they may become permantly affected adversely.

Underweight, stunting and wasting are all forms of growth retardation which are associated with Protein-Energy

Malnutrition -PEM (Ocloo,1993; Prentice and Cole, 1994). The NDHS report was based on anthropometric measurements alone, therefore there was the need to include other types of assessment of PEM to validate the findings as well as to uncover other asscciated nutritional problems among the children.

The study was therefore designed to assess the prevalence of various indices of PEM among the pre-school children (2- 5 years) of Kebbi state by anthropometric and biochemical assessments and use the dietary, demographic, socio-economic information to try to explain their occurence. The study has three levels:

1. An extensive anthropometric survey covering selected urban and rural areas of Kebbi State.
2. A demographic/socio-economic survey covering a subsample of 1 above (ie subjects in this category have both anthropometric and demographic/socio-economic data).
3. A biochemical analysis of blood samples collected from a subsample of 2 above. The subjects in the third category, therefore, also have (in addition to 2 above) biochemical data as well.

1.3 Objectives.

The study has the following specific objectives.

1. To use anthropometric measurements (weights, heights and arm-circumference) to survey the prevalence of PEM among pre-school children of Kebbi State.
2. To assess the prevalence of low plasma proteins (albumin, globulins and total protein) as indices of PEM and the prevalence of anaemia among the subjects.
3. To assess the association between demographic and socio-economic factors and the prevalence of PEM in Kebbi state and suggest solutions for its prevention among the subjects.
4. Determine the protein, energy, iron and zinc contents of the major meals (as important factors in growth) of the subjects and therefore assess the role they may play in the causation of PEM.
5. To evaluate the usefulness of international anthropometric standards in assessing PEM among Nigerian children and to propose local standards if necessary.

1.4 Justification.

Apart from achieving the objectives of this study, there are other reasons that necessitate the study. First, as mentioned earlier, there is no reported work on the prevalence of PEM among pre-school children in Kebbi State. Secondly, in NIgeria, there is a paucity of studies that included biochemical assessments to complement

information from dietary and anthropometric measurements. Thirdly, there is the question whether the international anthropometric standards are adequate for assessing Nigerian children? Therefore it is important to address this question and give Nigerian scientists and government a better focus on the validity and implications of earlier works. Finally, in the event it is necessary to develop local standards, this study will contribute to the data base from the northern region of Nigeria.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 Nutritional status: related definitions.

Food is an essential requirement for life. When there are wars or famines and food availability falls, people emaciate and diseases proliferate to epidemic levels. On the other hand, whenever the season of plenty prevails, the emaciated grow towards normal physique while the previously normal people now become more plump (Prentice & Cole, 1994). These observable changes are reflections of the state of the body's nutriture or as more technically usually referred to, the nutritional status. The emaciated are not getting enough food so they are undernourished, while the obese are consuming more than they need, so they become overnourished. Between these extremes lies a group that is just adequately nourished.

Both under and overnutrition are associated with impairments to normal living whereas adequate nutrition imparts normal living. The body's interaction with food (nutrition) is therefore a major factor in the determination of its well being or health. McLaren(1981) defined nutrition as the process by which organisms utilize food, and nutritional status as the state of the body produced by nutrition, as a result eating, digestion, absorption, transport, storage and metabolic effects at the

cellular level. Malnutrition according to Mata (1978), is a pathological state due to a deficient availability of essential nutrients at the cellular or basic level during a prolonged period; it manifests itself by physical, psychological and biochemical abnormalities.

Assessment of nutritional status aims at detecting physical, psychological and biochemical abnormalities that are precipitated by malnutrition (Jelliffe and Jelliffe, 1989). It is important to note however, that all the forms of abnormalities that can occur in undernutrition could also occur in overnutrition and equally constitute serious health risks. For example the thinness, irritability and low blood glucose associated with marasmus can be matched with or compared to the fatness, depression and high blood lipids in obesity and are equally life endangering (Guthrie, 1980). While overnutrition may only be a problem in developed countries like the U.S. where as high as 20% of the population are 10.0% or more overweight, the more serious problem, in developing countries is undernutrition. It has been estimated that at least 50.0% of the children in some developing countries as well as a good number of children from the lower socio-economic strata in the developed countries may be suffering from malnutrition. A substantial number of pregnant women in both the developing and developed countries also suffer from malnutrition (WHO,1989; UNICEF, 1995). The common features among the

affected population include poverty, poor sanitation, and lack of access to decent social amenities (Vanderslice et al, 1994).

Ignorance, poverty and the lack of social amenities such as clinics and hospitals are among the factors that help the vicious cycle of malnutrition and disease to continue leading to the loss of lives (Schroeder and Brown, 1994; Vandenbroek et al 1993). In assessing nutritional status, therefore, it is important to take cognisance of such non-nutritional factors that contribute to the precipitation of the observed status (Pellet, 1987). The complex web of causes of malnutrition as summarized by Jelliffe (1976) are presented in the table 1.

Rabee and Geissler (1990), in their study in Iran reaffirmed the involvements of poverty, maternal labour, food taboos, maternal deprivation and infections in the causation of malnutrition. Malnutrition is a result of several contributing factors and varies in severity accordingly. The ability to detect very mild or borderline cases of malnutrition depends on the sensitivity of the method of assessment employed (Jelliffe and Jelliffe, 1989). The problem can be better understood if the stages of the development of malnutrition are known.

2.2 Developmental Stages of Malnutriton.

Following an inadequate dietary supply of nutrients,

the body stores of the affected nutrients are drawn upon and they

Table 1. *Major causes of Malnutrition.*

Type of problem leading to defective nutrient availability	Some examples of causes
Poverty	Sickness, drought, flood, wars, improvidence, over population etc.
Food habits	Taboos, traditions, lack of education, poor care etc.
Maternal deprivation	Poverty, ignorance, psychological disorders, poorly spaced births etc.
Infections	Poor sanitation and immunity.
Congenital defects	Prematurity, metabolic errors, anatomical defects
Increased needs	Individual variation, growth, injury, pregnancy, lactation, illness, physical work, climate, drugs etc.,
Malabsorption	Enzymatic changes, microbial, intestinal anatomy, parasites, psychological, endocrine allergy, etc.
Defective consumption	Quantity, quality, timing, of food physical and other bio - chemical determinants (organoleptic qualities) etc.

Source: D.S. MacLaren (1985).

continue to shrink till depletion. The next stage is the start of biochemical lesions which can be confirmed by the reduction in activity of some enzymes. The continuation of

this last stage precipitates anatomic lesions or clinical signs which are observable and can be evaluated (and Davidson *et al* 1979). Before the last stage (anatomic lesions), biochemical measurements are more useful because there are no appreciable physical changes which are the basis for anthropometric and clinical assessments (Jelliffe, 1966). At the beginning of the appearance of the physical changes, the difference between the normal and abnormal is very small and makes accurate classification at this stage very difficult. Jelliffe and Jelliffe (1989) likened the dilemma to the saying of a famous philosopher and puts it; "nutritional deficiency, when less marked, will always, like beauty, be to some extent 'in the eye of the beholder'".

For well established cases of malnutrition with obvious biochemical, psychological and physical changes, various methods of classification have been used. In all cases, standards that are associated with normal health are first established and the assessed subjects are passed as normal or otherwise depending on where they fit in relation to these standards. The classification of subjects have been done using different notations and terminologies such as; 0, +, ++, +++ to indicate the presence or absence of a problem and its severity; mild, moderate, severe and acute or chronic to describe the degree and or nature of the problem (Jelliffe,1966; Jelliffe and Jelliffe, 1989).

However, recently, more precise descriptive terms such as stunted, wasted and underweight are used (WHO, 1989).

2.3 Protein-Energy Malnutrition (PEM): Forms, Aetiology, Biochemical Changes and Clinical Features.

As the name suggests, PEM is a form of malnutrition resulting from disturbed energy and or protein metabolism. When PEM is purely due to a lack of an adequate energy supply, marasmus is observed whereas if it is purely due to protein deficiency, Kwashiorkor is observed. In between these two extreems exists varying levels of coexistence of the lack of energy and protein giving rise to marasmic-Kwashiorkor. Under normal circumstances, this mixed form (marasmic-kwashiokoor) is the commonest form of PEM (Davidson *et al*, 1979).

The prevalence PEM is highest among pre-school children (children less than five years old) with marasmus being commonest among those about a year old while kwashiorkor is more rampant among the older children (2-5 years).The aetiology of the two forms of PEM is summarised in the flow diagram shown below (Figure 1).

From the flow chart, it can be seen that the first nutritional problem in both pathways is the introduction of an inadequate diet. The marsmus causing diet is dilute (low energy density and nutrients) while that of kwashiorkor is starchy and could be energy dense but protein deficient.

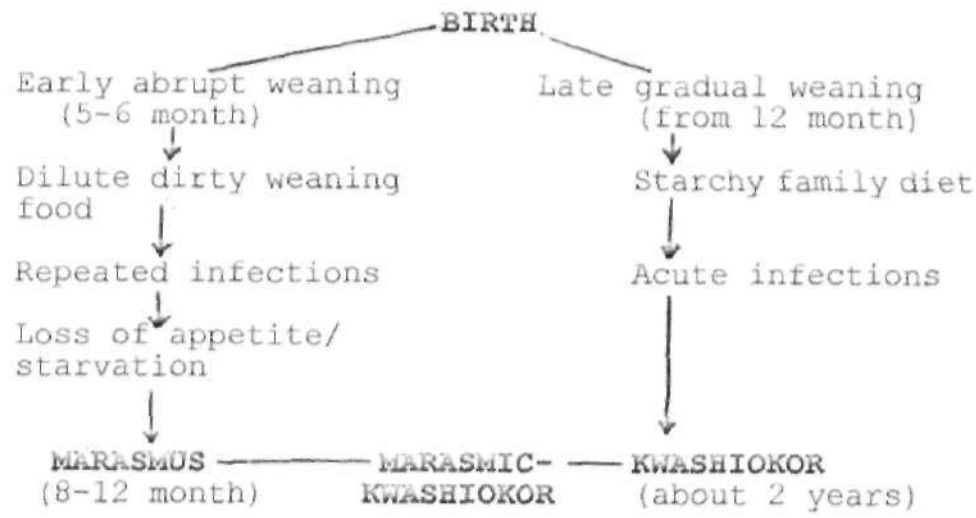


Figure 1. The aetiology of marasmus, marasmic-kwashirkor and kwashiorkor.

(**Source:** Davidson *et el*, 1979)

The metabolism of proteins and that of carbohydrate and fats are all interconnected. Firstly, eventhough carbohydrates and fats are the principal sources of energy for the body, proteins can also be used to generate energy especially when the other two sources are in short supply. Secondly, gluconeogenic amino acids can be used to synthesize glucose when there is a need (Stryer, 1994). Because of these interelations, ultimatly, marasmus and kwashiorkor mostly occur as marasmic kwashiokor.

The diets that cause PEM are not just inadequate in energy and or protein but also in other nutrients. Prominent among them are iron, potassium, folate and retinol. A patient with Kwashiorkor has low levels of plasma essential amino acids and albumin owing to a slow rate of synthesis of the later in the liver.

Hypoalbuminaemia is the major cause of oedema in Kwashiorkor. The levels of gamma globulius may be high as infections may be present to prompt thier production. The elvation of the gamma fraction is however relative as the response will still be weak when compared to that of a normal body with adequate supplies of amino acid. The overall effect of this is that, in PEM the total plasma protein is reduced. Although similar changes occur in marasmus, the plasma protein and amino acid profile may be slightlly better depending on how severe the case is. In both forms of PEM, plasma free fatty acid levels are elevated but the kwashiorkor patients normally also have a fatty liver due to an inability to provide the protein component to constitute lipoproteins (the usual form in which lipids are trasported in the body). This leads to the hepatomegaly associated with kwashiorkor(Davidson *et al*, 1979).

In the intestinal tract, atrophic changes lead to poor enzyme production and hence a reduced digestion and absorption capacity which causes diarrhoea. Endorine changes also occur in PEM. The pituitary gland secretes more growth hormone to try to counterbalance the growth failure, and the levels of circulating thyroxine may be low due to reduced levels of thyroid binding protein. In PEM, these biochemical alterations lead to the manifestation of clinical sighs such as Oedema, changes in skin texture,

hair density, colour and integrity, muscular weakness, mental changes etc all of which are linked to the shortage of protein and energy.

The most obvious feature of PEM however is the serious retardation of growth. This may amount to the patient being less than 60% of the expected normal body weight. The affected children appear skinny (underweight and wasted) and short (stunted). The changes in plasma proteins and body weight are therefore very useful in assessing PEM (Jelliffe and Jelliffe, 1989).

Children of pre-school age, unlike adults, require protein for maintainance as well as groth and maturation. This made their protein requirement (1.1g/kg body mass) much higher than that of adults which is about 0.5g/kg body mass. These requirements presuppose an adequate energy supply because the level of energy in a diet is an important determinant of the efficiency of protein utilization. As the level of energy increases, the efficiency increases till a plateau is reached where the amount of the protein becomes the limiting factor (WHO, 1993). Also, apart from the total requirement for protein, the pattern of the amino acids is very important. All the amino acids must be available in adequate quantities, particularly the essential ones which the body cannot make by itself. Failure to meet any of the critria can precipitate PEM.

2.4 Plasma proteins.

There are six major classes of plasma proteins constituting a concentration of 60-80 g/litre in healthy individuals. The levels of these proteins fall during PEM, except for the gamma globulins which may be elevated due to infections. The levels of the individual proteins and the total protein are therfore often used to assess PEM. The major classes of the plasma proteins are briefly discussed below.

2.4.1. Albumin.

Albumin is by far, the most abundant of the plasma proteins (55.0%). It serves as a protein reserve and a nonspecific carrier protein for many water insoluble metabolites such as free fatty acids, bilirubin, and some drugs. It also binds small ions like calcium thereby controlling the amounts of the free ions available for various biological roles. Its has a high negative charge at physiologic pH (7.4) which enables it to attract much water and by so doing retain water within capillaries. Also being relatively small in size and abundant, it is effective in increasing the number of particles in solution and hence osmotic pressure.

2.4.2. Globulins.

The globulin fraction of the plasma proteins

constitutes the remaing 45.0% of the total. They include the alpha (1 and 2), beta and gamma globulins and fibrinogen. The gamma globulin fraction is very important because of its immunological functions. The beta globulins (trasferrin) transport iron and are also found in association with low density lipoproteins. The alpha 2 globulin fraction participates in haemoglobin and copper transport and is found associated with very low density lipoproteins while the alpha 1 globulins are glycoproteins and are found commonly in high density lipoproteins (Montgomery *et al*, 1980).

2.5. Determinants of nutritional status.

As outlined in Table 2, nutritional status is determined by a complex web of factors. The major determinants of nutritional status are nutrient intake, infections, and socio-economic factors. Some aspects of their individual contributions in the causation of malnutrition are discussed below.

2.5.1 Nutrient intake.

Nutrient intake is by far the most important determinant of nutritional status under normal circumstances. The body is built, maintained and controlled by the interaction of

nutrients, and therefore a regular and adequate supply of nutrients is indispensable to normal health. If nutrient supply fails to meet the requirement of the body, development is arrested, maintenance fails and a deranged physiology and anatomy culminates into disease manifestations and even death.

Nutrient intake is affected by food production, storage, transport, purchasing, power, cultures and taboos, etc. Evaluating nutrient intake is a valuable tool in assessing nutritional status. The methodologies involved have been outlined by Levin and Morgan (1991). For an individual, the requirements for nutrients is determined by many factors including body size and composition, age, sex, climate and so on (Guthrie, 1989).

2.5.2. Infections.

Infection interferes with the body's utilization of nutrients by many complex mechanisms including increased rates of catabolism, diversions, and the like (Scrimshaw *et al* 1963; Lunn and Northrop-clewes, 1993). The FAO (1982) attributed proneness to infection to poor living conditions and sanitation. The worsening of the state malnutrition which accompanies infections reduces growth and productivity, further aggravating the problem and creating a vicious cycle (Lie *et al*, 1993 ; Behrman, 1992).

In Kebbi State and most of Nigeria, malaria and many

other parasitic infections are quite common. The malaria parasites attack the red blood cells and break them down gradually reducing their numbers and hence causing anaemia if the situation is allowed to persist. The parasites also use nutrients from the host as well as cause a fever which increases the metabolic rate leading to the loss of much energy (WHO, 1993). Kebbi State has many rivers and lakes and it has been reported that schistosomiasis is one of the major intestinal and bladder parsites. The infection leads to loss of blood from the intestines and the urinary bladder through the faeces and urine respectively. It also causes a fever and depresses appetite. Through these effects, the infection aggravates PEM and anaemia (Stephensen, 1993). These examples are typical of the ways in which diseases cause deliterious effects on nutrition.

2.5.3. Socio-economic factors.

Socio-economic factors affect both nutrient intake and the prevalence of infections. People in the higher socio-economic strata are wealthier and can afford more food and better living conditions thus making them relatively less prone to undernutrition. The situation in the lower socio-economic classes is exactly the opposite. Several members of a family are often crammed into living conditions without adequate sanitary provisions while food is scarce and prepared unhygienically (Rabee and Geissler,

1990).

Food poverty is a serious problem in West Africa and in many developing countries . Ocloo (1993) noted that as much as three-quarters of family income of many families is spent on food alone. The differences in the nutritional status of subjects from different socio-economic groups has long been recognized and reported (Oduntan, 1972; Nnanyelugo 1985, and Cornu *et al*, 1995). The general trend is that urban subjects whose families are usually better educated and economically better off compared to rural families are better nourished. The underlying factor was clearly brought into focus by Cornu *et al* (1995) when they showed that an economic crises in Congo elicited a significant lowering of nutritional status which continued to deepen as the crises continued.

The cultural influences in the society also contribute a lot to nutritional practices, by among other things, determining the family size; the larger the family the more the strain on the food budget and share. Pellet (1989) cited large family sizes, dependency ratios, birth order, illiteracy of parents, single parentage, maternal age, lack of land and poor access to social amenities among the factors that determine nutritional status. Other factors include the breakdown of marriages, death of either of the spouses, low birth weight, a malnourished mother and difficulties in breast feeding. Some of the problems of

mothers that result in poor health status in their children are consequences of poor prenatal management (Tronba *et al*, 1991).

Another important factor that precipitates malnutrition in children in developing countries is the lack of adequate care. Very often, mothers engage in long and strenuous labour on farms while their children are left at home where they may not be well looked after (Rabee and Geissler, 1992). Another nutritionally relevant problem in respect of societal practices are taboos. Many ancient communities have beliefs about food, some of which have no scientific basis and may even be against good nutritional practices. Some common taboos in Nigeria are shown Table 2.

Table 2: Some common taboos among the major ethnic groups in Nig.

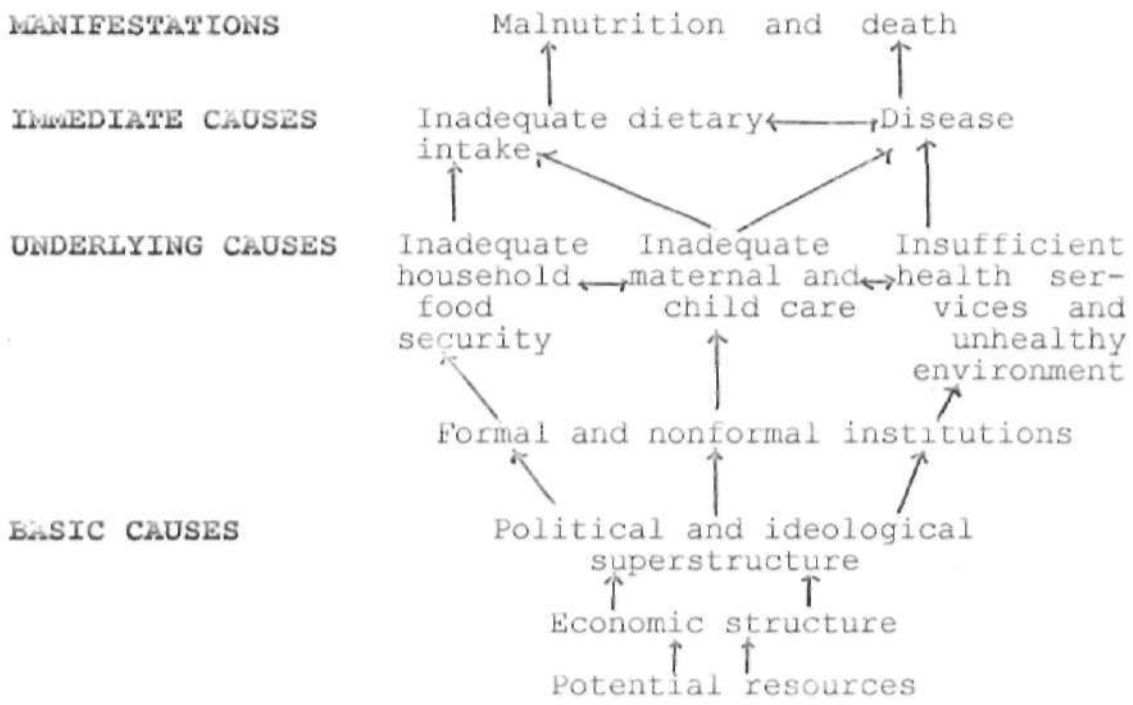
Ethnic group	**Taboos**
Hausa	-Children must not be given meat or eggs.
Igbo	-Lactating mothers to eat less beans, peanuts and melons. -Pregnant women not to eat eggs. -Pregnant women should not eat meat of porcupines, snails as well as gizzards and tails.
Yoruba	-Children not to be given meat or eggs. -Pregnant women to avoid snails.

Source: Aina *et al*, 1992.

The taboos about meat and eggs are the commonest ones and have been found to still exist among the Hausas (Almustafa and Oderinde, 1995).

The socio-economic conditions in most developing

countries are such that the families are large, food production is by the less efficient traditional methods and therefore food is often scarce and expensive. Food preservation and distribution systems are also very often poor and the illiteracy rate is very high. Thus good nutrition is almost unattainable except by a lucky few. An overview of the conceptual framework of the causes of malnutrition and death are highlighted in figure 2 below.



(Source: FGN/UNICEF, 1994).

Figure 2. *The conceptual framework of the causes of malnutrition and death.*

2.6. The need to prevent malnutrition.

The aim of assessments of nutritional status of a population is to identify group(s) that are at risk or already affected by malnutrition. This is very important because of the many grievous consequences of malnutrition particularly in vulnerable groups such as children, pregnant and lactating women. Malnutrition causes the retardation of physical and mental growth and increases the rate of morbidity and mortality in the society (Schroeda and Brown, 1994). It should therefore be carefully monitored with a view to combating it.

Unchecked malnutrition seriously puts strains on the community by robbing it of the potential contributions of the malnourished, who are now physically and mentally 'disabled' and require managment (Behrman, 1992). Levin (1987) demonstrated, in a Chinese village that correcting iodine deficiency by salt iodisation can lead to a five-fold increase in income. It is important to note that even children who are apparently normal by anthropometric assessments have been shown to improve their level of school performance by up to 10% after receiving iron supplementation (Soemantri, 1985).

2.7. The prevalence of PEM and associated defficiency diseases.

The monitoring of malnutrition is both a local and

international affair. In Nigeria, many works have been published over the last two decades. One common feature of all the reports is that they always conclude there is some form of serious malnutrition particularly among the children of pre-school and school age. In 1974, Oomen reported 10.0% chronic mal-nutrition (PEM) among Hausa school children in Malunfashi (northern Nigeria) using 85.0% of the Harvard standards as a cut-off point. The study by Alexander and Atinmo (1982), showed that the rate of chronic malnutrition in Rivers State was 20.0% among school age children.

Another study two years later (Addo, 1984) found the rate, among pre-school children of northern Nigeria (Kano, Kaduna, Zaria and Jos) was between 7 to 10.0 percent. There are many other studies but the common problem that prevents a good comparison between them is that the studies often use different cut-off points even if they happen to have use the same reference standards.

However, the recent report of NDHS (1990) was based on a nationwide survey conducted at the same time and with personnel who were similarly trained. This reduced the seasonal and design induced disparities which often prevent comparisons between reports on different parts of the country. A summary of the NDHS findings is given in Table 3.

From the data, it can be seen that Kebbi State, being

part of the northwest, is expected to be one of the most affected areas. The national average of 43.1% stunting among pre-school age children is also a very serious problem. The Africa Demographic and Health Surveys (Population Reference Bureau, 1992), two years after the NDHS (1990) publication, reported that the rate of chronic malnutrition in Nigeria was 40.0% ; Ghana, 30.0%; Burundi 48.0%; Mali, 24.0%; Senegal, 23.0% and Togo, Uganda and Zimbabwe, 30.0, 44.0 and 30.0% respectively.

Table 3. *The Prevalence of chronic malnutrition among pre-school children in Nigeria.*

Region	Stunting	Wasting	Underweight
Northwest	51.9	12.1	43.8
Northeast	50.4	11.3	44.6
Southwest	35.6	5.5	26.9
Southeast	36.6	7.6	29.6
Residence			
Urban	35.0	7.2	26.3
Rural	45.5	9.6	38.5
All Children	43.1	9.1	35.7

Note: The corresponding figures for severe malnutrition are much lower (by at least half of the rate of chronic malnutrition or much lower) in all cases. These figures were generated by comparison by to the NCHS standards (<Mean-2SD=chronic & <Mean-3SD = severe malnutrition).

It is therefore obvious that the prevalence of malnutrition in Africa is high and a major public health prolem. Looking at the NDHS (1990) figures, the national rate of wasting among pre-schoolers was 9.1% compared to the 21.1% in 1983 as reported by WHO (1989). Considering

the economic down-turn since the WHO-reported figures were published, it is difficult to reconcile the two figures (an improvement in the nutritional status against an economic crisis!).

The prevalence of malnutrition is not a geographical issue *per se*, rather it is more of a socio-economic one. Looking at other nations, between 1975-1980, Mexico had stunting rates of up to 59.0% among her pre-school age children. Jamaican pre-school children (black race) had stunting rates of just 15.7% (maximum), while New Zealand's figures ranged between 1.1 to 4.0%, and the U.S. and Europe are used for standards (WHO, 1989). This is obviously a clear case of socio-economic stratification. The more developed the country is, the better the food supply and the hence the better the nutrition of the citizens.

Within the adult population, pregnant women are the most vulnerable. Two recent reports have shown that the prevalence of anaemia among Nigerian's pregnant women stands between 17.0-25.0% (Gwarzo *et al*, 1994; Akeredolu and Fakeye, 1994). Low iron intakes and or infestation by intestinal parasites have been blamed as the major causes for the high prevalence of anaemia reported. Iron, iodine, vitamin A, and protein-calorie malnutrition are the leading nutritional problems in the world today (Buyckx, 1993). In summarizing the international community's commitment to combating micronutrient deficiencies, Buyckx (1993)

summarized their prevalence as shown in Table 4. The the prevalence of micro-nutrient deficiencies is closely associated with that of PEM. Their deficiency is also much more rampant among the developing nations children and the severity is much higher because they often coexist along side other deficiencies and or infections.

Table 4: *Numbers of people affected by micronutrient deficiency.*

Nutrient		Numbers of people affected (millions)
Vitamin A	40	pre-schoolers affected by vitamin A deficiency problems.
Iodine	200	have goiter.
	26	mentally retarded.
Iron	2000	anaemic or low iron intake. (deficiency levels of public health concern in both industrialized and developing nations, but much higher in developing nations).

(Source: *Buyckx, 1993*).

2.8. Combating Malnutrition.

Malnutrition, whether in the form of PEM or micronutrient deficiencies, reduces the quality of life of those affected and consequently the whole society at large. For this reason, various approaches have been adopted to maximize the effectiveness of combating the problem. The major areas usually exploited include government policies, specific agricultural programs, public health programs, nutrition education, nutritional surveillance, food supplementation, diversification and fortification, population education etc. Literally, all the cited domains

are best handled by national governments. International agencies like UNICEF, WHO, Helen Keller International (HKI) have also been contributing immensely. In most third world countries, there is no shortage of ideas. However, the problem is more often that of lack or misuse of funds to implement policies and programmes or simply a lack of willpower and prudent management (Jelliffe and Jelliffe, 1989).

2.8.1 Nutrition Education.

For the moment, nutrition education has a central role in improving the situation in Nigeria. Adedoyin and Adeniyi (1991) showed in a trial in Ilorin, that teaching with practical demonstrations can be as effective as providing supplements. This is because of the benefit of a better utilization of what is available through better selection of items and proper cooking practices. The level of general education has also been shown by Scott-Emuakpor (1991) to enhance the interest of fathers in the nutrition of their children. Regular community based growth monitoring can also help by serving as an early warning system which can stimulate the government or parents to take appropriate action in good time (Abosede, 1991).

2.8.2 Food Fortification and Supplementation.

Food fortification has been successfully used to

tackle the problem of some micronutrient deficiencies. Fortification of table salt with iodine is one of the good examples of this process which is currently being practiced in Nigeria. UNICEF/NPC (1995) have reported that 90.0% of marketed table salt in Nigeria is iodized. The fortification of iodized salt with iron has already been satisfactory carried out experimentally (Rao, 1994). In NIgeria, the fortification of sugar with vitamin A is also being considered by UNICEF and the Federal Government of Nigeria.

The fortification strategy is very effective as a preventive measure but it is not as appropriate when diseased conditions are already prevailing. In such cases, large-dose supplementations are more effective. Several trials have proven supplementation to be very beneficial both as a curative as well as a preventive measure. Lie and coworkers (1992) have shown that large-dose vitamin A supplementation (20,000IU at six months intervals) significantly reduced the incidence of diarrhoea and respiratory tract infections and significantly improved the serum retinol status of malnourished children. In another study carried out in Hubei Province of China, Wadhwa *et al* (1994) used local vegetable sources of beta carotene over a period of one month (while on the usual diet) to significantly improve vitamin A status. Food diversification is another very useful and less expensive

alternative form of supplementation but proper nutrtion education programmes must be put in place first.

2.8.3 Food Diversification.

Since poverty is one of the major causes of malnutrition, approaches to solving the problem need to be technically simple, and relatively ine::pensive, otherwise they will not succeed in developing nations because they cannot be sustained. Food diversification facilitated by home gardening, leaf protein extraction (Leaf For Life, 1994) and similar approaches are reasonable options for the *developing countries. The more frequent and appropriate use* of protein-rich plant seeds such as soya beans groundnuts, cow peas and other legumes should be encouraged particularly for children who are growing rapidly in order to curtail PEM and micronutrient deficiencies. Guthrie (1989) observed that most of the diets in the developing countries are largely vegetarian and carbohydrate dominated with little or no animal products most of the time. The diets are generally low in protein energy and micronutrients but high in carbohydrates and fibre. The problems associated with these "meatless" diets have been discussed by Sanders and Reddy (1994). The major features include low iron, zinc and calcium availability (even if present), and lack of cyanocobalamin. Guthrie (1989), stated that poor mineral availability due to chelation by

phytates and oxalic acid (Sanders and Reddy, 1994) are probable precipitants of poor skeletal growth in vegetarian children.

Introducing drastic changes in the dietary habits of people is not easy because of economic constraints. It is however possible to educate the people to try to solve their nutritional problems by using local alternatives. The nutrition education component is very important because many rural families already cultivate legumes, catch fish, and practice animal husbandry, but sell off literaly all these nutrient-packed foods leaving their children to suffer from PEM and micronutrient deficiencies. Although it is arguable that proceeds are used to procure staples for the family, this is not true in most cases. Besides, reserving a cup of fresh milk or an egg for he toddler will definitely not reduce the take home proceed by much and will forestall a lot of problems for the child's present and future life.

2.5 The Assessment of Nutritional Status and its Purposes.

Despite the vast body of knowledge on the aetiology of various micro and macronutrient deficiency diseases and the numerous strategies for combating them, malnutrition is not totally preventible even in the developed countries where both academic and material resources are readily available.

It is therefore necessary to have a system of regular monitoring of the nutritional status of the community. Being an important determinant of health status, nutritional status is always of great interest to all organizations concerned about health issues, and it is therefore a subject of constant assessment. In whichever form(s) the assessment is made, the final goal is invariably tied to one aspect of health or the other.

The WHO Working Group (1986) cited the following important purposes for which nutritional status may be assessed. They are as follows:-

1. Overall assessment of a population's health status with specific or general interests.
2. For identifying target groups or areas of priority for action.
3. Nutritional surveillance (continuous or periodic) for planning purposes.
4. Monitoring nutritional status to determine trends of particular importance to national health authorities.
5. To evaluate the impact of programmes such as supplementary feeding, health-care, agriculture ,etc.
6. For screening to identify groups who may require urgent attention in emergency situations like wars, famines, floods and the like.
7. Sequential assessments for studying the effects of seasonal changes in food supply or disease prevalence

and for identifying changes in growth at an early stage.

8. For specific diagnosis of a diseased state to facilitate appropriate medical intervention.

9. Monitoring the progress of patients on specific dietary or other therapeutic regimes.

The realization of the desired goal in each instance depends on the design of the study, the competence of execution and analysis of the data generated (WHO, 1986)

2.10. Methodologies Used in the Assessment of Nutritional Status.

The assessment of nutritional status can be approached from many angles but two broad domains can be identified. These are the direct and indirect assessments. The direct methods of assessment involve direct measurement of parameters on the subjects under investigation and are usually conducted by the researcher himself. Methods under this category include clinical examinations, biochemical tests, biophysical methods, and anthropometry. In contrast, the indirect methods of assessment are based on health statistics which may be collected by persons other than the investigator(s).

Indices used in the indirect method of assessment include age-specific mortality rates, health statistics, nutritionally relevant infections and cause-specific

morbidity and mortality. Jelliffe and Jelliffe (1989) gave a comprehensive account on each of the two major types of assessment and the techniques involved in each of them. Apart from the direct and indirect techniques, to understand the aetiology of any state of nutrition, information must also be gathered on ecological variables such as agriculture, food availability, accessibility, preparation, consumption etc., socio-economic and political factors, aspects of health, demographic issues, cultural influences, geography and climate (Jelliffe and Jelliffe, 1989).

As discussed under the aetiology and the complications associated with PEM, we saw that there are a number of biochemical and clinical changes and serious alterations in growth of the affected subjects. The prevalence of PEM can therefore be studied by employing clinical, biochemical or anthropometric assessments or a combination of any of them as the situation warrants.

2.11. Clinical Assessment.

Clinical examinations are the assessments of subjects for signs and symptoms of nutrient deficiencies which have persisted and have caused biochemical changes that are serious enough to create anatomical lesions. The signs and symptoms are usually visible or can be felt in superficial tissues or organs (Jelliffe and Jelliffe, 1989). Although

the method is fast, cheap and capable of giving valuable information, the investigators must be well trained in order to distinguish between closely related signs and appreciate the lack of specificity associated with clinical signs. For instance, oedema occurs in Kwashiorkor as well as beriberi (Guthrie, 1989). Skin changes can occur in vitamin A deficiency, in Kwashiorkor, Pellagra and even due to hash weather or infection (MacLaren, 1981). The method is therefore often criticized for being rather inconclusive except in severe malnutrition where the signs are very pronounced (Bender and Bender, 1982). Even in such cases biochemical tests should still be used to confirm the clinical underlying causes (Ulander *et al* 1993).

Whitney *et al* (1990) also supported the view that many common physical signs suggestive of malnutrition are nonspecific because they may reflect nutrient deficiencies or may be totally unrelated to nutrition. Assessors must therefore interpret physical findings in the light of and supported by other assessments. To minimize the problem of lack of specificity the clinical signs have been categorized and those that are more consistent with nutrient deficiencies (strongly suggestive clinical signs) are preferred for assessments of nutritional status (Jelliffe and Jelliffe, 1989). The strongly suggestive clinical signs are summarized in Table 5 below.

Table 5: *Commonly recorded Clinical signs (strongly suggestive of nutrient deficiencies).*

Sign	Suggested nutrient abnormality
A. Deficiency	
Pale conjunctiva	Iron, Folic acid,& B12.
Bitot spots	Vitamin A.
Angular stomatitis	Riboflavin.
Spongy bleeding gums	Vitamin C (after infancy).
Thyroid enlargement	Iodine.
Oedema (both legs -in Young Children)	Protein-energy malnutrition.
Epiphyseal enlargement (both wrists)	Vitamin D.
B. Excess	
Mottled enermel	Fluoride .
Dental caries (cavities etc)	Sugar (sticky forms;direct oral effect).

(Source: P23, Jelliffe & Jelliffe, 1989).

Since clinical examinations are largely subjective, it is always important that the method of reporting must be standardized so that results are comparable. Otherwise, even within the same study, different investigators could create varying impressions of what is actually the same type and degree of abnormality. At times, the same observer may even develop a bias, for one reason or another, before the end of a series of assessments. In the quest for solutions to this aspect of physical examinations, devices such as a spring-loaded probe for gum bleeding, the epiphysometer to gauge wrist enlargement and an oedema testing device have been developed (Jelliffe and Jelliffe, 1989). Despite these improvements, since even the

oedema that is categorised as being strongly suggestive of PEM is also unspecific, the method remains largely inconclusive.

2.13. Anthropometry.

The measurement of the variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition is the subject of nutritional anthropometry (Jelliffe, 1966). Although many parameters can be measured as indices of nutritional status in anthropometry, body weight, height, skin fold thickness and arm-circumference for age have been the most popularly used indices (WHO, 1989; NDHS, 1990; Toriola, 1990 and Gorstein *et al*, 1994). The measurements are relatively simple to carry out and the equipment used are reasonably cheap. With increasing technological advancements, however, anthropometry too is becoming more sophisticated. For example ultra sound is used in determining the amount of fat, infrared teractance for skin fold thickness; while computer tomographic scanning is employed to determine fat:muscle ratios, and dual photon and dual energy radiographic absorptiometry or neutron activation analyses for total body composition (Lipkin and Bell, 1993 and Hymsfield *et al*, 1982).

The sensitivity of anthropometric parameters in detecting malnutrition vary from one parameter to another

and the age group of the subjects. For instance, arm-circumference measurements are very useful indices for children below the age of five but it gradually loses its usefulness as age advances beyond five years (Jelliffe, 1966). The parameter is a particularly convinient one to use especially when quick results are desired. This is because it is very simple to determine, reliably capable of detecting wasting and shows no significant sex variation between the ages of two to five years (De-Omis *et al*, 1997). This makes arm-circumference measurements particularly useful for the proposed study which covers this same age group. The usefulness of arm-circumference measurements as indices for detecting malnutrition, a major mortality risk factor, was demonstrated by Alan *et al* (1989). They showed that the mortality rate amongst children with arm circumference less than 12.0 cm (in Bangladesh) is 12 times that of those with values greater than 14.0cm.

Weight, the oldest correlate of morbidity and mortality (Lipkin and Bell,1993; Melchior,1995), is widely accepted as being the most sensitive anthropometric index. Determining weight however has both intrinsic and extrinsic errors which could reduce its validity as a correlate of mortality. Wellborn (1951) and Latham (1972) both emphasized that unless age is accurately known, the reliability of weights as an index of mortality is poor.

Apart from age, inaccuracies can also be introduced due to the inclusion of the weights of gastrointestinal contents, urine etc -ie intrinsic errors (Martin, 1935). Extrinsic errors include weights of clothing and any other worn materials not removed or properly accounted for. Morgan *et al* (1980) determined the sensitivity of correctly detecting weight changes as being 67.0% and its predicting power with respect to nutritional status as 75.0%.

Height is less sensitive to malnutrition compared to weight, and it is of little use if weight is not known (Gavan, 1950 and Wijn, 1952). It can however be more accurately determined than body weight, even in infants where the task is more difficult (Doull *et al*, 1995). Weight and height-for-age and their derivatives constitute the current standard ways of expressing the types of growth retardation associated with PEM (WHO,1989). The major classifications are briefly discussed below.

2.13.1. Stunting.

This is deficit of height for age which is an indication of failure of skeletal growth due to malnutrition. It often remains unnoticed for some years (chronic malnutrition). Stunting is determined by comparing subjects' heights to reference standards. Subjects whose heights are less than two standard deviations (-2SD) below the reference heights are classified as mildly stunted

while those less than three standard deviations (-3SD) are considered severely stunted.

2.13.2. Wasting.

A deficit of tissue and fat mass compared to the amount expected in a child of the same height or length which may result from failure to gain weight or from actual weight loss. The assessment of wasting is also based on a comparison to reference standards and the classification of subjects below -2SD as mildly wasted, and those below -3SD as severely wasted.

2.13.3. Underweight.

This classification is based on expectd weights-for-age and indicates general growth retardation for whatever reason. If the weights deviate from the standards by -2SD or -3SD, such subjects are classified as mildly or severely underweight respectively. In most reports, wasting overshadows underweight (WHO, 1989).

All these three forms of growth retardation have already been cited among the consequencies of PEM. Therefore anthropometry is a valuable technique in the assessment of PEM. But, although anthropometry is very useful in indicating gross changes in body stature it has no capacity to define causes. As a matter of fact, early clinical conditions that are eodematous may easily be

mistaken for good health going by weight alone. Similarly, early stages of vitamin A deficiency, though detectable by biophysical methods, escape the anthropometrist very easily (Visweswara, 1970). It is therefore necessary to use other forms of assessment to determine the exact cause(s) of the alteration found in the body measurements assessed.

In addition to the already cited limitations of anthropometric assessments, the question of which standards and cut-off points are most appropriate for different populations is currently attracting much attention. The major points of contention are:

1) Population are made up of individuals of different genetic constitutions and who respond to environmental factors such as disease, nutrition, in predetermined manners. For instance a Zulu child will grow very tall on the same diet on which a pygmy child will remain very short (Jelliffe, 1966). It is therefore apparent that standards prepared in Zulu-land are inappropriate for pygmies and possibly many other races.

2) The design of studies used in the preparation of the standards, e.g: (a) longitudinal or cross sectional (b) mixed or 'pure' racial constitution (b) techniques of determining parameters -e.g. standing height or recumbent length, etc, all introduce variations which must be taken into consideration before comparisons are made between studies, or they should be conceded as sources of error.

In discussing the limitations of the current CDC/WHO reference curves, Gorstein *et al* (1994) noted the portion from 0-3 years was derived from white middle class children followed longitudinally. They concluded that the sample was not representative of the U.S. itself! Also, while the Federal Educational and Life Sciences (FELS) Research Institute used recumbent length, the National Centre for Health Statistics (NCHS) used standing heights. This introduced an average of 0.5cm error in the height measurements of the two standards and hence the discontinuity where the two 'standards' overlap. Jeejeebhoy *et al* (1990), quoting Symreng *et al* (1983) states that when malnutrition is diagnosed by the use of only one parameter (anthropometric), then 22.0% of the normal population could be classified as abnormal.

Assessors must therefore use different methods and parameters before diagnosing nutritional status. Having identified that the NCHS (CDC/WHO) standards are not even representative of the U.S. children and the 0.5cm technique-induced error in subjects' heights and the unreliability of one-parameter measurements (22% mis-classification), reports based on anthropometric findings alone, should in all fairness, think of correction factors or simply admit being, at best, estimation if these 'standards' are used.

(3) Even within the same population, statures change as

seasons change and as socio-economic levels vary. With time, therefore, even within the same population, standards may become gradually less adequate (Davidson *et al* 1979).

(4) It is a very difficult task to define optimum health by just comparing parameters for one individual to a so called expected normal value. After all, what is important is that the subject should be physically and mentally functioning to a level that is acceptable as normal rather than whether he is as heavy or tall as normally expected (UNICEF, 1990). This problem has led to the use of varying cut-off points in the forms of percentages of standards, standard deviations from the mean, etc., (Schroeder and Brown, 1994). As discussed earlier, the currently accepted classification of malnutrition is that all subjects who are two standard deviations below the reference standards for a particular index are considered mildly malnourished in respect of that index, while those whose deficits are three or more standard deviations below the standards are regarded as severely malnourished (WHO, 1989). This approach was adopted to solve the incompatability in the presentation of results which has prevented easy comparisons.

Due to these enumerated problems, many anthropometrists have indicated that there is a need to reconsider the appropriateness of international reference standards in assessing, particularly, children from developing countries and the possibiity of shifting to indigenous standards (Addo, 1984; Toriola, 1992; Almustafa,

1992; Know and Geissler 1991). UNICEF (1990) tried to solve the problem by making the recommendation that the international standards could be scaled downwards to about 95.0% for more meaningful assessments.

In the light of the shortcomings discussed, evenhough the international standards are useful guides in anthropometric assessment and allow valid comparisons between different works that have used them, they are by no means perfect. Therefore, results and conclusions based on them should be treated with some resevations.

2.14. Biochemical Assessments.

Biochemical analysis of blood, urine and tissue samples are among what is viewed as the confirmatory component of the assessment of nutritional status (Ulander *et al*, 1993). However, errors can still arise due to one or more of the following reasons:

i) Mistakes in the collection and handling of samples (G:rry and Koehler, 1990);

ii) Analytical errors due to either a poor method or bad technique;

iii) Interpretational errors emanating from standards used or complications within the subject. For example, vitamins and minerals found in the blood may reflect disease processes, and abnormal hormonal levels, rather than excess or low dietary intake (Whitney *et al*, 1990).

Biochemical assessments are however not very easy to

incorporate in nutrition surveys because they are invasive, require the consent of the subjects, and are very often expensive (Jelliffe and Jelliffe, 1989). In the less developed countries, practical difficulties often force researchers to settle for less sensitive indices such as serum albumin and iron instead of the more sensitive ones such as retinol binding protein (RBP) and transferin respectively. For these reasons assessments including biochemical parameters are scarce in many of the reports from developing nations. However, since PEM is associated with many biochemical changes, even in developing nations, the simpler biochemical assessments aimed at any of these changes can be used to investigate and confirm other methods' findings in relation to growth retardation.

2.15. Biophysical Methods of Assessment.

These methods rely on observations of changes in functional ability of biological tissues (physical, physiological or cellular), and alteration of structures inaccessible for clinical examination (Jelliffe and Jelliffe, 1989).

Tests carried out under functional ability include, work capacity and energy expenditure using step tests, heart rate, energy expenditure rate for different tasks and the dark adaptation test, etc. Commonly advocated biophysical examinations dealing with alteration of structures are shown in Table 7.

Table 6 : *Some common biochemical tests.*

Diseased state	Test
Anaemia	-Haemoglobin level -Hematocrit -Serum iron
P. E. M.	-Serum albumin -Serum RBP
Xerophthalmia	-Serum retinol -Serum RBP
Rickets	-Serum alkaline phosphatase.
Diabetes	-Serum glucose
Beriberi	-Serum pyruvate
Iodine deficiency diseases	-urinary iodine -serum *TSH* and *T4*

(Source: Jelliffe and Jelliffe, 1989).

Table 7: *Some biophysical tests.*

Test	Tissue	Remark/Purpose
Radiography	Bone	Problems in skeletal growth and health as in rickets and osteomalacia.
Occular impression cytology	Conjuctiva	To estimate the presence or absence of mucus-secreting goblet cells as in xerophthalmia
Hair root morphology	Hair	Dispigmentation and atrophy *as in P.E.M.*
Buccal smear cytology	Buccal mucosa	Cornified and non-cornified cells ratio (non-cornified drop from 60-70% to 20% or less in P.E.M.).
Immune response	Intradermal	Response rate to antigens or lymphocyte count.

(Source: pp 52 - 54, Jelliffe & Jelliffe, 1989).

Although biophysical methods are useful in some instances, for now, they are not feasible under most field circumstances.

2.16. Health Statistics (Indirect Assessment).

Valuable information about nutritional status can be obtained from health statistics. The data available in the less developed countries (where available at all) are however mostly inaccurate because of the lack of resources, cultural anxieties lack of interest and motivation (Jelliffe and Jelliffe, 1989). Health statistics data may be compiled from hospital records, calculated from census figures or by administering questionnaires. The data may be categorized in several ways that can enhance extracting information e.g., age-specific mortality rates, cause-specific morbidity and mortality or the prevalence of nutritionally relevant infections etc.

The data may be used to identify vulnerable groups and the kinds of problems that are the major causes of morbidity and mortality. The fact that the data used are often collected by people other than the investigator, and that the collector may not even be interested in nutritional status makes this secondary method very unreliable. Its usefulness in comparative studies of health status has however been demonstrated by Grossman *et al* (1994) in a study on urban American Indian and Alaska natives. Grossman *et al* (1994) used birth weights, infant mortality rates and the prevalence of infection to demonstrated that white Americans had better health status over the other races and that urban subjects had better health status compared to their rural counterparts.

CHAPTER THREE

3.0 MATERIALS AND METHODS.

3.1. The Area and Subjects.

The subjects used for the study were pre-school children living in selected towns and villages in Kebbi state. The ages of the subjects were either 2, 3, 4, or 5 years as ascertained by parents or guardians whose consent was obtained prior to the study. The towns and villages were selected from six Local Government Areas (LGAs) based on their classification as urban or rural, and ease of accessibility by road. Table 8 shows the towns and villages involved in the study.

Table 8. Towns and villages used for the study

Local Government Area	Town/ Village	Status/ Sector
Argungu	Argungu*	Urban
	Gwazange	Rural
Birnin-Kebbi	Birnin Kebbi*	Urban
	Ambursa	Rural
Jega	Jega*	Urban
	Kashinzama	Rural
Koko	Koko	Rural
Yauri	Yauri*	Urban
	Hinanbiru	Rural
Zuru	Zuru*	Urban
	Dabai	Rural

*= Local Government Headquarters.

The villages designated as rural areas were selected such that they are not more than a 15-20 minutes journey

away from the urban sites by car or motor cycle. This was in order to avoid difficulties in transferring blood samples to the laboratories located at the urban sites, and to maximize the geographical similarities between the paired-samples (of urban-rural) in each local government area.

3.2. Experimental Design.

Within the study towns and villages, areas from which the samples were drawn were identified with the assistance of the local government personnel, who mostly used the primary health-care numberings on houses as a guide in demarcating the study areas. After carving out an area, households were selected by calculating the relevant sampling interval and identifying the households from which subjects were to be drawn. Where a scheduled household had no suitable subject, the next household after it was used to replace it and the sampling was continued on the scheduled basis thereafter.

3.2.1. Sample Size.

The sample size for the study was determined using the formula shown below (FAO, 1992).

$$\text{Sample size} = \frac{t \times P\,(100-P)}{d}$$

Where t = Level of probability that the true Percentage or prevalence is within the chosen value of d,

d = Level of precision required of results (±Percent),

p = Estimated Percentage of nutritionallydisadvantaged households in the area.

The precision required (d) is ± 5.0%, estimated percentage of nutritionally disadvantaged is 50% (NDHS, 1990; Almustata, 1992) and a t-value of 2 (that is 95.0% certainty that the true prevalence lies within 'd').

Substituting we obtain:

$$S = \frac{2 \times 50 (100 - 50)}{5} = 1,000$$

Thus a minimum of 1,000 subjects were to be surveyed. However, since the analysis of the results was intended in an age-wise manner, a consideration to have at least 30 subjects (staistically large sample) per age group for each location was adhered to. The final sample size was 1,147 and 1,392 for the urban and rural areas respectively making a grand total of 2,539 subjects.

3.2.2. Categories of Samples.

As already highighted in the introduction, the research had 3 levels which are summarized below.

Table 9: *Categorization of different sample types.*

Level	Parameter(s)	Sample	n
1.	Anthropometry.	all subject	2,539
2.	Anthropometry and Socio-economic/demographic/dietary information (questionnaire).	sub-samp. of 1	308
3.	Anthropometry, socio-economic/Demographic and biochemical assessments.	Sub-samp. of 2	174

In addition, after a preliminary analysis of the dietary information, the five major types of meals commonly consumed by the subjects were collected from different locations, pooled and analysed for proximate composition, iron and zinc. The meals were Rice and Sorghum balls (hard boiled -"Tuwo") with vegetable soup, rice and beans with stew, millet porridge (Kunu) and millet porridge (Fura) prepared with partially skimmed sour milk ("nono").

3.3. M A T E R I A L S .

The materials used in the study were as follows;

(A). For the demographic, socio-economic and dietary information, a pretested structured questionnaire was used (Appendix 1).

(B). The instruments utilized for the anthropometric measurements were;

i. A Salter type bathroom scale calibrated in kilograms for determination.

ii. A standiometer calibrated in centimeters for heights.

iii. A fibre-glass tape calibrated in centimeters for the assessment of arm-cicumference)

(C). The biochemical assessments were carried out using the instruments/materials and chemicals listed below.

(i). ***Instruments and materials:***

A Corning "252 model" colorimeter, an atomic absorption spectrophotometer, an oven, a Soxhlet extractor, Markham distillation apparatus, a muffle furnace, disposable hypodermic needles, 5ml syringes, 5ml heparinized sample vials, cool-box (EPI type), hematocrit centrifuge (microfuge), heparinized capillary tubes, and plasticine.

(ii). ***Chemicals.***

Chemicals used were of analytical grade. They are sodium hydroxide,bromocresol green, brij-35, sodium citrate, citric acid, sodium azide and albumin standard for the albumin determinations. For the total plasma protein hydrated copper sulphate, sodium citrate, and carbonate, and albumin standards were used. In the dietary

analysis, sulphuric, hydrochloric, perchloric and nitric acids were used. Others are sodium hydroxide, iron and zinc sulphates, and petroleum ether.

3.4. METHODS.

3.4.1. Anthropometric Measurements.

The anthropometric parameters measured were weight, height and arm circumference.

(i) **Weight.**

The Salter bathroom-type scale calibrated in kilograms was used in weighing the subjects. Clothes, shoes and other articles with substantial weight were removed before weighing was made. All values were recorded to the nearest 0.1 kilogram (Jelliffe and Jelliffe, 1989).

(ii) **Height.**

The standing heights of the subjects was measured using a stadiometer fitted with a detachable head-board. Female subjects were requested to remove head-ties and excess hair (in both sexes) was pushed down with the head-board. The subjects wore no shoes and stood upright during measurement. The heights were taken to the nearest 0.5 Cm.

(iii) **Arm-circumference.**

Mid-arm circumferences were measured to the nearest millimeter on the upper left arm. A fibre glass tape graduated in centimeters and millimeters was used for the measurements.

3.4.2.Biochemical Analysis.

(a) **Sample Collection.**

Blood samples were collected by venepuncture from the fore arm or back of the palm using sterile disposable hypodermic needles and 5 ml syringes. Blood samples were promptly transferred into labelled heparinized sample vials and swirled to properly mix with the anti-coagulant. Sample vials were kept in the cool-box prior to transportation to the laboratory for analysis. The total number of blood samples collected was 192.

(b) **Hematocrit.**

The packed cell volume (PCV) was determined by centrifugation. Samples were warmed to room temperature and gently shaken to uniformly redistribute cells that might have sedimented. The blood samples were then taken up in separate capillary tubes to about three quarters of each ones length, and one end of each tube was then sealed using plasticine . The capillary tubes were placed in grooves of the hematocrit centrifuge and spun for five minutes.

The PCV was measured as the fraction of the column occupied by cells in relation to the length of the whole column (cells and plasma) and expressed as a percentage. The haemoglobin concentration ([HB]) was derived from the values of the packed cell volume by dividing by 3 (Schalm *et al* 1975; Jelliffe and Jelliffe, 1989). This convertion is based on the fact that HB constitutes about one third of the erythrocyte and the method yields reliable results.

(c) **Plasma Proteins Determination.**

Blood plasma was obtained by centrifuging the remaining blood sample. The plasma was stored at 4°C and transferred to the chemical pathology laboratory at UDUTH, Sokoto, for analysis. Albumin and total plasma proteins were determined colorimetrically by the bromocresol green method of Daumas *et al* (1971) and the Biuret method as outlined by Henry *et al*, 1957 respectively. The globulin concentrations were calculated by subtracting albumin from the total protein.

(i) Total Plasma Protein.

The total plasma protein was determined using the Biuret method. The method is based on the principle that the Biuret reagent forms a violet coloured complex with copper ions in an alkaline solution. The same colour reaction takes place with peptide ($-CONH_2$) linkages of

proteins producing a colour intensity depending on the amount of protein present. The relative absorbance of samples in relation to that of a standard at 540nm is used to calculate the amount of protein in the sample.

Reagents.

(a) **Copper Sulphate Solution.**

The solution was prepared by dissolving 17.3g of $CuSo_4$ in 100 ml of hot water.

(b) **Buffer Solution.**

Sodium citrate (173g) and anhydrous sodium carbonate (100g) were dissolved in 800ml of water by heating.

After allowing the two solutions to cool, they were mixed (ie a + b) and made up to one litre. The resultant solution (**Biuret reagent**) was stored and used throughout the research.

(c) **Sodium Hydroxide Solution (3%).**

Three grams of NaOH pellets were dissolved in 100ml of water to constitute the solution.

(d) **Protein Standard.**

A solution of 5g/dl bovine serum albumin was used as the standard.

Proceedure.

The determinations were made according to the scheme shown in Table 10.

The mixtures were allowed to stand for 15 minutes before reading the absobance at 540nm using the blank to zero the colouremeter.

Table 10. Total protein determination proceedure.

REAGENTS	BLANK	STANDARD	SAMPLE
3% NaoH	5ml	4.9ml	4.9ml
Standard prof	-	0.1ml	-
Sample	-	-	0.1ml
Biuret reagent	1.0ml	1.0ml	1.0ml

The amoun. of protein were calculated as follows:

$$\text{g protein/dl} = \frac{\text{Absorbance sample}}{\text{Absorbance standard}} \times 5$$

(ii) Plas.. Albumin Determination (BCG method).

The method is based on the fact that in an acidic medium (pH 3.8), the dye bromocresol green, selectively binds to albumin to give blue-green colured complex which absorbs at 630nm.

Reagents.

(a) **Stock BCG Solution (0.01m).**

Twenty millilitres of 0.2N NaoH was added to 0.698g of bromocresol green (indicator grade) and made up to a litre with distilled water.

(b) **Stock Brig - 35 Solution.**

Twenty five grams of solid Brij-35 was melted and made up to 100ml with distilled water.

(c) **Buffer-dye Solution.**

A solution of sodium citrate (10.16g), citric acid (13.7g) and sodium azide (0.2g) was made in 1.5 litres of distilled water. To this was then added 8ml of stock BCG solution and 2ml stock Brij-35 solution and made up to 2 litres with distilled water. The pH was adjusted to 3.8 and the solution was stored at 4°C and used for the research.

(d) **Albumin Standard.**

The standard used was 5g/dl of bovine serum albumin dissolved in water together with 50mg sodium azide.

Proceedure.

The BCG-dye solution was used as the blank to zero the colourimeter. Subsequently 4ml of BCG and 20µl of different samples were mixed in separate tubes and absorbances read after 10 minutes at 630nm.

The concentration of albumin was calculated using the relationship shown below.

$$\text{g/dl albumin} = \frac{\text{Absobance sample}}{\text{Absobance standard}} \times 5$$

(iii) Globulin Estimation.

The plasma globulin concentrations were estimated by subtracting the albumin concentration from the respective total protein concentrations for each subject. Normal plasma has about 55.0% albumin and the remaing 45.0% are the globulins including fibrinogen and some enzymes (Montgomery *et al*, 1980).

3.4.3. FOOD ANALYSIS.

Equal weights of eleven homogenised samples of each of the major meals consumed by the subjects were analysed for proximate composition according to the guidelines of Oyeleke (1984).

(a) Dry Matter.

Was determind by drying samples at 105°C until a constant weight was achieved. The percentage dry matter was calculated as:

$$\frac{\text{Final constant weight of sample}}{\text{Ininial weight of wet sample}} \times 100$$

(b) Crude Protein.

Crude protein was estimated by the micro-kjeldhal proceedure. About 0.25g of each pooled sample was digested using 5ml concentrated nitrogen free sulphuric acid in the presence of $CuSO_4$ as a catalyst. The clear digest was then

distilled after mixing with 12ml 40% NaOH and the ammoniun hydroxide libtrate was traped in 15ml of 0.1m HCl with phenolphthalene indicator.

The amount of ammonium hydroxide collected was deduced by back-titration with 0.1m NaOH. The crude protein content was calculated using the equations shown below.

Total protein (mg) = (15-v) x 1.4 x 6.25

and % protein (dry sample) = $\frac{\text{Mg protein} \times 100}{\text{Mg sample used}}$

Note: volume of 0.1M HCl used to trap NH_4OH in all cases was 15ml, and v = volume of NaOH used in titration.

(c) Ether Extract.

The amount of fat in the food samples were quantifred by soxhlet extraction for six hours using petroleum ether (60-80°C). The percentage fat was calculated as:-

$$\frac{\text{wt of fat extracted}}{\text{wt of food sample}} \times 100$$

Note: The weight of fat extracted was obtained from the weight gain in the recieving flask used in the extraction.

(d) Ash Content.

The samples were ashed in a muffle furance at 650°C until a white product of constant weight was obtained. The percentage ash was calculated as the weight of the ash devided by the weight of the sample used.

(e) Carbohydrate and Energy Estimation.

The carbohydrate content of the respective samples were deduced by difference. Also, since all the energy giving nutrients were quantified, the gross energy values of each sample was calculated using the Atwater factors of 17, 16 and 37 KJ/g for carbohydrates, proteins and fats respectively (Bender, 1993).

(f) Iron and Zinc Determination.

A known weight of each of the samples was digested using a mixture of concentrated sulphuric, nitric and perchloric acids (1:8:2) till a clear final digest was obtained. Each of the digest was then made up to 100ml using deionised water. The amounts of iron and zinc were subsequently determined by an atomic absorption spectrophotometer using iron and zinc sulphate as standards.

(g) Food Intake.

In order to determine the size of the meals eaten at a time, 110 random weights of served meals were taken. The daily frequencies of the various types meals (porridges or solid meals) was also noted in each of the 110 cases. The data were used as a basis to deduce nutrient intakes.

3.4.4.Demographic, Socio-economic and Dietary Information.

A comprehensive questionnaire (Appendix 1) similar to that developed by UNICEF (1992) was used to collect the information. The questionnaire was divided into seven broad sections: subject identification, family size, occupation, income, literacy level, weaning practices and child care and health, and dietary information.

The questionnaires were administered to about 80 subjects in each location. The completed questionnaires were retrieved and analyzed according to the respective sectionns (above). A total number of eight hundred questionnaires were administered.

3.5.STATISTICAL ANALYSIS.

3.5.1. A. Anthropometric Indices.

The anthropometric data were sorted out manually according to locations (urban or rural),and ages (2,3,4, and 5 years). The data were then entered into a computer and analyzed using the Statistical Package for Social Sciences (SPSS) program. The analyses covered the following:

1. Age group means ($\pm$ SD) by sectors (urban or rural) for each local government area.
2. Overall means for urban and rural for each age group.

3. Percentile points for each parameter at each age level and sector.
4. The rates of wasting, stunting and underweight in comparison to the NCHS standards.
5. Histograms of deficits in weight and heights at different age levels
6. T-tests to assess the significance of differences between means and standard deviations of groups of interest -eg urban vs rural.

3.5.2. Biochemical Parameters.

Results of the biochemical analyses were tabulated as the means and standard deviation for each location for total protein, albumin, globulins and [HB]. The overall urban and rural means, irrespective of local government areas, were also calculated. The percentages of subjects who are anaemic was determined by comparison to the WHO (1972) standards - ie. haemoglobin levels of less than 11g/dl (Davidson *et al*, 1979). The data for different urban and rural groups were also tested using the student's T-test to determine the significance of the differences between them.

3.5.3. Demographic, Socio-economic, and Dietay Intake Questinnaire.

The questionnaires were first coded according to each major section and subsection and scored with letter and numerical codes as appropriate. Subsequently, the frequency of each type of response was determined and expressed as a percentage or an average as the case warranted. The information was then tabulated for each location, sector and the whole state, and statistically analyzed using the SPSS programme.

3.5.4. Integrated Analysis.

The three major types of data (anthropometric, biochemical, socio-economic and demographic and dietary information, were then subjected to an integrated analysis to identify any associations or their absence between specific parameters. The analysis was such that only subjects who specifically have records for the parameters under examination were used at each level. For instance only the weights of subjects in level '2' were used when testing the relationship between meat intake and body weight. The SPSS correlation and regression sub-programs were used for the analysis. The dietary analysis and meal frequency data were used to compute the likely nutrient intakes of the subjects and to project how much food they have to consume in order to meet their daily rquirements.

CHAPTER FOUR

4.0 R E S U L T S

4.1 ANTHROPOMETRIC RESULTS.

The weights (kg), heights and arm-circumferences (cm) of the subjects were analyzed by age, sector (urban or rural) and location (local government area) and tabulated as means and their respective standard deviations. The mean differences between the pairs of parameters (rural/urban) for each group was tested for statistical significance using the student's T-test.

4.1.1 Weights.

The mean weights (Table 11) of the urban subjects ranged from 9.2±1.49 to 11.8± 1.27 kg among two year olds and increased steadily with age. Among the five year olds, the minimum mean weight was 16.2± 1.43kg (Argungu) and the maximum was 17.3± 1.64 kg (Jega). The weght of children in rural areas were generally lower than those of the urban children and had a range of 9.7±1.72kg (Argungu) to 10.7± 1.12kg (Yauri) for the two year olds and increased till age 5 years where the minimum was 14.9± 1.62kg (B/kebbi) and the maximum 16.8± 1.65kg (Jega).

The difference in the subjects' body weights were consistently (90.0% of all comparisons made) higher among the urban subjects compared to those in rural areas and statistically significant ($P<0.05$) in 50.0% of the comparisons made (Table 11). However, in one instance (Argungu), the urban subjects (2 years) had significantly

Table 11: Weights (Mean±SD)Kg of urban and rural pre-school children from selected local government areas in Kebbi state.

AGE/ SC	L O C A L G O V E R N M E N T A R E A S					
	ARGUNGU (252/153)	B/KEBBI (213/157)	JEGA (214/229)	YAURI (267/314)	ZURU (201/282)	KOKO (257)
2U	9.2±1.49	11.8±1.27	11.0±1.77	11.2±1.13	10.5±1.51	--
2R	9.7±1.72	9.9±1.35	10.7±1.50	10.7±1.50	10.3±1.54	9.9±1.40
3U	12.1±1.63	14.3±1.61	13.3±1.35	13.7±1.30	13.3±1.57	--
3R	12.0±1.20	11.4±1.41	13.1±1.34	13.4±1.32	12.4±1.61	12.2±1.25
4U	14.3±1.61	15.2±1.39	15.1±1.74	15.0±1.74	14.9±1.28	--
4R	13.9±1.71	13.3±2.01	14.6±1.55	14.9±1.26	14.2±1.32	14.5±1.24
5U	16.2±1.43	17.2±1.47	17.3±1.64	16.6±1.47	17.0±1.37	
5R	16.5±2.15	14.9±1.63	16.8±1.65	16.1±1.44	15.9±1.41	16.2±1.70

Legend.

Age/SC = Age in years and sector
U and R = Urban and Rural respectively.
* = Urban significantly heavier than rural at $P<0.05$.

Note: The figures in the brackets are the numbers of subjects for the respective urban and rural areas.

(P<0.05) lower body weight than the rural.

4.1.2. Heights.

The heights of the subjects followed a similar pattern as that of their weights. The minimum mean heights recorded were 75.7± 10.8cm (Argungu) and 80.5 ± 7.06cm (Yauri) for urban and rural 2 year olds respectively. Heights also increased with age and the tallest children measured were the Jega urban 5 year olds who were 109.2±5.29cm tall. Generally the urban children were taller than their rural counterparts but the differences were only significant (p<0.05) in about one third of urban/rural comparisons (Table 12).

4.1.3. Arm-circumference.

The differences in arm-circumference measurements between urban and rural subjects was generally very small and only statistically significant (p<0.05) in one qurter of the urban/rural comparisons(Table 13). The figures however maintained the same pattern observed in respect of weights and heights (ie increased with age). In 80.0% of all comparisons made, the urban subjects had bigger arm-circumference measurements than rural subjects. The smallest mean arm-circumference among the urban children was 13.8± 1.27cm (Argungu, 2 year olds), while the highest was 15.6± 0.91cm

Table 12: _Heights (Mean ±SD) cm of urban and rural school children from selected LGAs in Kebbi state.

AGE/	L O C A L	G O V E R N M E N T	A R E A S			
SC	ARGUNGU	B/KEBBI	JEGA	YAURI	ZURU	KOKO
	252/153	213/157	214/229	267/314	201/282	257
2U	75.7±10.87	91.9±4.72*	86.1±8.22	88.1±4.53*	84.0±6.64	80.7±7.35
2R	83.9±7.91*	83.6±6.38	86.2±5.96	80.5±7.06	82.7±6.81	80.7±7.35
3U	89.6±7.09	100.1±4.02*	95.7±6.74	97.0±5.31	93.3±5.44	--
3R	91.1±4.78*	92.2±5.25	94.4±6.76	96.3±6.89	93.3±5.29	93.8±5.67+
4U	100.0±5.52	102.9±3.50*	101.9±6.37	103.3±4.65*	101.3±4.60	--
4R	101.1±6.99	98.9±5.57	102.5±4.96	101.2±4.65	100.1±4.59	100.5±5.30+
5U	107.4±4.48	107.6±3.97*	109.2±5.29	108.3±4.44	106.0±6.40	--
5R	109.2±6.16	102.3±5.46	108.6±6.10	108.7±3.78	107.2±5.66	108.3±4.44

Legend.
Age/SC = Age in years and sector (eg. 2U = 2 year urban subjects).
U = Urban and R = Rural
* = Urban significantly taller than rural at P <0.05
+ = Significantly shorter than Yauri urban.
Note: The numbers under each LGA represent the numbers of subjects assessed in the urban and rural areas respectively.

Table 13: Arm-circumferencce measurements (Mean±SD)cm of urban and rural pre-school children in Kebbi state.

AGE	L O C A L		G O V E R N M E N T		A R E A S	
SC	ARGUNGU 252/153	B/KEBBI 213/157	JEGA 214/229	YAURI 267/314	ZURU 201/282	KOKO 257
2U	13.8±1.27	14.7±0.82	14.3±1.19	14.3±0.79	14.5±1.02	--
2R	13.9±1.18	14.2±1.28	14.1±1.10	13.6±0.86	14.2±3.82	13.8±1.05
3U	14.7±0.95	14.8±0.89	14.8±1.04	14.9±0.93	15.0±0.91	--
3R	14.5±0.85	14.7±0.89	14.5±0.88	14.0±0.74	14.5±1.16	14.0±0.92
4U	14.8±0.96	14.8±0.90	15.3±0.95	15.1±0.85	15.2±0.87	--
4R	15.0±0.89	15.0±1.21	15.1±1.35	14.8±1.24	15.0±0.88	14.8±0.85
5U	15.2±1.28	15.3±1.01	15.6±1.91	15.4±1.04	15.6±0.99	--
5R	15.5±0.85	15.2±0.99	15.7±1.02	15.0±1.03	15.3±1.04	15.1±0.98

Legend.
Age/SC = Age in years and sector
U = Urban and R = Rural
* = Urban significantly taller than rural at P <0.05
Note: The numbers under each LGA represent the numbers of subjects assessed in the urban and rural areas respectively.

(Jega urban five year olds). In the rural sector the values ranged from 13.6± 0.86cm (Yauri) to a maximum of 15.7±1.02cm (Jega).

4.1.4 Overall Urban and Rural Indices.

Table 14 shows the overall urban and rural means and their respective standard deviation from their means. All the three parameters showed a consistent pattern in favour of urban subjects who are heavier, taller and have larger arm-circumferences at all the ages compared to their rural counterparts. The differences in weights are statistically significant at $p<0.05$ for all ages (urban > rural). Height differences are also significant ($p<0.05$) at ages 2 and 4, whereas for arm-circumferences the differences are significant at ages 3 and 4 at $p<0.05$.

Tables 15, 16, and 17 show the anthropometric indices expressed as centiles for the urban and rural subjects. In this presentation too, the urban subjects were consistently better than their rural counterparts. The centile curves for weights, heights and arm-circumferences for the urban subjects are shown in appendices 2,3 and 4 respectively.

4.1.5. The prevalence of PEM in Kebbi state.

The prevalence of PEM was assessed by determining the percentages of children who are stunted, underweight or wasted in comparison to the NCHS standards. Each form of

Table 14: *Anthropometric indices of urban and rural pre-school children in Kebbi state.*

Sector	Age (yrs)	Wt in kg Mean± SD	Ht in cm Mean± SD	AC in cm Mean±SD	n
Urban	2	10.7±1.66	84.9±9.03	14.3± 1.06	249
Rural	2	10.3±1.47*	82.7±7.15*	14.0±2.11	384
Urban	3	13.3±1.16	94.2±7.40	14.8± 0.94	226
Rural	3	12.6±1.49	93.9±6.11	14.3±0.96*	331
Urban	4	14.9±15.2	101.8±5.16	15.1± 0.92	318
Rural	4	14.3±1.53*	100.8±5.30*	14.9±1.08*	377
Urban	5	16.9±1.53	107.6±5.07	15.4±1.01	354
Rural	5	16.2±1.71*	106.9±5.88	15.3± 1.02	300

Legend.
Wt = Weight
Ht = Height
AC = Arm-circumference
* = Urban/rural are significantly different at $p<0.05$

Table 15: *Weight percentiles for urban and rural pre-school children in Kebbi state.*

Sector	Age/n	WEIGHT PERCENTILES IN KILOGRAMMES. 3rd	25th	50th	75th	97th
Urban	2 (249)	7.3	10.0	11.0	12.0	13.5
Rural	2 (384)	7.5	9.2	10.5	12.2	13.1
Urban	3 (226)	10.0	12.1	13.5	14.5	15.8
Rural	3 (331)	10.0	11.5	12.7	13.9	15.0
Urban	4 (318)	11.9	14.0	15.0	16.0	17.5
Rural	4 (377)	11.0	13.5	14.5	15.5	16.9
Urban	5 (354)	14.0	15.9	17.0	18.0	19.5
Rural	5 (300)	13.0	15.0	16.0	17.2	19.5

Table 16: *Height percentiles for urban and rural pre-school children in Kebbi state.*

Sector	Age/n	HEIGHTS PERCENTILES IN CENTIMETERS.				
		3rd	25th	50th	75th	97th
Urban	2 (247)	70.4	79.0	86.5	91.00	97.5
Rural	2 (347)	71.0	77.5	82.0	88.0	96.8
Urban	3 (226)	79.2	90.0	95.0	99.5	105.5
Rural	3 (331)	80	90.0	94.0	99.0	104.5
Urban	4 (318)	90.3	99.5	102.0	105.0	111.3
Rural	4 (377)	90.0	97.5	101.0	104.4	110.8
Urban	5 (354)	96.3	105.0	107.5	111.0	117.0
Rural	5 (300)	95.0	103.1	107.0	110.6	118.0

Table 17: *Arm-circumference percentiles for urban and rural pre-school children in Kebbi state.*

Sector	Age/n	ARM-CIRCUMFERENCE PECENTILESS (cm)				
		3rd	25th	50th	75th	97th
Urban	2 (249)	12.0	13.7	14.5	15.0	16.0
Rural	2 (384)	11.9	13.0	14.0	14.3	16.0
Urban	3 (226)	13.0	14.0	14.9	15.4	16.2
Rural	3 (331)	12.5	13.7	14.2	15.0	16.2
Urban	4 (318)	13.3	14.6	15.0	15.7	17.0
Rural	4 (377)	13.2	14.2	15.0	15.5	16.8
Urban	5 (354)	13.8	14.7	15.3	16.0	17.2
Rural	5 (300)	13.5	14.5	15.1	16.0	17.4

growth retardation was classified as mild (<-2SD) or severe(<-3SD) and tabulated by age, sector, LGA and the whole State.

The results show that all the three types of malnutrition occur more frequently in the rural areas than in the urban and affect more children in the lower age groups of 2 to 3 years compared to those 4 to 5 years. The mild forms of all the types of malnutrition are also more prevalent at all age levels and in both sectors. All the three forms of groth retardation also show a slight upturn at 5 years.

4.1.6. The prevalence of Stunting.

The prevalence PEM manifested as stunting (height defict for age) is presented in Tables 18 and 19. The data show that there are more of both the mildly and severely stunted children among the 2-3 year old children compared to 4-5 year olds in both sectors. For example, while only 13.0% of the 4-5 year old children are mildly stunted in the rural sector, 21.0% of the 2-3 year olds are stunted in the same sector (Table 18). The corresponding figures for the urban sector follow the same pattern. Also, in respect of severe stunting, the pattern is the same. For instance, while only 1.4% of 4-5 year old urban children are severely stunted, 12.6% of the 2-3 year olds in the same sector are affected (Table 18).

Table 18: *Prevalence of stunting among pre-school children in Kebbi state***.

Sector	Age	Percentage of children affected			
		Normal	Mild	Severe	n
Urban	2	59.4	23.7	16.9	249
Rural	2	54.4	29.7	15.9	384
Urban	3	74.8	15.9	9.3	226
Rural	3	82.8	12.4	4.8	331
Urban	4	91.2	6.9	1.9	318
Rural	4	89.1	8.5	2.4	377
Urban	5	97.1	2.0	0.9	354
Rural	5	79.0	17.7	3.3	300
ALL URBAN		82.9	10.5	6.6	1147
RURAL		75.9*	17.3*	6.8	1392

Legend.
* = Urban/Rural are significantly different at P<0.05
** = Derived in comparison to NCHS/WHO standards.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

Table 19 : *The prevalence of stunting among children from different LGAs in Kebbi state.*

LGAS n	Percentages of children affected. NORMAL URBAN	RURAL	MILD URBAN	RURAL	SEVERE URBAN	RURAL
Agungu 405	63.3	67.9	23.8	20.8	12.9	11.3
B/Kebbi 370	98.6	84.8	1.0	12.7	0.4	2.5
Jega 443	79.7	74.9	12.0	17.1	8.3	8.0
Yauri 581	94.6	85.5	3.3	12.0	2.1	2.5
Zuru 483	75.3	67.9	15.8	23.1	8.9	9.0
Koko 257	-	72.5	-	19.7	-	7.8

Legend.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

The prevalence of stunting was generally higher in the rural areas and the rural sector had significantly ($P<0.05$) more mildly stunted children than the urban sector. The differences in respect of severe stunting between the two sectors was however not significant (Table 18).

On LGA basis, the proportion of mildly stunted children in the urban sector was highest in Argungu (23.8%) and lowest in Birnin Kebbi (1.0% ; Table 19). Within the rural areas, Zuru had the highest proportion of mildly stunted children (23.1%) while Yauri had the least (12.0%).The prevalene of severe stunting was significantly lower than mild stunting in all the LGAs. The prevalence of mild and severe stunting among all pre-school children in Kebbi state was 14.0% and 6.7% respectively (Table 18).

4.1.7. Prevalence of Underweight.

The occurrence of underweight is tabulated in Tables 20 and 21. The data shows that it is also more prevalent among the 2-3 year old children compared to the older ones. The lowest incidence of both mild and severe underweight was found among the 5 year old urban children (4.2 and 0.6% respectively; Table 20). The differences between the proportion of subjects affected by the different degrees of underweight in the rural and urban sectors was also significant ($P<0.05$). In half of the urban/rural comparisons, the rural rate of underweight was at least

Table 20: *Prevalence of underweight among pre-school children in Kebbi state**.*

Sector	Age	Pecentages of children affected Normal	Mild	Severe	n
Urban	2	61.0	23.7	15.3	249
Rural	2	62.3	26.8	10.9	384
Urban	3	85.4	12.8	1.8	226
Rural	3	75.2	23.0	1.8	331
Urban	4	94.1	5.0	0.9	318
Rural	4	87.8	10.1	2.1	377
Urban	5	95.2	4.2	0.6	354
Rural	5	85.3	12.7	2.0	300
ALL URBAN		85.6	10.3	4.1	1147
RURAL		77.3*	18.3*	4.4	1392

Legend.
* = Urban/Rural are significantly different at P<0.05
** = Derived in comparison to NCHS/WHO standards.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

Table 21: *The prevalence of underweight among children from different LGAs in Kebbi state.*

	Percentage of children affected.						
	NORMAL		MILD		SEVERE		
LGAs	**URBAN**	**RURAL**	**URBAN**	**RURAL**	**URBAN**	**RURAL**	**n**
Agungu	58.2	67.6	31.5	21.9	10.3	11.1	405
B/Kebbi	97.1	69.2	1.9	28.8	1.0	2.0	370
Jega	91.7	85.0	5.1	10.5	3.2	4.5	443
Yauri	92.8	84.8	4.1	11.5	3.1	3.7	581
Zuru	84.3	69.5	10.8	25.6	4.9	4.9	483
Koko	-	69.1	-	19.7	-	11.2	257

Legend.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

double that of the urban. The prevalence of severe underweight was significantly ($P<0.05$) lower than that of severe underweight in both sectors and about the same in the two sectors at the state level (Table 20).

At the LGA level, the proportion of children affected by underweight is higher among the rural children (Table 21).

The mild form of underweight was least in urban Birnin Kebbi, followed by Yauri, Jega, Zuru and highest in Argungu (1.9 to 31.5%; Table 21). The severe form of underweight conformed to the same pattern. At the state level, the prevalence of mild underweight was 10.3 and 18.3% among urban and rural pre-school children respectively and the difference was significant ($P<0.05$). The rate of severe underweight in the two sectors was about the same (Table 20).

4.1.8. Prevalence of Wasting.

Wasting (a major feature of children with PEM) was the commonest form of malnutrition among the pre-school children of Kebbi state (Table 22). Even the children of urban Birnin Kebbi who had 1.0% mildly stunted and 1.9% underweight, had 14.0% mildly wasted children. The children who were most afflicted by wasting were those of the rural sector of Zuru (43.8%; Table 23).

The severe form of wasting affected 5.1 to 8.2% of

Table 22: *Prevalence of wasting among pre-school children in Kebbi state**.*

Sector	Age (Yrs)	Percentages of children affected Normal	Mild	Severe	n
Urban	2	33.3	46.2	20.5	249
Rural	2	24.0	51.8	24.2	384
Urban	3	76.1	19.0	4.9	226
Rural	3	49.5	37.2	13.3	331
Urban	4	80.8	17.6	1.6	318
Rural	4	71.1	23.9	5.0	377
Urban	5	87.6	11.3	1.1	354
Rural	5	75.0	22.3	2.7	300
ALL	URBAN	71.7	22.1	6.2	1147
	RURAL	46.2	34.4	11.8	1392

Legend.
* = Urban/Rural are significantly different at P<0.05
** = Derived in comparison to NCHS/WHO standards.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

Table 23: *The prevalence of wasting among children from different LGAs in Kebbi state.*

	Percentage of children affected.						
	NORMAL		MILD		SEVERE		
LGA	URBAN	RURAL	URBAN	RURAL	URBAN	RURAL	n
Agungu	76.7	66.3	17.0	20.3	6.3	13.4	405
B/Kebbi	80.9	50.1	14.0	41.6	5.1	8.3	370
Jega	61.2	53.0	30.6	34.3	8.2	12.7	443
Yauri	76.2	55.1	18.6	35.1	5.2	9.8	581
Zuru	69.5	41.9	24.0	43.8	6.5	14.3	483
Koko	-	55.8	-	32.2	-	12.0	257

Legend.
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

children in the urban sectors of the various LGAs (Zuru to Jega) and 8.3 to 14.3% in the rural sector. The age-wise prevalence of wasting (Table 22) also showed that it diminished from 2 to 3 years but rose again from 4 years. Both forms of wasting were about twice as prevalent as the corresponding forms stunting and underweight. The rural sector had about twice as many wasted children as the urban and the analysis at the state level revealed that while 21.0% of urban children were mildly wasted, 34.4% of the rural children were similarly wasted (Table 22). Severe wasting was found in 6.2% and 11.8% of the urban and rural subjects respectively.

In another approach to assessing the prevalence of PEM among the children, arm-circumference measurements were used to assess extent of wasting. Again, consistently, the rural sector had more wasted children and the problem was severest among the two year olds of both sectors (Table 24). The level of mild wasting, as determined by arm-circumference assessments, is least at 15.1% (urban 4 year olds) and highest at 40.9% (rural 2 year olds). The level of severe wasting as determined by arm-circumference among the urban 3 and 5 year olds was 0.0% whereas both sectors had a 6.8% rate among the 2 year olds. These resullts also show that there is a slight upturn in the prevalence of wasting at the fifth year of age.

At the state level the results indicated that the

Table 24: *Assessment of wasting by arm-circumference measurement.*

SECTOR	AGE GROUP (YEARS)	W A S T I N G MILD(%)	SEVERE(%)	n
Urban	2	25.3	6.8	249
Rural	2	40.9	6.8	384
Urban	3	16.8	0.0	226
Rural	3	30.2	3.9	331
Urban	4	15.1	2.8	318
Rural	4	22.6	2.4	377
Urban	5	22.3	0.0	354
Rural	5	31.0	4.0	300
Urban	All	19.9	2.3	1147
Rural	All	31.3*	4.3	1392

Legend.
* = Urban/Rural are significantly different at P<0.05
Normal = >-2SD
Mild = <-2SD
Severe = <-3SD

incidence of both mild and severe wasting were significantly higher ($p<0.05$) among rural subjects compared to urban subjects. The rate of mild wasting by arm-circumference assessment agreed very well with those determined using weight-for-height (19.9 vs 22.1% for the urban and 31.3 vs 34.4% for the rural subjects respectively; Table 22 and 24). The severe form of wasting as determined by the two methods also agree very well (Table 22 and 24).

4.2. BIOCHEMICAL FINDINGS.

4.2.1. The Packed Cell Volume (PCV) and Haemoglobin Concentration [HB] of the Subjects.

The mean PCV values of the subjects assessed ranged from 32.3±6.7 to 40.9 ±4.3%. while the [HB] varied from 10.8±1.9 to 13.6±1.4 g/dl (Table 25). Like the anthropometric indices, the mean PCV values and the [HB] were higher for the urban subjects compared to the rural. In two urban versus rural comparisons, the urban subjects' PCVs were significantly ($P<0.05$) higher than those of rural subjects. In these same instances, the [HB]s were also significantly ($p<0.05$) higher in the urban subjects. In the overall analysis of the two parameters (PCV and [Hb]) between the two sectors, the rural subjects had significantly ($p.<0.05$) lower values for both PCV and [Hb] (Table 25).

Table 25: *PCV and HB concentrations of urban and rural pre-school children in Kebbi state.*

LGA/ Sector	**(PCV%)**	**[HB]g/dl)**	**n**
Argungu LGA			
Rural	40.0±6.9	13.4±2.4	17
B/Kebbi LGA			
Urban	40.9±4.3	13.6±1.4	10
Rural	38.2±4.3	12.7±1.4	17
Jega LGA			
Urban	37.8±5.4	12.6±1.8	10
Rural	32.3±6.7*	10.8±1.9*	26
Yauri LGA			
Urban	39.7±6.4	13.2±2.1	24
Rural	36.4±5.2	12.2±1.7	15
Zuru LGA			
Urban	39.5±4.7	13.1±1.6	37
Rural	34.0±5.5*	11.3±1.8*	14
Koko LGA			
Rural	33.9±6.5	11.8±1.4	14
ALL KEBBI	39.5±5.0	13.1±1.8	81
ALL RURAL	35.3±6.2*	11.5±1.6*	93

Legend.
* = Urban-rural significantly different at $P<0.05$.

4.2.2. The Prevalence of Anaemia.

The percentages of the subjects that are affected by variuos degrees of anaemia are shown in Table 26. Those affected by mild to moderate and severe anaemia are 10.0 and 17.2% in the rural and urban sectors respectively. The cases of severe anaemia were very few with none among the urban subjects and only 2.6% in the rural sector. A very high risk group with marginal [HB] exists in both sectors. This category accounts for 14.6% of the rural subjects while only 8.4% of their urban counterparts are in the same class. Overall, the prevalence of the various degrees of anaemia in the rural sector are about double the corresponding urban rates.

4.2.3. Plasma Albumin Concentration.

The mean plasma albumin levels ranged from 3.7±0.4 to 4.3±0.29 g/dl. The magnitude of the difference between the albumin levels of the subjects from the two sectors was very small, but on average, the urban subjects had higher albumin levels than the rural subjects. This superiority was statistically significant ($P<0.05$) in the same instances as in PCV and [Hb] (Table 25). The overall differences in the levels of albumin between the two sectors was also significant at $p<0.05$ (Table 27).

Table 26: *The prevalence of various degrees of anaemia among urban and rural pre-school children in Kebbi state.*

CLASSIFICATION	URBAN (%)	RURAL (%)
Nomal ([HB]>11g/dl)	81.6	68.2
Marginal ([HB]10.0-10.9g/dl)	8.4	14.6
Mild to Moderate ([HB]8.0-9.9g/dl)	10.0	14.6
Severe ([HB]<8.0g/dl)	0.0	2.6
Anaemia (All degrees)	10.0	17.2

Table 27: *Plasma protein concentrations (Mean±SD) of urban and rural pre-school children in Kebbi state.*

LGA	Sector	[Albumin] g/dl)	[Globulin] (g/dl)	[Total prot] (g/dl)	n
Argungu	Urban	4.1±0.2	-	-	18
	Rural	4.1±0.4	-	-	17
B/Kebbi	Urban	4.3±0.3	2.1±0.5	6.4±0.4	10
	Rural	4.1±0.2	2.2±0.3	6.3±0.4	07
Jega	Urban	4.3±0.2	1.9±0.4	6.2±0.4	10
	Rural	4.1±0.3*	2.1±0.8	6.2±0.7	26
Yauri	Urban	4.0±0.3	2.3±0.7	6.4±0.6	24
	Rural	4.0±0.2	1.9±0.8	5.8±0.7*	15
Zuru	Urban	4.0±0.3	2.2±0.5	6.2±0.5	37
	Rural	3.7±0.4*	2.6±0.8	6.3±0.7	14
Koko	Rural	4.2±0.3	2.5±0.6	6.7±0.6	14
ALL	URBAN	4.1±0.3	2.2±0.6	6.3±0.5	99
ALL	RURAL	4.0±0.3*	2.2±0.7	6.2±0.7	93

Legend.
* = Urban and rural significantly different at $P<0.05$.

4.2.4. Plasma Globulin Concentration.

The mean globulin concentrations ranged from 1.9±0.8 to 2.6±0.8g/dl. The levels were generally higher in the rural subjects compared to the urban. However, none of the differences was statistically significant in any location or the overall analysis. Regarding the albumin/globulin ratio, the difference between the two sectors is insignificant but slightly lower in the rural subjects (**1.86** vs **1.82**). This shows that the higher prevalence of infections within the rural sector has left its trace by way of slightly elevating the globulins in the rural subjects. The gamma globulins are responsible for immunological defense against infections, therefore this elevation is likely to be due to their increase during previous infections.

4.2.5. The Prevalence of Hypoalbuminaemia and Hypoproteinaemia.

The percentage of subjects with albumin levels below 3.5g/dl (the value of plasma albumin concentration below which protein energy malnutrition is suspected) was much higher in the rural sector compared to the urban (**3.7% urban vs 9.7% rural**) and the difference is significant ($P<0.05$). The fraction of subjects with plasma protein concentrations less than 6.4g/dl (normal value of total plasma protein for healthy individuals) was also significantly difrerent between the two sectors (**24.7% urban vs 30.3% rural**; $P<0.05$).

4.2.6. Dietary Composition.

The major feature of all the diets analysed was their very high content of moisture and consequently low dry matter (average -80.0% moisture: 20.0% dry matter; Table 28). The millet porrige (Kunu) was particularly watery (91.8%), while rice and beans served with stew was an exception with a relatively low value of 70.4%.

The amounts of protein, fat and carbohydrates in the diets were all low because of their high moisture contents. The protein content ranged from 1.4-3.0g/100g and the fat content ranged from trace (negligible) amounts to 7.3g/100g.

The results revealed that most of the dry matter component of the diets was carbohydrates. The values ranged from 5.8-17.8% with an average of 12.7%. In respect of all these three nutrients, rice and beans served with tomato stew was the best, while the millet porridges (Kunu and Fura) alternated for the least values (Table 28). The energy contents of the diets was very low for the two porridges ((21.8 and 76.5 Kcal/100g: Table 28) but the others ('solid meals') have reasonable values which averaged over 100 Kcal/100g.

The diets' contents of iron and zinc were quite low and averaged 2.9 and 0.4 mg/100g respectively. In this case also Kunu has the lowest amounts of both minerals (0.8 and 0.2 mg/100g iron and zinc respectively) while rice and beans has the most. However, in respect of zinc, the sour milk porridge (Fura) is the second highest. This is most

Table 28: *Nutrient composition of 100g portions of the major diets of Kebbi state.*

Diet No	H2O %	DM %	PROT. g	FAT g	CHO g	E N E R G Y Kcal	KJ	ASH %	Fe mg	Zn mg
1	91.8	08.2	2.1	Tr	05.8	21.8	91.2	0.3	0.8	0.2
2	81.4	18.6	1.4	0.5	16.3	76.5	320.2	0.4	1.2	0.5
3	81.7	18.3	2.0	4.8	10.6	91.5	383.0	0.9	3.1	0.2
4	78.9	21.1	2.5	4.5	13.0	102.4	428.6	1.1	1.4	0.4
5	70.4	29.6	3.0	7.3	17.8	148.6	622.0	1.5	7.9	0.6
MEAN	80.8	19.2	2.2	3.4	12.7	88.2	368.9	0.8	2.9	0.4

Legend.
1 = Kunu (Millet porridge)
2 = Fura (Millet porridge prepared with partially skimmed sour milk -nono)
3 = Tuwon dawa (Hard boiled guinea corn paste with vegetable soup.
4 = Tuwon shinkafa (Rice equivalent of 2 above)
5 = Wake da shinkafa (Rice and beans with tomato stew).
Tr= Trace.

likely due the contribution of the milk (animal product) added. Animal products are better sources of zinc compared to plant products.

4.3. DEMOGRAPHIC, SOCIO-ECONOMIC AND DIETARY INFORMATION.

4.3.1. Family Size and Occupations.

The numbers and classes of people that comprise the families of both the urban and rural sectors are similar. The overall mean numbers of adult men, women, and children less than five years, and children between 5-18 years of age per family were similar (about 3 in each case) thus giving a mean family size of 12 people. The members of the families surveyed are all engaged in more than one occupation. However, the single, most popular occupation was farming (43.0%), followed by civil service (22.0%) then fishing (20.0%) and trading (15.0%) as shown in Table 29.

Fifteen percent of the families surveyed earn less than 3000 naira per month while only 22.0% earn up 6000 naira per month. The remaining families' income lie between the two income levels. In terms of education, about half of the fathers in Kebbi state have had primary education whereas only 22.0% of the mothers are educated to the same level (Table 30).

4.3.2. Infant feeding and weaning practices .

Mothers in Kebbi state adopt varied modes of infant feeding with respect to the basic foods as well as

Table 29. *Family composition and the percentages of surveyed families engaged in differnt occupations as their major source of income.**

SECTOR	MEAN FAMILY COMPOSITION (No.)					OCCUPATION PRACTICED (% of families)			
	MEN	WOM	<5 Yrs	5-18 Yrs	TOTAL	FARM	WAGE	TRAD	FISH
ARGUNGU LGA									
URBAN	1	3	3	2	09	32	10	05	53
RURAL	1	2	2	5	10	38	07	18	37
B/KEBBI LGA									
URBAN	3	3	3	2	11	28	45	17	10
RURAL	2	3	3	3	11	65	10	13	12
JEGA LGA									
URBAN	3	3	4	3	13	44	23	21	12
RURAL	1	2	4	4	11	56	13	31	00
YAURI LGA									
URBAN	3	6	3	3	15	30	20	26	24
RURAL	1	2	3	3	09	22	06	07	65
ZURU LGA									
URBAN	3	3	3	3	12	45	46	09	00
RURAL	2	2	3	2	09	75	24	01	00
KOKO LGA									
RURAL	7	3	3	3	16	38	38	15	09
KEBBI (All)	3	3	3	3	12	43	22	15	20

Legend.
WOM = Women.
* = Members of all surveyed families practice more than one occupation.
Note: The number of subjects involved were 308 with about 30 from each LGA.

Table 30. *Percentages of surveyed families with different income levels and pecentages of mothers and fathers who have completed primary education.**

SECTOR	INCOME IN NAIRA <3000	3000 -5999	<6000	LITERACY FATHER	MOTHER
ARGUNGU LGA					
URBAN	10	67	23	80	13
RURAL	13	45	42	29	13
B/KEBBI LGA					
URBAN	06	53	41	66	44
RURAL	26	53	21	43	09
JEGA LGA					
UBAN	07	82	11	39	72
RURAL	04	92	04	22	04
YAURI LGA					
URBAN	09	82	09	48	24
RURAL	55	24	21	10	13
ZURU LGA					
URBAN	04	69	27	55	27
RURAL	16	79	05	59	22
KOKO LGA					
RURAL	11	51	38	80	46
ALL KEBBI	15	63	22	51	22

Legend.
* = The number of subjects involved were 308 with about 30 from each LGA.

supplements and enrichments added. The practices in the urban and rural sectors are closely related and often identical. Breastfeeding is practiced by a 98.0% of the mothers. Only 19.0% give their infants breast milk and water only, while 79.0% administer local supplements from about the age of 7.3 month (Table 31). Only 6.0% of all the mothers substitute or complement the commercial formula for infant feeding.

The most popular supplement used by mothers in Kebbi state is pap (79.0%) enriched with sugar. Seven percent of all the surveyed mothers use milk based formula as supplements while 15.0% use other foods items (Table 31). About half of the mothers (57.0%) introduce their children to the family meals before a year, another 32.0% do so between 12-18 month while the remaining 11.0% follow suit after 18 month (Table 32).

4.3.4. Health and Childcare.

There is no consistent pattern in the variation of the percentages of children with complete immunization in the different locations but the overall rate is high (64.0%). In Jega (urban) the figure is as low as 19.0% but in others as high as 100.0% (Table 33). The most prevalent form of illness among the subjects during the one month prior to the study was malaria (43.0%), followed by diarrhoea (11.0%). In all, a mean of 64.0% of the subjects had one form or another of illness during the one month preceeding the study. Health cards were maintained by about

Table 31: *Percentages of families who practice different methods of infant feeding, types of supplements used and month of introduction to family meals.*

SECTOR	MOTHOD OF FEEDING			TYPE OF SPL.		MONTH OF SPL.	
	Breast and H_2O	Comm. fom.	Breast & Spl.	Pap	Comm. fom.	Oth-ers	
Arg. LGA							
Ur	10	00	90	80	06	24	7.2
Ru	25	00	75	88	05	07	9.8
B/KB. LGA							
Ur	33	04	63	55	07	38	10.6
Ru	09	00	91	83	06	11	7.3
Jega LGA							
Ur	35	00	65	84	08	08	7.6
Ru	00	00	100	97	00	03	7.2
Yauri LGA							
Ur	52	05	43	77	03	20	6.4
Ru	00	00	100	80	05	15	7.5
Zuru LGA							
Ur	09	00	91	68	14	18	5.0
Ru	00	00	100	90	00	10	5.1
Koko LGA							
Ru	41	13	46	72	14	14	6.1
ALL	19	02	79	79	06	15	7.1

Legend.
Arg. and B/KB = Argungu and Birnin Kebbi.
Comm. fom = commercial fomular.
Others = Animal products and beans.
Spl. = Supplementation.

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Table 32: Percentages of families with different *weaning periods*.

Sector	Weaning period in month <12	12-18	>18
Argungu LGA			
Urban	57	30	13
Rural	54	33	13
Birnin Kebbi LGA			
Urban	65	16	19
Rural	74	22	04
Jega LGA			
Urban	38	50	12
Rural	63	32	05
Yauri LGA			
Urban	53	31	16
Rural	44	51	05
Zuru LGA			
Urban	55	36	09
Rural	70	20	10
Koko LGA			
Rural	59	34	07
ALL KEBBI	57	32	11

Table 33: *Prevalence of diseases (%) among the subjects and health care practices among their families (%).*

SECTOR	DISEASE PREVALENCE				HEALTH CARE PRACTICE			
	Ill	Mala	Dia	Others	H/cd	Immu	Hos	Self
Argungu LGA.								
Urban	80	60	07	13	97	100	100	00
Rural	75	69	05	01	96	75	87	13
B/Kebbi LGA.								
Urban	64	41	22	01	50	22	75	25
Rural	70	41	25	04	13	86	26	74
Jega LGA.								
Urban	45	33	07	05	50	19	17	83
Rural	87	78	00	09	91	91	96	04
Yauri LGA.								
Urban	73	50	17	06	95	64	73	27
Rural	64	53	03	08	100	100	100	00
Zuru LGA.								
Urban	73	40	09	24	78	59	11	89
Rural	73	36	14	23	72	63	07	93
Koko LGA.								
Rural	61	27	14	20	50	22	00	100
ALL KEBBI.	70	48	11	10	72	64	54	46

Legend.
Ill = Ill within a month to the study period.
Mala = Malria.
Dia = Diarrhoea.
Others = All other diseases.
H/cd = Maintain a health card.
Hos = Goes to the hospital for treatment of diseases.
Self = Uses self medication.

three quarters of the mothers, most of whom (54.0%) rely on hospital visits to detect and identify health problems. The remaining 46.0% claimed to have the ability to use, one sign or the other to detect early symptoms of health problems and either report to the hospital/clinic or use home remedy or self medication.

When going out of the house the most of the mothers (63.0%) in Kebbi state leave their children in the care of other adult women (91.0%) at home. The practice of leaving children to be cared for at home is more common among rural mothers compared to urban mothers. Overall, only about 9.0% of fathers play some role in this respect (Table 34).

4.3.5. Food Procurement and Consumption Pattern.

Being primarily an agrarian society, most of the food consumed by families are self-produced (78.0%). Fifteen percent of the families depend on buying and 8.0% produce some and also bought some to make ends meet(Table 35). It is also a usual practice that within the 78.0% who claimed to be self sufficient, a number of them do make some petty purchases, particularly, of various food items and even of the major staple (cereals) especially during ceremonies and the like.

The food consumption pattern (Table 36) shows that in Kebbi state, cereals (made into hard boiled balls -Tuwo, served with vegetable soup or porridges) are the most important staple foods. Pulses and tubers are an important second and third food groups in the state. Meat and fish

Table 34. *Percentages of mothers who leave children at home or take them out during outings and the gender of care givers at home.*

LGA	SECTOR	Left at Home	Taken Out	CARE GIVER Female	Male
Argungu	Urban	100	00	100	00
	Rural	100	00	100	00
B/Kebbi	Urban	64	36	100	00
	Rural	33	67	100	00
Jega	Urban	33	66	85	11
	Rural	78	22	100	00
Yauri	Urban	21	79	88	12
	Rural	100	00	100	00
Zuru	Urban	69	31	60	40
	Rural	39	61	80	20
Koko	Rural	50	50	88	72
ALL	KEBBI	63	37	91	09

Table 35. *Percentages of the surveyed families with different modes of food procurement.*

LGA	SECTOR	MODE OF PROCUREMENT Prod.	Buy	Both
Argungu*	Urban	100	00	00
	Rural	100	00	00
Birnin kebbi	Urban	60	32	08
	Rural	83	13	04
Jega	Urban	44	50	06
	Rural	96	04	00
Yauri*	Urban	91	09	00
	Rural	100	00	00
Zuru	Urban	50	10	40
	Rural	59	23	18
Koko	Rural	73	19	08
All	Kebbi	77	15	08

Legend.
Prod = Produce own food.
Buy = Rely on buying.
Both = Produce as well as buy.
* = Have swamps (Fadama) for rice cultivation.

Table 36: *Frequency of consumption (days/week) of different food groups Kebbi state.*

LGA/ SECTOR	Cre-els	Tub-ers	Pul-ses	Veg	Frut	Mit	Fish	Nono	P/ oil	G/ oil
Argungu										
Urban	7.0	3.2	5.7	7.0	5.3	6.9	6.7	7.0	6.7	6.6
Rural	7.0	1.0	5.3	7.0	2.4	4.2	6.3	6.8	6.3	6.0
B/kebbi										
Urban	7.0	5.3	6.2	7.0	5.2	6.5	5.0	5.8	6.0	6.1
Rural	7.0	4.6	3.9	7.0	5.3	4.8	4.8	3.9	4.8	5.3
Jega										
Urban	7.0	3.9	7.6	7.0	4.0	5.9	4.1	3.3	5.2	5.5
Rural	7.0	0.9	4.5	7.0	4.8	6.5	5.2	6.4	0.6	6.2
Yauri										
Urban	7.0	5.4	6.1	7.0	6.0	6.0	5.2	1.5	6.1	4.2
Rural	7.0	3.2	4.4	7.0	6.8	7.0	6.7	6.6	1.0	6.1
Zuru										
Urban	7.0	4.8	5.8	7.0	4.6	5.5	4.3	3.1	6.3	5.6
Rural	7.0	4.7	4.2	7.0	4.5	4.9	4.5	3.9	4.3	4.3
Koko										
Rural	7.0	5.1	3.3	7.0	5.3	4.8	4.4	4.1	5.1	5.0
Overall	7.0	3.8	5.2	7.0	4.9	5.7	5.2	4.8	4.8	5.6

Legend
Veg = Vegettables
Frut = Fruit
Mit = Meat
P/oil= Palm oil
G/oil= Groundnut iol

are frequently used in making the soups that are served with the cereal meals. Sour partially skimmed cow milk ("Nono") is regularly used in the preparation of the local porridge known as "fura". Fruits that are in season are also widely consumed. The common ones include mangoes, guava, lemon, oranges, bananas, cashew, garden eggs, etc. Groundnut and palm oils are the two major cooking oils used in Kebbi state.

4.3.6. URBAN-RURAL COMPARISONS.

4.3.6a. Socio-economic and Demographic Characteristics.

The urban families are slightly larger than the rural families (12 vs 11 Persons) and also richer going by the proportion of people who earn less than 3,000 naira per month (Table 37).

Both fathers and mothers in urban families are more literate (completed primary education) than those of the rural families. The mothers literacy rate is significantly higher ($P<0.05$) among the urban compared to the rural.

Table 37: *Urban-rural comparison: Demographic/socio-economic; infant feeding and health; and food habits.*

Parameter	Urban (n=143)	Rural (n=165)
DEMOGRAPHHIC/SOCIO-ECONOMIC.		
Family size (people)	12.0+ 2.0	11.0+ 2.3
Income (>3000 Naira/Month)	30.8+ 8.7	19.3+14.3*
Fathers literacy(Primary)	52.6+27.6	47.3+18.4
Mothers " " "	23.4+11.7	20.3+13.4
INFANT FEEDING AND HEALTH.		
Start supplementation (month)	7.3+1.8	7.3+ 1.4
% ill a month to study	68.1+11.5	76.7+ 8.2*
% who that had malaria	36.1+17.4	58.5+20.6*
% Who that had diarrhoea	16.3+10.1	19.4+ 1.6*
FOOD HABITS.		
Mean weekly frequency of consumption of:		
- Cereals	7.0+0.2	7.0+0.0
- Fruits	5.2+0.7	5.1+1.4
- Vegetables	7.0+0.1	7.0+0.0
- Meat	6.2+0.5	4.9+1.2*
- Pulses	6.3+0.7	4.2+0.6*
- Fish	5.2+0.9	5.4+0.9
- Milk (as "nono")	4.0+2.1	5.3+1.3*
- Tubers	4.5+0.8	3.3+1.7*
- Palm oil	6.1+0.5	3.5+2.2*
- Groundnut oil	5.6+0.8	5.4+0.8

* = significantly different at $p<0.05$

4.3.6b. Infant feeding and health.

The age at which solid supplement food is introduced to infants in Kebbi state is about the same in both sectors but the rural mothers slightly prolonged breastfeeding compared to the urban mothers (19.8 vs 18.6 month). The frequencies of occurrence of illness (general), malaria and diarrhoea within a month prior to the study were all significantly higher ($P<0.05$) among the rural subjects (Table 37).

4.3.6c. Food habits.

Both sectors use cereals as their staple, with pulses and tubers ranking 2nd and 3rd in importance as shown by their frequencies of consumption (Table 37). Both pulses and tubers are more frequently consumed by the urban families than their rural counterparts ($P<0.05$). Meat is also consumed more ($P<0.05$) by the urban families compared to the rural. The consumption of milk ("nono") is much higher in the rural sector ($P<0.05$) compared to the urban sector (Table 37).

4.4. INTERELATIONSHIPS BETWEEN DEMOGRAPHIC, SOCIO-ECONOMIC, DITARY HABITS AND SUBJECTS' BODY WEIGHT.

The influences of these factors on the body weghts of the subjects for whom they were investigated was examined by carrying out correlation and regression analysis between them. This was done to see how they affect the body weight both in terms the nature of the influence (ie positive or negative) and to get an idea of what sort of magnitude. The analysis was also intended to uncover the specific effects of certain practices in the way and manner in which they are done in Kebbi State.

4.4.1. Family Size and Structure.

Results of the correlation analysis (Appendix 5) shows that the number of adult members of the family and children aged between five to eighteen years have a positive correlation with weight whereas children less than five years and an increase in family size have negative correlations with weight. This could be because while the former category can contribute to the income, the children less than five years are simply consumers.

4.4.2. Occupation, Income and Literacy.

The results show that all the major occupations in the population have very little correlation with nutritional status except for farming (r = -0.5 ; Appendix 5). An income of less than 3000 naira per month (low) has an insignificant negative correlation with weight (r =-0.01) whereas an income of greater than 6,000 naira per month (high) has a positive correlation of +0.2 with weight. The results also show that the father's literacy enhances the child's nutritional status (r = 0.06), but that of the mothers is more important (r = 0.38; Appendix 5).

4.4.3. Infant Feeding and Weaning Practices.

The analysis indicated that breastfeeding the infant is the best method of feeding (r = 0.28) followed by feeding with infant formula (r = 0.22). The overall effect of breastfeeding with supplementation as practiced in Kebbi has a negative correlation (r = -0.27) on weight gain. This is likely to be due to the replacement of breastfeeding sessions with the nutritionally inadequate supplements, rather than using them to complement breastfeeding. Among the types of supplements used, animal products are the best followed by commercial fomula and the least is pap with sugar (r = 0.17, -0.15, and -0.38 respectively; Appendix 6).

The analysis also revealed that it is not desirable to

introduce children to the usual family diets before the age of 1 year r =-0.41) and it is best to introduce them after one and a half years (r = 0.54; Appendix 6).

4.4.4. Weekly Consumption of Animal Products and Fruits.

The results of the study revealed that among these foods, only meat has a significant positive correlation with weight (r =0.53). The consumption of sour milk has no association with the weight of the subjects (r = 0.00). Similarly, fish, which is a good source of animal protein has a surprising correlation of -0.24. This is because only small amounts of both the sour milk and fish are used in the preparations in which they are used. The results are therefore indicating the inadequacy of the quantities being used rather than suggesting that these items are not nutritious. Fruits consumption had a correlation of 0.19 with weight (Appendix 7). This value is about the same as the correlation of earning greater than 6000 naira per month with weight, indicating that it is this group who can afford to eat fruits regularly.

4.4.5. Health and Childcare.

The analysis has reaffirmed that poor health (frequent illness) has a negative effect on children's weight (r = -0.08 to -0.19; Appendix 8). The results also indicated that leaving children to be cared for at home when mothers go out is better than taking them along (r =

0.08 and -0.08 respectively).

4.4.6. REGRESSION ANALYSIS.

The sensitivity of body weight to changes in selected variables was examined in order to see what fraction of its change can be theoretically attributed to a given group of variables. This was done to enhance the understanding of which varibles could be the most important to address when proffering solutions to the problem of PEM among the children. The summary of the results of the regression analyis (R^2 values) for different sets of variables are presented in Appendix 9.

The most prominent feature of the analysis is that nutritional status is a function of multiple variables and that the final effect of any set of variables is not just a function of how many variables are put together for for the analysis but more importantly the strength of their individual influences. For example, the group of variables that costituted set No.8 are just 2 but they accounted for 56.0% of change in body weight whereas set No.9 with six variables only accounted for 37.5%. Similarly, sets No.5,6, and 7 all with 8 variables each accounted for 70.4, 84.9 and 94.2% respectively.

In the final analysis, set 7 has revealed that the 8 strongest influencers of children's weight in Kebbi State were pap consumption, disease (malaria), poverty, number of dependents, meat consumption, breastfeeding, using animal products (meat, fish, & eggs) as supplements and mothers

literacy (Appendix 10).

From the results of the various sets of regression analysis, the Beta-values for selected variables were used to compile values for the expected variation in weight for a 1.0% change in selected parameters (Appendix 11). The results conclusively show that the family structure and type of food consumed are the most important factors in determining a child's body weight. These are two very strong determinants of nutrient intake and hence their strong influence on the body weights of the subjects.

CHAPTER FIVE

5.0 DISCUSSION.

5.1.ANTHROPOMETRIC FINDINGS.

5.1.1. Anthropometric indices of urban and rural pre-schoolers in Kebbi state.

In all the types of analysis made, the overall trend in respect of all the three parameters (weight, height and arm-circumference) was that they increased with advancing age and the urban subjects always had better indices than the rural subjects. When all the subjects were grouped according to sector (Table 14), the the urban subjects were found to be better in respect of each parameter and at all the ages. Regarding weight (-the best index of nutritional status; Limpkin and Bell, 1993) the differences were also significant ($P<0.05$) at all the ages.

Pertaining to heights and arm-circumferences of the subjects, the differences were significant ($P<0.05$) at ages 2 and 4; and 3 and 4 respectively. Therefore, as in other similar works, the results of the anthropometric assessments have confirmed that there are sectoral differences in the growth of the children.

As we saw in the results of the assessment of the demographic, socio-economic characteristics and dietary practices of the families in the different sectors, they

also show similar differences between the two sectors. It has been reported time and again that these socio-econmic differnces are responsible for the observed differences in growth achievements (Addo, 1984). The importance of these factors and how they dictate childrens' growth has been highlighted under the review of literature and it will be revisited again when discussing the socio-economic findings.

5.1.2. Comparison: Kebbi Children vs NCHS Standards.

The comparisons between the anthropometric indices children from urban areas of Kebbi state and the NCHS standards (Table 38) revealed that the differences in weight and arm-circumferences were significant ($p<0.05$) in all the age groups studied. The heights differences however, were only significantly different ($p<0.05$) at the age of 5 years. The bar charts in Figures 3 and 4 show the magnitude of deficits in mean weight and height between Kebbi children and NCHS standards at the different ages.

The mean weight deficits amount to about 1.2kg at each age level whereas height deficits were minimal (0.1cm) at two years and increased exponentially to 1.6cm at 5 years. Although the pattern of change was striking, it was only statistically significant at age five years. These differences have been attributed to among other things, malnutrtion, genetic and socio-economic differences between

Table 38: *A comparison between the weights, heights and arm-circumferences of urban Kebbi Pre-schoolers and NCHS standards (Means ±SD).*

Age	WEIGHTS (KG).		HEIGHTS (CM)		ARM CIRC. (CM)	
	NCHS	KEBBI	NCHS	KEBBI	NCHS	KEBBI
2	12.1±1.2*	10.7±1.7	85.0±3.2	84.9±9.0	16.0±1.2*	14.3±1.1
3	14.4±1.6*	13.3±1.6	94.4±3.8	94.2±7.4	16.3±1.2*	14.8±0.9
4	16.3±1.8*	14.9±1.5	102.3±4.2	101.8±5.2	16.6±1.2*	15.1±0.9
5	18.2±2.0*	16.9±1.5	109.2±4.5*	107.6±5.1	16.9±1.2*	15.4±1.0

Legend.

* = NCHS Significantly greater than KEBBI at $P<0.05$.

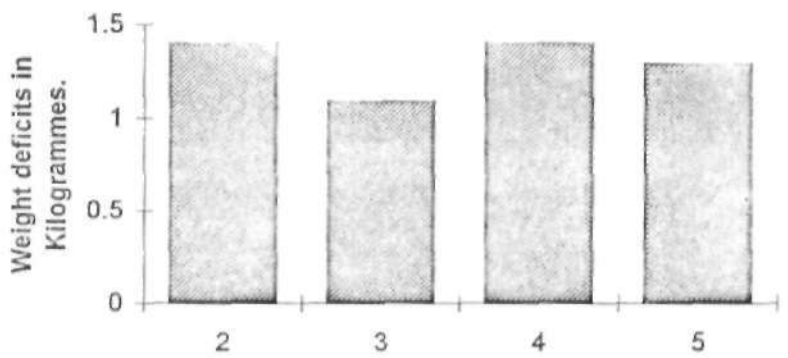


Figure 3. Weight deficits of urban pre-school children of Kebbi State compared to NCHS standards.

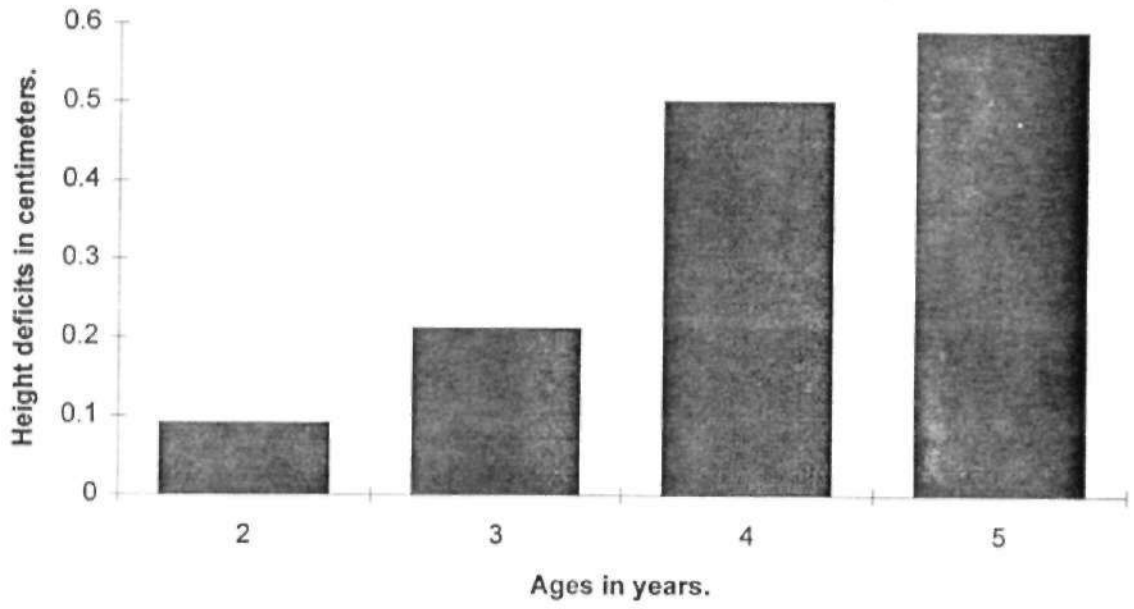


Figure 4. Height deficits of urban pre-school children of Kebbi State compared to NCHS standards.

our children and the American children used to compile the standards (Gostrein *et al*, 1994).

Looking at it from a different angle, the percentile curves for the urban subjects and the NCHS standards shown in Figure 5 revealed that the 75th weight percentile for Kebbi is approximately the same as the NCHS standards. Figure 6 shows that the 50th percentile for heights are virtually the same as the NCHS standards. This implies that the children generally have body heights that are about normal in relation to the standards, but it should also be remembered that being well is not just a matter of matching standards but the quality of life.

5.1.3. Comparisons: 'Nigerian mean', Ibadan elite and urban Kebbi pre-schoolers.

The data for the 'Nigerian mean' was derived from Addo (1984), who also presented the Ibadan elite figures from Oduntan (1972). Both data are shown in Appendix 12. The graphs generated from the weights (Fig. 5) and heights (Fig. 6) of the three groups alongside the NCHS standard show that the Kebbi subjects compare very well with the 'Nigerian mean' in both weights and heights, but both the Kebbi and Nigerian means fall short of the NCHS standards for weight. The 'Nigerian mean' heights, like Kebbi, are also about the same with the NCHS standards. The Ibadan elite are however consistently much heavier and taller

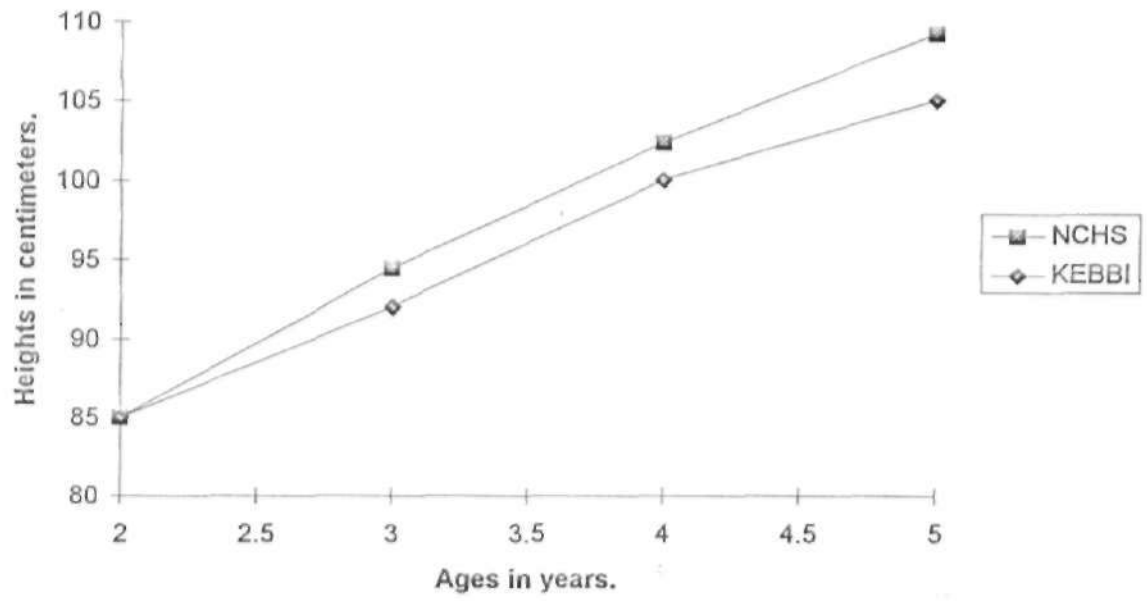


Figure 5. A comparison of mean heights of urban pre-school children in Kebbi State to NCHS standards.

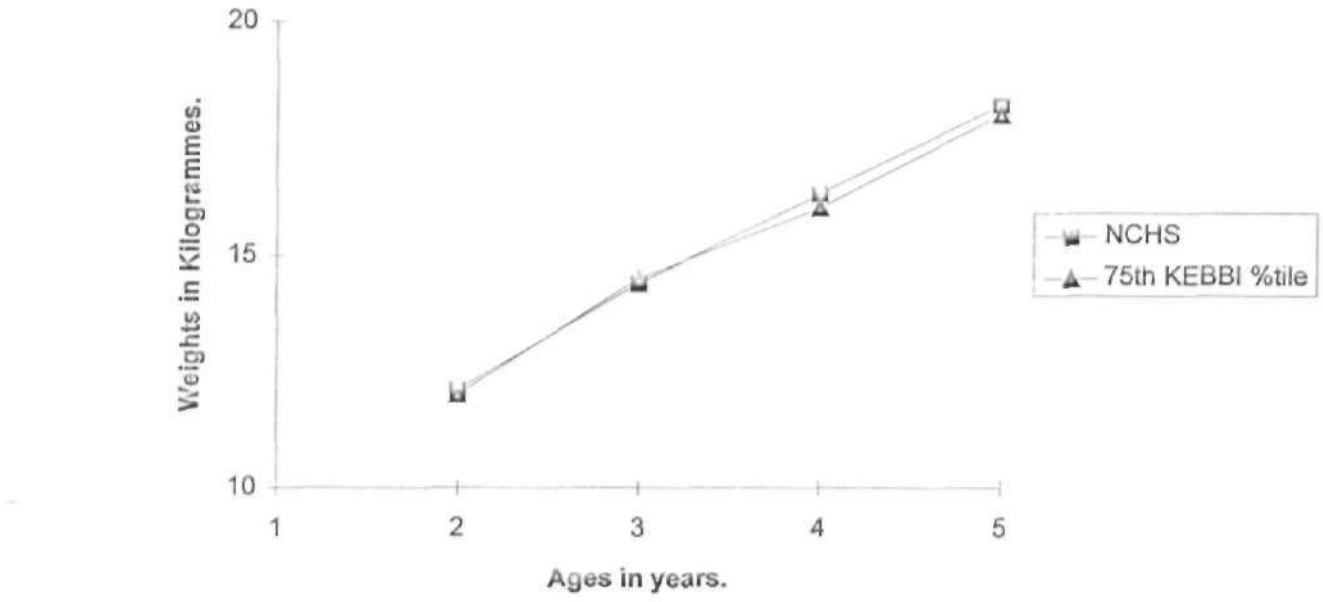


Figure 6. Seventy fifth percentile weights of urban pre-school children of Kebbi State compared to NCHS standards.

compared to both the Nigerian groups and the NCHS standards. This shows that well nourished Nigerian children can grow well enough to match the so called foreign standards. It is therefore not totally true to say that they are unsuitable for the assessment of healthy Nigerian children. To confirm that judging by heights alone is not enough, the study has found that the pre-school children in Kebbi state have weights and arm-circumferences that are persistently significantly lower than the standards. Noteworthy however, is the fact that the deficit maintained a consistent pattern of being always between 89.0-92.0% of the NCHS standards at all the ages.

This pattern conveys the message that these children have growth curves similar to those of the children used to compile the standards. The plateau of the Kebbi childrens' growth curve is however limited to a point (abuot 90.0%) of the standards. The reasons for this include factors such as the level of nutriton, socio-economic, and genetic differences etc. It must also be accepted that, though small, there are always errors both in the compilation of the standards and all other works. Despite all these, the consistent and relatively small difference between the indices of the pre-school children of Kebbi, and by extension Nigerian children, indicates that it is reasonable to just scale the NCHS standards slightly downwards (to about 95.0%) and adopt them rather than to

embark on the production of fresh standards for Kebbi or Nigeria.

The scaling down anthropometric standards and adopting them for use in developing nations like Nigeria has already been suggested by UNICEF (1990). As we have already seen in this study adequately fed Nigerian children (75th percentile and above for Kebbi and Ibadan elite) can match and surpass the NCHS standards (Figures 7 and 8). The argument for adopting a modified international standard is also supported by the findings of this study which show that the prevailing socio-economic conditions (Tables 29-37) in our community are among the major obstacles against our children attaining their full developmental potential.

Therefore, only part of the difference between their growth and that of the children used in compiling the standards can be discarded as being due to genetic and other non-socio-economic factors. To still support the argument that the socio-economic status is very important, Figures 7 and 8 show how the urban Kebbi children match other average urban Nigerian children's weights and heights and to some extent that of the NCHS standards but fall very far behind the Ibadan elite children to whom they are genetically more similar. Therefore, at least in this instance, it is the socio-economic status that is more important.

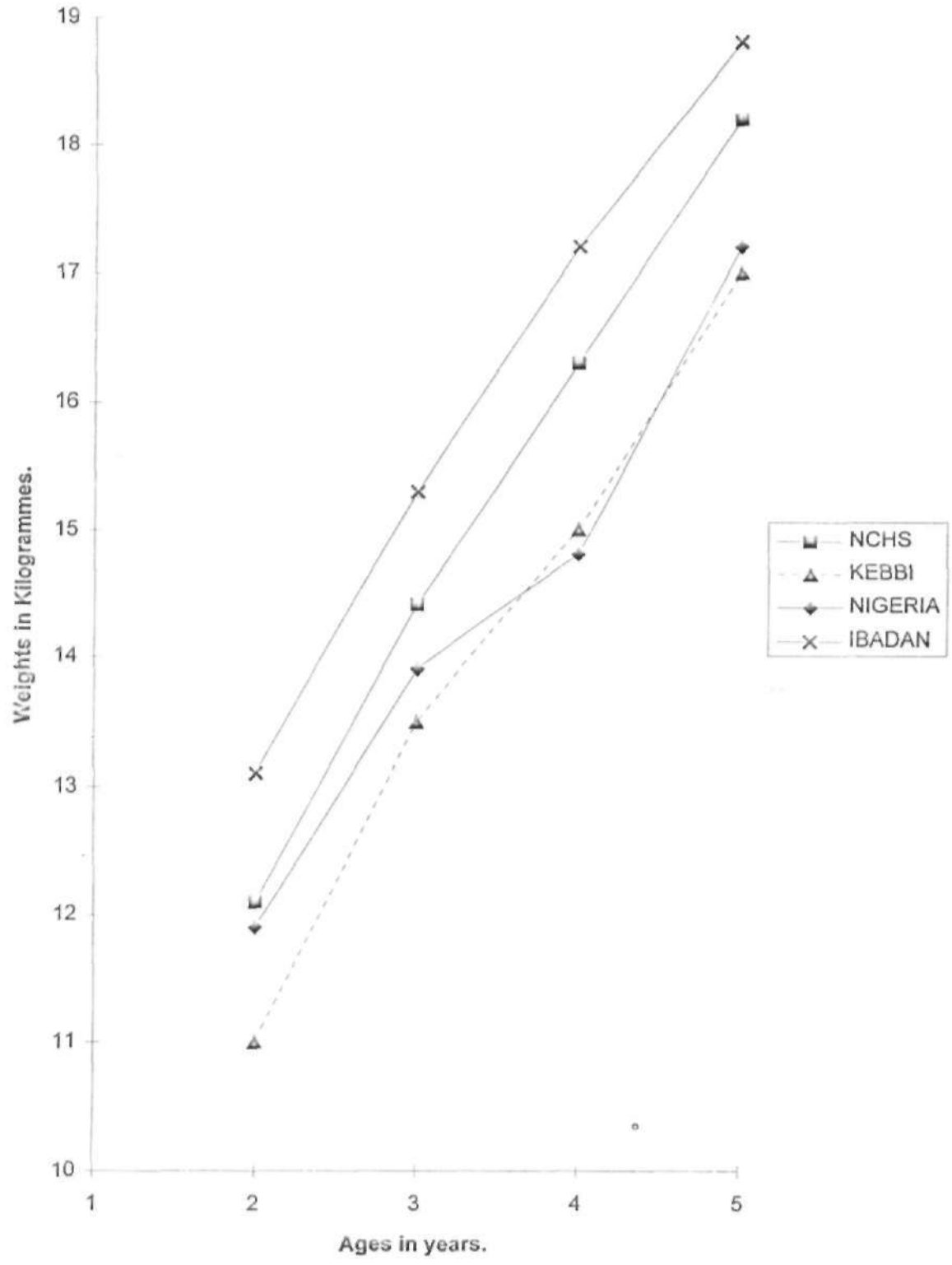


Figure 7. A comparison of mean weights of Nigerian, Kebbi and Ibadan Elite children to NCHS standards.

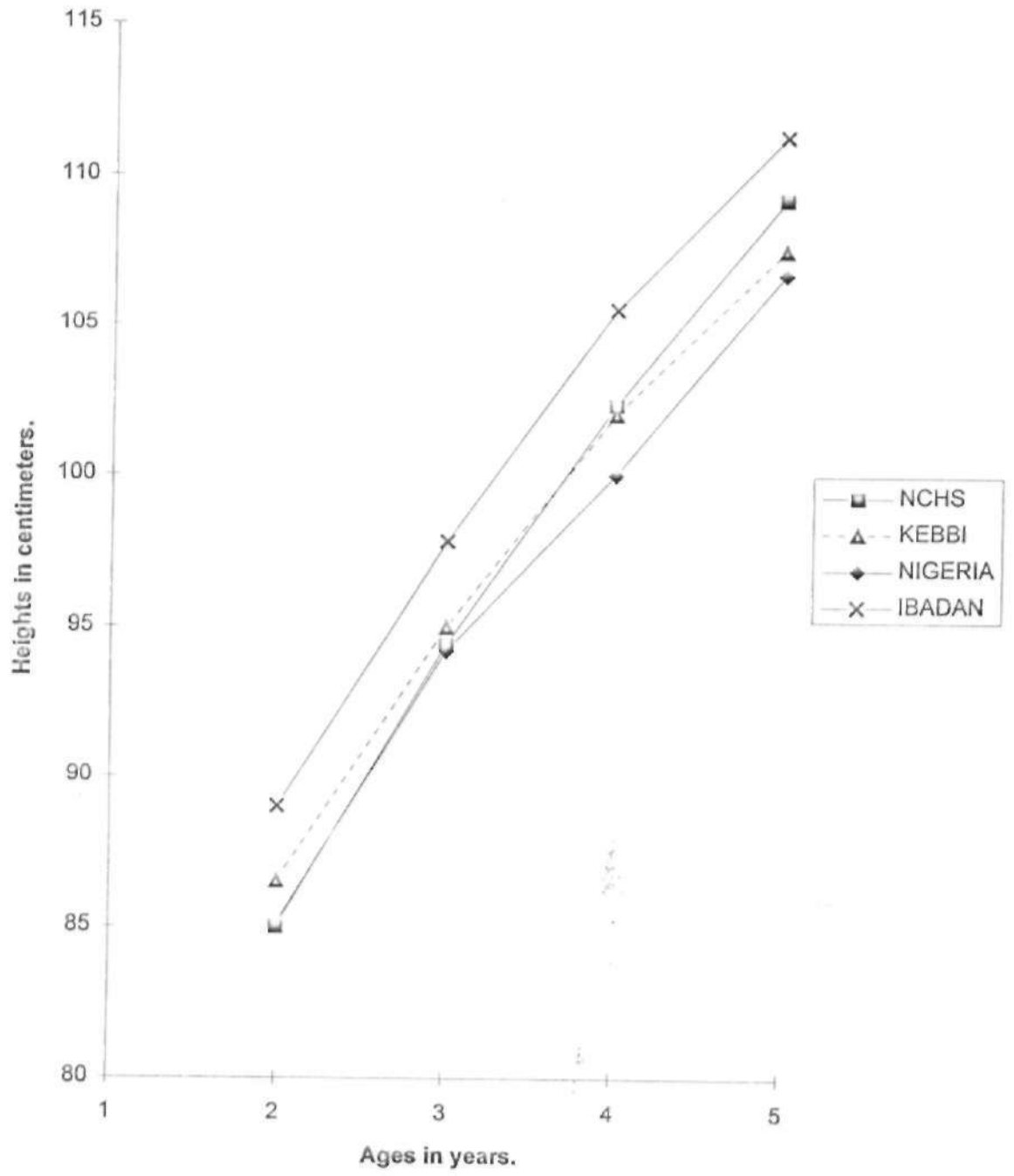


Figure 8. Acomparison of mean heights of Nigerian, Kebbi and and Ibadan Elite children to NCHS standards.

5.1.4. The Prevalence of Stunting, Underweight and Wasting in Kebbi State.

The findings of the study (Tables 18-24) illustrated a clear and consistent urban/rural pattern, with the rural areas always higher regarding the prevalence of wasting, underweight, and stunting. In the overall analysis (Kebbi State as a whole), the level of prevalence of all the forms of PEM (mild and severe stunting, underweight and wasting) in the rural sector were greater than the corresponding urban levels and the differences were significant at $P<0.05$ for all the mild forms of the three indices and severe wasting. The most obvious reason for the discrepancy in the levels of PEM in the two sectors is their differing socio-economic status as it determines their nutrient intake and general caring capacity.

Wasting was the major form of malnutrition among the subjects with its mild form found in 21.1% of the urban subjects and 34.4% of the rural. The corresponding figures for the severe form were 6.2 and 11.8%. This alarming rate of wasting was confirmed by the arm-circumference assessments (Table 24) which generally tallied with the weight-for-height assessment of wasting within 2-3% difference (Tables 22 and 23). The overall levels of mild stunting underweight and wasting among the children were 13.9, 14.3, and 28.8% respectively while the severe forms existed at levels of 6.7, 4.2 and 9.9%

The results also showed that generally all these indices of PEM were more prevalent among the younger ages (2-3 years) compared to the older ones (4-5 years). This can be explained by the fact that the younger children are growing faster and require more nourishing diets than the ones they are getting (UNICEF/NPC, 1995). Coupled with this handicap is the fact that their immune difences are weak and they tend to fall ill with infections more frequently than the older children who have more established immune responses (Scrimshaw and Taylor ,1968). The quality of care provided to these very dependant children is also not as good as it should be (Rabee and Geissler, 1992).

A striking trend that also emerged from the results was that at the age of 4 or 5, there is an upturn in the prevalence of all these indices of PEM. This is most likely because at about this age, the children spend more time outside the house and may eat less well. The boys often follow their parents and brothers to the farm while the girls may engage in activities such as wandering after older women who are fetching water and other similar activities which demand energy. This extra demand can easily create problems for children who are on marginal energy intakes.

In the different towns and villages used for the study, Birnin Kebbi, the state capital, had the lowest incidence of all the forms of malnutrition. This finding is

attributable to its better socio-economic status. In contrast, rural Zuru and rural Birnin Kebbi which had the highest rates of malnutrition are comprised of poor illiterate peasants, who have no access to clean water, decent health facilities and other important social amenities. As Karp (1995) states, "the dimensions of poverty are spelt out in the growth of children".

In comparison to the NDHS (1990) study cited earlier, the prevalence of the various indices of PEM found by the study are lower for stunting and underweight but higher for wasting. The higher prevalence of wasting among the children could be due to the natural slim physique of the Hausa-Fulani ethnic group (Kaka and Shuaibu, 1989) distorting the assessments in a population which they dominate (Audu *et al*, 1982). The level of malnutrition observed in these pre-school children is a bad beginning which continues into the years of school age. Almustafa (1992) discovered that 54.0% of Sokoto and Kebbi school children were less than 80.0% of the WHO (1989) standards for weight-for-age.

These levels of malnutrition are quite alarming, but not unexpected. Again, it all has to do with the demographic and socio-economic characteristics of the population. It is still very conspicuous that food poverty is a major problem in Kebbi state and indeed most of Nigeria. This is supported by the UNICEF/NPC (1995) report

which shows that the proportion of annual income spent in Nigeria on food was 80.0% in 1993 and that 41.0% of Nigerians are below the absolute poverty level. Right now, the slow growth of income and fast food price escalations means that the proportion could have risen much higher. Furthermore, the types of foods eaten are basically starchy and poor in protein, some vitamins and minerals (Addo, 1994; Almustafa, 1992 and 1995). UNICEF (1996) also reported that the adequacy of energy in Nigerian diets was 93.0%. This has a profound implication for PEM as the presnt diets of these subjects are still generally low in protein (Table 28). In addition, as earlier cited, Kebbi state has a reported vitamin A deficiency rate of 17.0% and iodine deficiency rate of 13.0% (UNICEF/NPC, 1995). Since vitamin A is also very important for normal growth, the defficiency is a further cause for concern.

The combinations of low protein, energy, iron and zinc (Table 28) constitute a very serious nutritional problem and the persistence of such shortage will not only precipitate higher morbidity but mortality as well. As a matter of fact, PEM, vitamin A, Iron, and iodine deficiencies are the four leading health problems of the world today (UNICEF,1990; Buykx, 1993). Already, vitamin A supplementation using megadoses (200,000 I.U), iron supplements and iodization of salt have been tried out and the results are encouraging (Nestle, 1993; ICCIDD, 1994).In

Nigeria, about 90.0% of the salt is iodized and vitamin A fortification is in the pipeline. It is however not possible to fully ameliorate the problem of malnutrition until poverty and illiteracy are substantially curtailed.

5.2. The Biochemical Findngs.

5.2.1. The Prevalence of Anaemia.

The prevalence of anaemia (low [HB]) was devided into three categories. The first category comprised of those who had [HB] just below the cut-off point for adequate [HB] at sea level (ie 11g/dl). The category was made up of the subjects with [HB] between 10.0-10.9g/dl and referred to as "marginal" becuase they could easily go either way depending the prevailing ircumstances. For instance an attack of malaria, haemorrhage, etc can easily make them become anaemic. With respect to this category, the urban subjects have 8.4% while the rural have 14.6% (Table 26). This confirms the anthropometric findings that the urban subjects are better nourished than their rural counterparts and hence their lesser percentage of subjects within this 'high rik group'.

With regards to those who are classified as being mild to moderately anaemic the urban sector has 10.0% while the rural again has 14.6%. Severe anaemia was not found in the urban sector but the rural sector had a 2.6% rate of

prevalence. Once again, the rural/urban distinction is quite obvious; with rural rates about double that of the urban.

WHO (1992) defined nutritional anaemia as "a condition in which the Hb concentration of the blood is lower than normal as a result of a deficiency of one or more essential nutrients, regardless of the cause of the deficiency". The major causes of the nutrient deficiencies were identified by WHO as being low intake, poor absorption and utilisation and increased nutrient losses and or demands. In discussing the aetiology of nutritional anaemia, WHO (1992) recognised that poverty, pointing to dietary short comings related to cost as well as dietary and cooking habits can precipitate anaemia.

The extent of poverty in Kebbi state has already been analysed in this study (Table 29). Many families in kebbi can neither produce adequate food nor afford to buy enough and the normal diets have poor nutrient density (Table 28) and the repercurtions of this was clearly reflected by the level PEM as indicated by the anthropometric results. PEM is known to be associated with anaemia because the PEM-precipitating diets are low in protein which is essential for the synthesis of the globin component of the haemoglobin as well as the synthesis of transferrin for iron transport. In addition, the atrophic changes in the gastrointestinal tract that are associated with PEM reduce

the absorption of iron, folates and vitamin B_{12}. Effective iron absorption is enhanced by vitamin C which is maily obtained from fruits, and they are not well consumed by the rural families among whom anaemia is more rampant. Vitamin B_{12} absorption requires an intrinsic factor (a glycoprotein) while folates which are mostly present in the diets as polyglutamates must first be hydrolysed by enzymes. Both the intrinsic factor and enzymes require proteins and a healthy gut mucosa for their production. The changes associated with PEM, therefore, create a physiological condition which generally reduces the gut's capacity to absorb haemopoetic nutrients.

The diets of the people of Kebbi are poor sources of protein, as well as iron and zinc (Table 28), the deficiencies of which are among the causes of anaemia. The diets have a mean iron content of 2.9mg/100g but the porridges have a mean of 1mg/100g which makes them particularly very inadequate. The situation is even worse with zinc where the mean content of the diets is 0.4mg/100g and kunu (one of the porridges) has just 0.2mg/100g. This means that to meet the daily requirement of 0.4-0.8mg/kg body mass, a five year old child has to consume up to 4.0kg of porridge.

The diets, being based on cereals and vegetables also contain phytates which reduce iron absorption. Meat, the best source of all the haemopoetic nutrients (Iron, folate,

vitamin B_{12} and protein) is rather expensive and only features regularly in the urban sujects' diets, hence their lesser rate of all the degrees of anaemia. In the rurual areas, there is also the possibility of infestation by intestinal worms which divert haemopoetic nutrients as well as cause bleeding (WHO, 1992). UNICEF/NPC (1995) have already reported the prevalence of anaemia among pre-school as 14.0% in the northwest of Nigeria. This report is in consistence with the present study's findings of a mean prevalence rate of 13.6% for Kebbi state (Table 26).

Anaemia reduces oxygen supply to the body leading to general weakness, tirediess, dizziness and headahes. This seriously reduces functional capacity both in terms of physical and mental activities thereby reducing productivity. In this manner, anaemia can be an initiator of a vicious cycle of poverty and malnutrition and a cause for underdevelopment (Behrman, 1992).

5.2.2. The Prevalence of Hypoalbuminaemia.

The rural rate of hypoalbuminaemia (low albumin) was more than twice that of the urban and was statistically significant at $P<0.05$. The prevalence of hypoalbuminaemia shows that albumin is not very sensitve in detecting mild PEM. This is because of its reduced rate of synthesis when there is a shortage in the supply of dietary protein is counterbalanced to some extent by a reduction in its rate

of breakdown. Also, albumin has a relatively long half-life of about 18 days making it less sensitive to mild or short lived protein shortages (Limpkin and Bell, 1993; Widel *et al*, 1994). This explains why the prevalence of hypoalbuminaemia is closer to the prevalence of severe underweight, stunting and particularly wasting rather than their mild forms (Table 31). However, the degrees of correlation between hypoalbuminaemia and underweight, stunting and wasting among the subjects were 0.64, 0.74 and 0.81 respectively (Appendix 13), which still indicates its usefulness as an indicator of their existence in a community. Since the figures for the prevalence of hypoalbuminaemia, are more indicative of severe PEM (Waterlow, 1978), they support that Nigerian children are fairly assessed when compared to the NCHS (foreign) standards.

5.2.3. The prevalence of Hypoproteinaemia.

The difference in the percentages of subjects who had hypoproteinaemia in the two sectors was also statistically significant at $P<0.05$. While it affected 30.3% of the rural subjects, only 24.7% of urban subjects were affected. Total plasma protein being a reflection of the plasma protein pool is quite sensitive to protein undernutrition such as is the case in PEM. This is because in PEM, the plasma proteins are are not replenished at the normal rates due to

dietary protein shortages and hence their levels gradually deminish thereby precipitating hypoproteinaemia. Hence if we compare the values for the prevalence of hypoproteinaemia to the values for mild wasting as determined by different methods (weights or arm-circumferences) in the two sectors, it can be seen that hypoproteinaemia is a good index of particularly mild wasting.

Method of assesment	%tage mildly wasted. Urban	Rural
Weight-for-height	22.1	34.4
Arm-circumference	19.9	31.3
hypoproteinaemia	24.7	30.3

Since these three methods of assessment are independent of one another, yet they all agree, it is most likely that they have only done so because it is in respect of a fact; and that fact is that PEM is rampant among the subjects. This pathetic situation of rampant malnutrition among these children has very serious consequences regarding both their physical and intellectual abilities both in childhood and in later life (ICCIDD, 1994 ; Behrman, 1992).

5.3. Interactions of the Social Environment and Nutritional Status.

5.3.1. The Demographic and Socio-economic Characteristics, and Food Habits of Kebbi State and the Prevalence of PEM.

The importace of these factors in the determination of nutritonal status is an obvious one. This is because they constitute important variables which dictate whether food will be available or otherwise, which type of food is accepted or not and how much of it is eaten, how is it to be prepared, who gets what share; what is the caring capacity, and so many other things. As already cited sevaral times, the literature is replete with findings on how these factors affect the nitritonal status of communities. It also well accepted that there are significant differences in the pattern of these important factors as one moves from the urban to the rural sector or vice versa. It is also simple logic that since these factors affect nutritional status their urban/rural differences are expected to be transmitted to the nutritonal status of the sujects living in the two sectors (Jelliffe and Jelliffe, 1989).

With 12 people per family, the average family in Kebbi is rather crowded and difficult to adequately cater for

nutritionally. Considering the fact the majority of the population are subsistent farmers, and that 78.0% of the families earn less than six thousand naira per month (Table 29), it is obvious that adequate feeding is a problem. This means that the vulnerable members of the family (women and children) are at a high risk of being malnourished. As it was seen from both the anthropometric and biochemical assessments, the levels of the various indices of malnutrition confirmed again and again that the the prevalence of undernutriton among the subjects is about 30.0%. With a large family and a low income, the task of providing enough food is a difficult one, not to talk of the quality of the food. Thus the high prevalence of malnutrition among the sujects.

Another major problem is the serious illiteracy rate (78.0%) among the mothers (Table 29). This reduces the competence to select the right types of foods to prepare appropriate meals for the children as well as give the appropriate care (Araya and Devi, 1991). Mother's literacy has a positive effect on children's nutritional status . This fact has been confirmed by the present study. A correlation analysis showed that there is a substantial positive correlation between mothers' literacy and children's weight. The fact that more urban mothers are literate means that their children get more of this beneficial effect of education as reflected in their

growth. Another dimention to the issue is that the more educated the family, the better their prospects of income and hence their ability to feed well, thus a better nutrition for their children (NDHS, 1990 ; Adedoyin and Adeniyi, 1991).

5.3.2. Infant Feeding, Weaning Practices and Nutritional Status in Kebbi State.

Infant feeding practices in Kebbi state seem to be a matter of tradition. The urban and rural habits are very similar and this was not surprising because, literacy, which is supposed to change the traditions, is only different by 3.0% between the urban and rural sectors (Table 29). Breastfeeding is the major method of infant feeding among the mothers (98.0%) and this is an acknowledged positive habit (Uchegbu, 1991 ; Prentice and Cole, 1994).

Unfortunately, however, except in Zuru LGA, the age of introducing supplements to complement breastfeeding is later than the recommended 6 months, by a period ranging from 3-5 months (Table 32). This means, for the period beyond six month, the affected children will have their growth rate slowed down or thy may try to adapt by becoming less active. This is because at that time breast milk alone is no longer enough to meet their nutritional requirements (Aina *et al*, 1992). With the high prices of infant formulae

and the low literacy rate of mothers, the 4.0% who adopt formula feeding could fall in some traps of poor nutritonal practices. The commonest ones are overdiluting the formula to make it last longer so as to cut costs and poor sanitary practices. These can easily lead to malnutrition and infections (Davidson *et al*, 1979 and Aina *et al*, 1992).

The concept of supplementation is not well understood by mothers in Kebbi state. To many of them, it is replacing a breastfeeding session by administering the supplement, which in 79.0% of the time is millet porridge enriched with sugar (Table 32). Not surprising then, this low energy and protein 'substitute' (Table 28) has a negative correlation with childrens' weight (Appendix 6). Protein and energy rich (solid) foods such as beans and animal products which are better supporters of growth (Abidoye and Fakunle, 1989) were not used as supplements as frequently as the should be. The stumbling block here is most probably illiteracy rather than poverty as such. To support this view, the low rate of using beans as a supplement cannot be explained by its cost as most families cultivate it or can afford the small quantities required as a complementary food for the child.

The total weaning of children in Kebbi state starts at about 1 year and terminates at about 19 months. The one major problem in this regard is that the family meals which are introduced to the children and which gradually become

the major weaning diets are very low in protein and energy (Okeke and Okafor, 1989). This is also true of the weaning diets of kebbi (Table 28).

The hard boiled cereal balls ("Tuwos") are fair when served with rich soups but the porridges (Kunu and fura) are too dilute to enable children to eat enough to meet their requirements. These diets, from the correlation analysis (Appendix 6), are unsuitable as sole diets until at least about one and a half years. After this age, growth rate has slightly declined and the child can eat more quantity of food as well as other snacks outside the normal meals.

The protein and energy deficits inposed on the children by feeding them these diets forces their bodies to mobilize fats and lean tissue (mainly protein) and oxdise them to make up for the energy shortage and gradually waste away (Stryer, 1994). The analysis of the dietary patterns of the subjects revealed that the problem is more of that of energy than protein deficits and it is more serious in the rural sector who consume the porridges more frquently. Eventually, when the PEM takes its grip on those affected, the gut morphology changes and complications such as diarrhoea lead to loss of appetite and reduce nutrient intake even futrther. In this manner, complications like anaemia, vitamin A deficiency may all develop (Basu, 1977).

5.3.3. Health and Childcare in Kebbi State and Nutritional Status.

Infectious and other diseases alone or combined with poor childcare are very potent in causing malnutrition or accelarating it (Lunn and Northrop-clews, 1993). The high overall rate of full immunization (64.0%) in Kebbi state has effectively reduced the incidence of measles, cough and DPT to insignificant levels. However, the overall morbidity level during the one month period preceding the study stood at 70.0%. The illnesses were principally malaria fever and to a much lesser extent diarrhoea (Table 33). Illness alters the body's metabolism and generally reduces the efficiency of nutrient utilization (Jackson, 1993). In the case of malaria, the parasites destroy red blood cells causing a loss of haemoglobin gradually making the victims anaemic (Stephensen, 1993; WoldeGabriel *et al*, 1993). The fever associated with malaria also means a lot of energy is wasted apart from the supression of appetite which lowers nutrient intake.

Diarrhoea is also a serious health problem among the children. It causes dehydration and loss of electrolytes disturbing the water balance of the body and may result in death if unchecked promptly (UNICEF, 1996). While suffering from diarrhoea a child cannot take a new supply of

nutrients orally. This halt in nutrient intake may aggravate previous shortages and mark the inception of deficiency diseases. The correlation analysis (Appendix 8) has shown that illnesses, quite expectedly, have negative effects on children's weights. Unfortunately, the incidence of malaria and diarrhoea are unlikely to reduce in Kebbi State till something is done about the poor drainage and lack of clean drinking water. Water is mainly obtained from open wells and streams even in the so called urban areas, except for the state capital (Birnin Kebbi) which has an irregular flow of pipe bone water. According to figures released by UNICEF (Nig.) and the National Planning commission -NPC (1995), malaria and diarrhoea accounted for 30.0 and 20.0% (respectively) of deaths among under fives in Nigeria as at 1994.

The quality of child care by mothers is much reduced by their illiteracy and further compounded by poverty. In many cases, the subjects' mothers go out and work on farms or get engaged in some strenuous labor apart from the various family chores. This leaves very little time and energy to care for the children. Generally, the children are better cared for when at home with their mothers or other adult women (Table 34 ; Appendix 8). A child's nutriton depends very much on the quality of care given as it affects the nutrient intake and the physiological state of the body.

5.3.4. Food Habits and Nutritional Status in Kebbi State.

The food habits of Kebbians revolve round the cereals sorghum, millet, and rice. Sorghum and rice are consumed as "Tuwo" served with fresh or dried vegetable soups prepared with or without fish or meat. In the case of rice, it might also be boiled alone or with beans and served with stew. Very often, poor families simply add fried oil alone to serve the boiled rice. Millet is mostly used for preparing the porridges "kunu" and "fura".

Because of the low efficiency of the methods of farming being used, most families' harvests do not last them the whole year and they often have to buy additional food to supplement their harvests. The problem of procuring enough basic food stuff is more acute among those who rely solely on buying as market prices often double before the next harvest.

In a study in Kebbi state, Almustafa (1994) found that a family of 12 people consume the food shown in Table 39 per month.

Table 39: *Estimate of food consumed by a typical Kebbi family and costs for a month.*

Food item	Quantity	Current Cost(naira).
Rice	8 tares	880.00
Sorghum	20 "	800.00
Millet	18 "	792.00
Beans	4 "	360.00
Palm oil	4 bottles	240.00
	Total	3,072.00

This estimate is grossly incomplete as soup ingredients, processing costs, etc are all left out. Even then, the amount is still more than the take-home pay of a civil servant on grade level 12 (ie about 3,000 naira). This is a clear confirmation of food poverty (UNICEF, 1996). The food poverty is not only among those who rely solely on buying. Because by this estimate, families who produce the food for subsistence also require harvests of about 15 full bags (of 100kg) of grains for the year. But only a small fraction can ever attain it due to either poor land holdings, lack of farm inputs, etc. Because of these problems, each year, just before the next harvest, the food stores become exhausted and prices escalate. This precipitates a period of seasonal hunger from about early April to the end of August (Prentice and Cole, 1994; Hudsen 1995).

The consumption pattern of various types of foods (number of days consumed per week) among the families are very similar in the urban and rural sectors. The values are, however, rather misleading because although an item may be a daily feature of the diet, it might be used in very insignificant quantities. As a matter of fact, apart from the cereals and the tubers, all the other items shown in Table 36 are either by far small fractions of a major dish or simply used as thickeners or to enhance flavor. Below are figures for some weighed amounts of such items

used by a typical family of 12 per meal.

Table 40: *Estimated intake of some food items per*

Food items	Av. Amount	Wt/person
Vegetable (fresh)	700g	63
(dried)	20g	2
Meat	230g	21
Dried fish	45g	4
Nono (water diluted)	660ml	60

Source: Almustafa, 1994.

From the figures above, it can be seen that dried vegetables (Baobab leaves and Okra) are used merely as soup thickeners, whereas dried fish and nono are, as in this case, often used as flavoring agents for soups and nono for fura. Confirming the point, the correlation analysis (Appendix 7) revealed a lack of any positive association between fish and milk and children's weights despite their well known nutritional qualities. With meat however, the amount consumed per individual/meal (Table 40) is about 5 times that of fish and from the correlation analysis it is the food which is the most positively correlated to weight (Appendix 7). This finding is because meat is the most corrective food item for diets low in protein and energy such as the types consumed in Kebbi (Torres *et al*, 1994).

In Kebbi State, the consumption of vegetables are seasonal. The high rate of consumption found by the study

was only so because the study was during the raining season when vegetables were available at cheap prices and also at no cost in the wild. Unfortunately bad cooking practices such as extensive cutting and overcooking of vegetables reduce their contributions to nutrient intake (Almustafa and Oderinde, 1995). Various fruits are also consumed during their respective seasons but they are only regularly consumed by the rich families. Groundnut oil was the most popular oil used in cooking but palm oil was also patronized. Both oils were used sparingly due to economic constraints.

5.3.5. The Composition of the Common Meals Eaten by Kebbians and the Subjects Nutritional Status.

The diets of the subjects can be categorised into two groups; namely the porridges (liquid based) and the solid meals (the Tuwos and rice and beans). The nutrient cotent of the porridges is generally very low. The protein and energy content averages are 1.85g and 50.2Kcal/100g edible portions respectively. This implies that children who weigh 10-20kg have to consume over a kilogram of porridge to meet their daily requirement of protein. But since the net protein utilization value of cereal proteins is less than 70 (based on which these recommendations are made) much more has to be consumed.

The major problem, however, is the energy requirements

of these children, which stands at 1360-1830 Kcal/day (Bender, 1993). To meet this, the chilren have to consume between 3.0-5.0kg of porridge daily; a task that is hardly possible to accomplish with the childrens limited stomach capacities. If the energy needs are not met, it means the little protein injested cannot be utlized for growth. Rather, they are diverted to supplement energy and a state of protein-energy malnutrition is gradually established. The rural subjects who rely more on the porridges therefore have higher rates of PEM. The solid meals are much better than the porridges and the quantities to be consumed to meet the daily requirements of both protein and energy are within the limits of what children can consume per day. In respect of rice and beans the amount is about 1.8kg for five year olds. Generally, three 'solid meals' and three drinkings of the porridges a day will meet all the protein, iron and zinc needs but still not meet that of energy.

The analysis of the dietary intake data showed that the urban subjects have a modal frequency of solid meals cosumption of 2, while the rural have a modal frequency of 1. The rest of the nutrient intake is accounted for by porriges and snacks where available. The average amount of food given at a meal was about 400 and 300g for the solid meals and porridges respectively.

The rural sector dwellers however have very irregular meal patterns. Generally there is no specially cooked lunch

or breakfast and therefore the children and the family at large survive through the day on vegetable snacks or left overs and repeated drinks of diluted porridge (Farau-farau). In contrast, in the urban sector there is often a cooked lunch and snacks are occassionally provided. These differences in dietary habits clearly show the superiority of the urban dietary patterns over that of the rural one and hence the differences in the growth of the subjects from the two sectors.

The role of protein and energy-rich snacks in solving the observed nutrient shortages cannot be overenphasized. Some of the locally available ones are fried bean cakes (Kosai), roasted groundnuts, groundnut cake, and tigernut cakes (Dakuwa). Even better still, where available, bush meat, poultry products, milk from goats, camels, sheep etc could be provided for the children as suuplements. These snacks are very light but very nourishing and would make much difference in the children's nutrition.

5.3.6. Urban/Rural Differences and Nutritional Status.

The two sectors have always been recognized as being characteristically different in many of their aspects and particularly so in their socio-economic status (Toriola, 1990). In Table 37, a statistical comparison between various parameters that have serious consequences on

nutritional status was made. The urban sector was significantly ($P<0.05$) better in most of the parameters that had positive correlations with the children's body weight (income, literacy, freedom from infections, meat, pulses, tubers, and oils consumption). It is, therefore, expected that the urban subjects' nutritional status would follow the same trend (urban subjects being better nourished than the rural subjects) and it did. This fact is vividly illustrated by the anthropometric results in Tables 11-24. The Nigeria Demographic and Health Survey of 1990 has shown that in Nigeria, wasting, stunting and underweight are all higher in rural areas compared to the urban.

Since the family compositions are similar in the two sectors, then the higher consumption of animal products, pulses, tubers and oils, means the urban families consume more protein and energy and hence their children grow better.

CAPTER SIX

6.0. CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary of findings.

The results of the study have revealed the major patterns regarding the demographic and socio-economic characteristics of the urban and rural sectors of Kebbi state highlighting significant differences between them. The study's findings have shown that demographic and socio-economic factors together with dietary habits of the two sectors strongly influenced the nutritional status of the subjects in the two sectors.

The findings of the study have confirmed that, like in other places, the socio-economic status of urban dwellers in Kebbi state is better than that of the rural dwellers. The level of literacy among mothers in Kebbi state is also significantly ($P<0.05$) better among the urban compared to the rural. These factors have made the urban families, which were about the same in size as the rural families, able to establish better food habits and hence acquired better nutritional status as indicated by the different methods and standards used for assessment (Tables 11-27). The nutritional status of the urban sujects was significantly ($P<0.05$) better than that of tha rural in respect of PEM, anaemia, hypoalbuminaemia and hypoproteinaemia. The rate of malnutrition in the rural

sector is of particular concern with the prevalence of mild stunting, underweight and wasting at 17.3, 18.3, and 34.4% respectively and anaemia at 14.6%. Considering the findings of this study and the supporting information from UNICEF/NPC (1995), it is believed that the 54.0% prevalence of underweight among school children in Sokoto and Kebbi states (Almustafa, 1992) had its root from their pre-school years.

The study has also reached the conclusion that nutritional status is a function of multiple factors. It was found by the study that the number of dependants is the strogest negative correlate of body weight and the consumption of meat is the strongest positive correlate. This is because, while the former increases food poverty, the later is a sign of affluence and better feeding. That is to say, nutrient intake is the most decisive factor in determining the body weights.

The study has also highlighted the fact that the way and manner of using fish and fermented milk in the state are more like flavoring agents rather than major meal constituents and hence they are not comparable to meat (despite being animal products also) in their abilities to positively influence weight (Appendix 7). Generally, the quality of the major meal eaten by the subjects is poor. The diets are particulary low in enegy and zinc, and to a lesser extent protein and iron (Table 28). The proper

utilization of the protein and iron are however handicapped by the low energy and the presence of phytates respectively.

The frequency of illness and specifically that of malaria is much higher in the rural sector compared to the urban and are causes for conern as they clearly militated against the development of the children studied as shown by their negative correlations with weight(Appendix 8). It is a pitty to obseve that a vicious cycle of poverty and illiteracy; poor food habits and sanitation; and disease has become established in rural Kebbi.

6.2. Implications of the Findings.

The finding of the study that pre-school children in Kebbi state have mean heights that are not statistically significantly different from the NCHS standards, and body weights and arm-circumference measurements that maintained a consistent pattern in relation to the standards (about 10.0% deficit) suggests that it is unnecessary for Nigeria to produce fresh anthropometric standards. Instead the existing NCHS standards should be modified by scaling them down to 95.0% for weight and arm-circumference. The standards for height do not even require any such modifications at all.

Kebbi state has a very serious problem of malnutrition (PEM and anaemia) particularly among rural children. They

must therefore be urgently rescued by putting in place the relevant nutrition related activities that will alleviate their suffering and boost the quality of human resources in the state . The continued neglect of the problem is undoubtedly a source of all kinds of backwardness now and in the future.

6.3. Recommendations.

1. Adequate food production and measures to ensure the food produced is retained for local consumption should be addressed by the state government.

2. Home gardening should be encouraged through nutrition education in order to enhance vitamin and mineral intake through vegetable and fruit intake as well as possibly generate some income.

3. Public enlightment should be undertaken by both the state and local governments through health facilities, schools and the mass media to promote the production of protein and energy-rich foods and their inclusion in children's diets. Target foods should include beans, groundnuts, cashew nuts, and animal products where possible. They may be part of regular meals or snacks to be specially provided.

4. Nutrition education regarding infant feeding and general child care should be organized for expectant mothers by local government health departments at strategic places such as maternity clinics to prepare them for successful child management.

5. The use of animal products (rich in protein, energy, iron and zinc) in children's diets is highly recommended and therefore, whenever available children should be given a special consideration while sharing.

6. Milk from cows, sheep and goats are all relatively cheap and available, so they should be used to supplement weaning diets rather than rely on the usual starchy and watery family meals only.

7. Small scale poultry or free rearing of bird species should be encouraged by agricultural extension schemes and supported by government as this will provide some eggs and meat as well extra income to occasionally buy some other foods.

8. The ministry of health should establish child-care centers where educated mothers and health workers interact with other mothers to exclusively learn more about child

caring and regular weighing of their children as part of a regular health monitoring effort for infants and pre-school children.

9. All the local government areas in the state should establish partnership with organizations like UNICEF to obtain expert advice and assistance in areas such as complementary food production, breast-feeding training and nutrition education generally.

6.4. Suggestion for Further Study.

The very high prevalence of stunting, wasting underweight, hypoalbunaemia, hypoproteinaemia and particularly anaemia among the children indicates that there may be micronutrient deficiencies among them. It is therefore suggested the a study focussed on the micronutrient status of the children and their mothers should be carried out. Nutrients to be looked at should include vitamin A, iron, zinc and iodine. The levels of phytates in the diets should also be studied in order to get an insight about the mineral bioavailability.

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Appendix 1.

HOUSEHOLD QUESTIONNAIRE** (HHQ. ID.....)

QUESTIONNAIRE IDENTIFICATION.
NAME:_____ AGE_____(YEARS) SEX: M() F()

ETHNIC GROUP _____ TOWN/VIL._____ SECTOR: UR() RU()

LOCAL GOVERNMENT AREA _____

B. FAMILY SIZE (Numbers).

Adult men	-------
Adult women	-------
Children five to eighteen years	-------
Children of five years and less	-------
Total number of people	_____

C. OCCUPATION.
Put a tick against the major occupations of the members of the household and **underline** the most important one.
1) Farming () (2) Fishing () (3) Rearing ()

4) Trading () (5) Food selling () (6) Wage/Salary ()
7) Artisans () (8) Others
(Others; specify).....

D. MONTHLY INCOME RANGE (NAIRA).
Tick the appropriate income range for the household.

1) Below 500,00 () (6) Up to 5,000.00 ()
2) Up to 1,000,00 () (7) " " 6,000.00 ()
3) Up to 2,000.00 () (8) Up to 7,000.00 ()
4) " " 3,000.00 () (9) Above 7,000.00 ()
5) " " 4,000.00 ()

E. LEVEL OFLITERACY.
What is the highest educational qualification or quivalent of:

1) The head of thehousehold_____
2) The mother of the child_____

F. WEANING PRACTICES AND CHILD CARE.
1. How was the child fed before weaning?
Breastfed only () Formular feeding ()
Breast feeding with supplimentation ()
2. If the child was breastfed with supplimentation, at what age was the supplement introduced?
Time _____ (Month).

**Modified from UNICEF/HFSN/
92/WH/20000 & ID40000.

3. Place a tick against the type of supplement used.
   Kamu () Formular () Soya milk ()
   others (Specify).....

4. Which of the following did you use to enrich the supplementary food given to your child? Tick as appropriate.
   Groundnut flour () Palm oil () Fish () Sugar ()
   Beans () Meat () Eggs () Others (specify).....

5. When was the child introduced to the family meals?
   Before three month after birth ()
   3 - 6 month after birth ()
   6 - 12 month after birth ()
   12 - 18 month after birth ()
   After 18 month of birth ()

6. At what age was breast feeding totally stopped?
   _____ (Age in month).

7. Was a health card maintained in respect of the child during any period after birth to date?
   a. Yes () No ()
   b. If yes, examine the card and comment on growth and health generally _____

8. Place a tick against the immunisations the child has had.
   BCG/Oral polio () DPT/Oral Polio () Measels ()
   If none please state 'NONE' _____

9. How do you handle diarrhoea cases?
   Stop feeding () Give ORT () Pray ()
   Hospital/Clinic() Herbalist ()
   self medication with -Herbs() Drugs() Herbs and drugs()

10. How was the child cared for during outings?
    Taken along () Cared for back at home ()
    If cared for at home, please provide the following information about the care-giver.
    Age ____ (Yrs) Relationship to the child _____
    Sex: M() F().

11. When the child is sick or not growing well, how do you know?.....

12. Has the child been sick in the last one month?
Yes () No()
If yes what was the sickness ?
Malaria () Diarrhoea () Measles ()
Cough () Common cold ()
Resp. infection () Urinary tract infection()

13. Where did the child receive treatment? _____

14. How often did the child suffer from this sickness?
Weekly () Monthly () 4 Times a year ()

3 Times a year () 2 times a year () once a year ()

C. THE FAMILY DIET.

1. How is the food eaten in the family obtained?
Produced by the family () Bought from the market ()
charity () Combinations (specify)----------
2. Are there any foods considered bad for any member of the family under any specific conditions or generally? Yes () No ().
If yes please provide the relevant details below
.....

FOOD FREQUENCY.

Tick the average number of days/week that your family consumes each of the following food items.

Food item	AVERAGE WEEKLY CONSUMPTION							
CEREALS	**0**	1	2	3	4	5	6	7
Maize								
Sorghum (Dawa)								
Millet								
Rice								
ROOTS AND TUBERS/DERIVATIVES								
Cassava								
Garri								
Yam								
Yam flour								
Cocoa yam								
Sweet potatoes								
Irish potatoes								

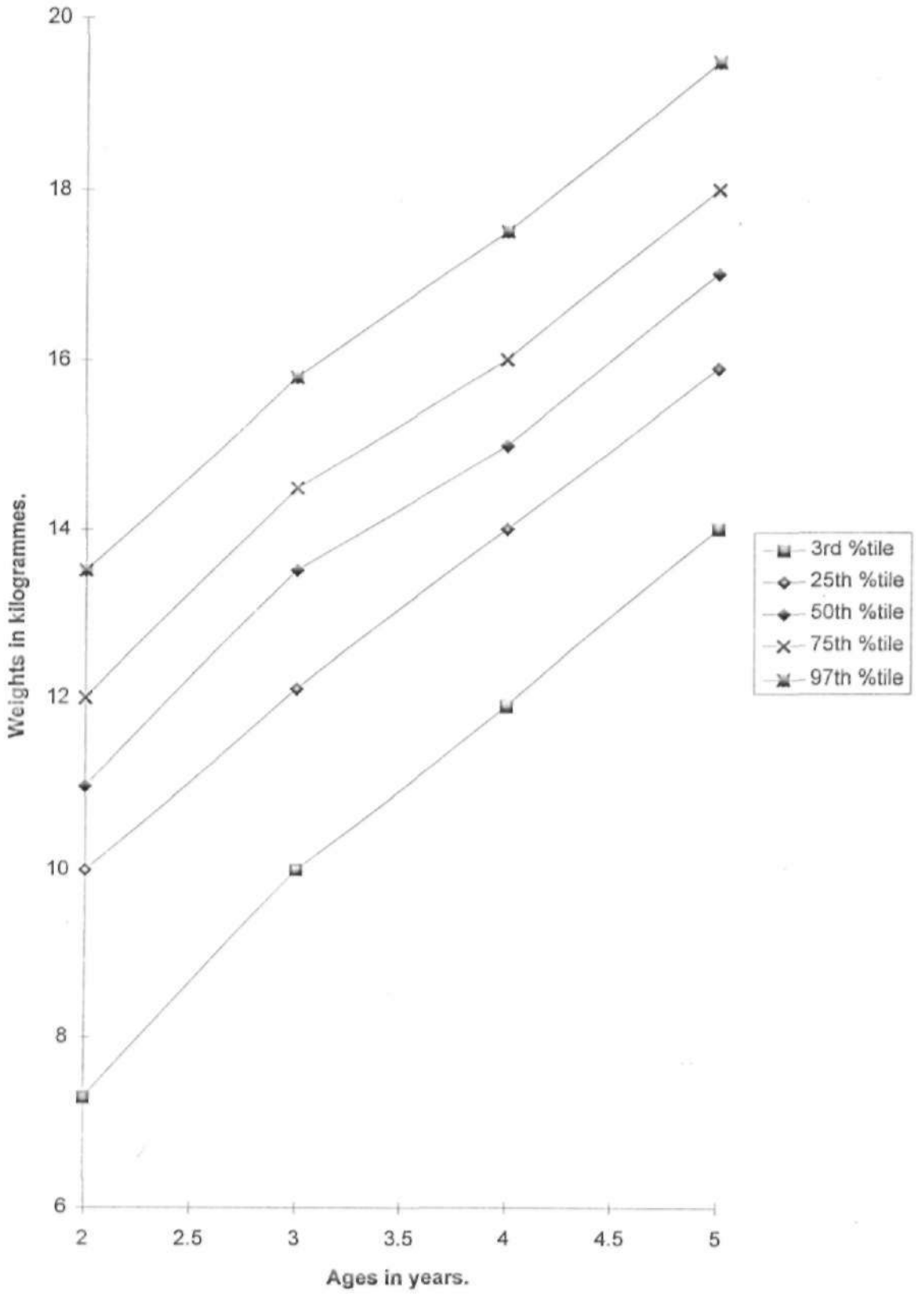
LEGUMES, NUTS, SEEDS AND OILS.
Beans
Soya beans
Groundnut
Palm oil
Groundnut oil

VEGETABLES
Leaf vegetables
Okro
Tomatoes
Pepper
Onion

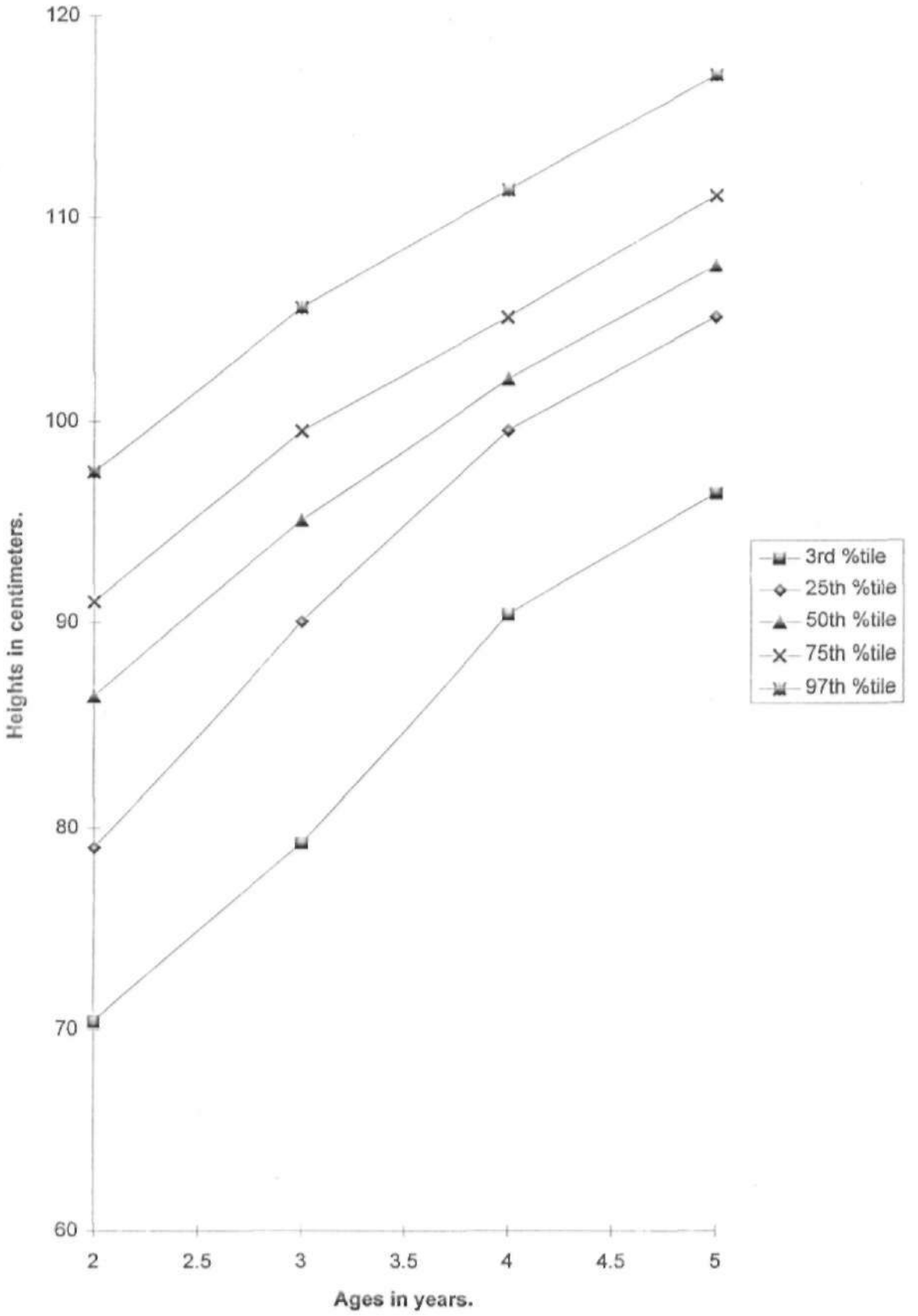
FRUITS
Banana/Plantain
Pawpaw
Oranges
Guava
Cashew

ANIMAL PRODUCTS
Meat (all types)
Dried fish
Fresh fish
Eggs
Milk/Yoghurt

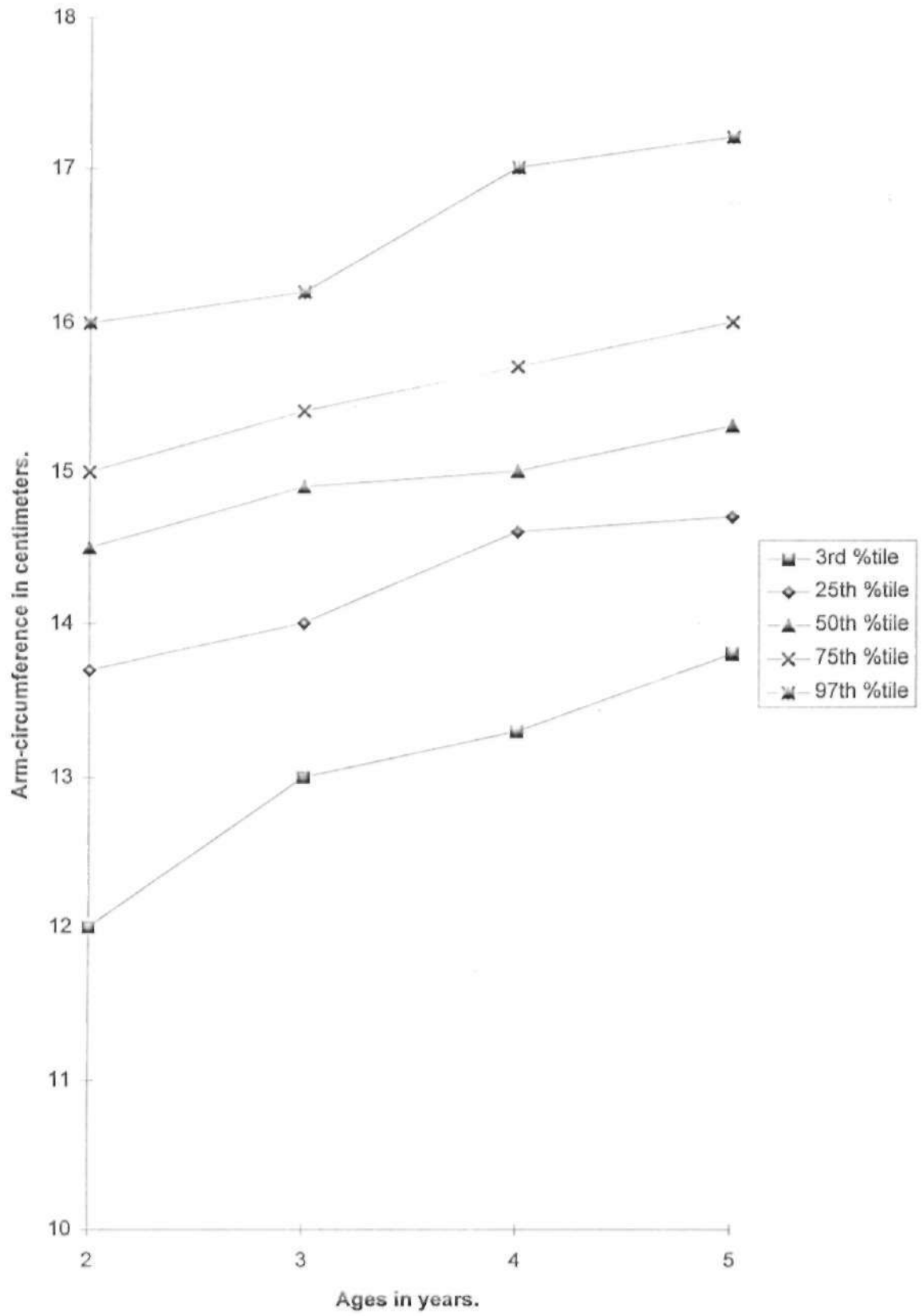
THANK YOU!



Appendix 2. Weight percentiles of urban pre-school children of Kebbi State.



Appendix 3. Height percentiles of urban pre-school children in Kebbi state



Appendix 4. Arm-circumference percentiles of urban pre-school children in Kebbi State.

Appendix 5: *Correlation analysis: Demographic and socio-economic factors vs subject's weight.*

OVERALL DERMINANT	COMPONENT PARAMETERS	r value
THE FAMILY		
	1. Number of adult men	+ 0.02
	2. Number of adult women	+ 0.17
	3. Number of children 5-18yrs.	+ 0.39
	4. Number of children <5	- 0.14
	5. Overall family size	- 0.17
OCCUPATION		
	1. Farming	- 0.50
	3. Fishermen	- 0.06
	4. Trader	- 0.02
	5. Civil servant	+ 0.04
INCOME LEVEL		
	1. <3,000 naira	- 0.01
	2. >6,000 naira	+ 0.20
LITERACY		
	1. Fathers Literacy	- 0.06
	2. Mothers Literacy	+ 0.38

Appendix 6. *The correlations between infant feeding and weaning practices and subjects's weight*

OVERALL DETERMINANT	COMPONENT PARAMETERS	r value
INFANT FEEDING.		
	1. Breastfeeding alone	+0.28
	2. Formular feeding	+0.22
	3. Breast-feeding with supplementation	-0.27
TYPES OF SUPPLIMENTATION		
	1. Pap and Sugar	-0.38
	2. Formula	-0.15
	3. Animal Products	+0.17
AGE OF INTRODUCTION		
TO FAMILY DIET (month)		
1.	< 12	-0.41
2.	12-18	+0.14
3.	>18	+0.54

Appendix 7: *The correlations of animal food and fruits' consumption with weight.*

Food item	**r value**
Milk (nono)	0.00
Meat	+0.53
Fish	-0.24
Fruits	+0.19

Appendix 8. *The correlations between health and child care with subject's weight.*

Parameter	**r value**
Health Care	
Frequency of Illness	-0.19
Malaria fever	-0.19
Diarrhoea	-0.08
Child Care	
Taken along on outings	-0.08
Left behind during outings	+0.08

Appendix 9: *Percentage of variation in weight accounted for by some parameters (R^2 values).*

SET NO	PARAMETERS	Number of variables	% Accounted.
1	Illness	3	08.0
2	Income	3	12.0
3	Literacy	2	30.0
4	Family size & number of dependants	3	25.0
5	Illitracy.,<12mo,>3000 Family size,Illness, Pap,<5, Malaria.	8	70.4
6	Fruit,B/feeding,>18mo, Family size,>6000, Literacy,Fish,& Meat.	8	84.9
7	Pap, Meat, Malaria, <3000,B/feeding,Animal products,>5,Literacy.	8	94.2
8	Meat & Fruit.	2	56.0
9	Fruit,Illness,<5,Fish, Illitracy,Family size.	6	37.5

Legend.
<12mo = Age (month) when first introduced to family meals.
<5 = Children <5 years.
B/Feeding = Breastfeeding
<18mo = Age (month) when first introduced to family meals.
<3000 = Monthly income in naira.
>6000 = Monthly income in naira.

Note: The various percentages accounted for in each case was extracted from separate analysis (similar to the one shown for set No. 7 shown in appendix 8) on the respective sets of variables.

Appendix 10. *Regression analysis showing the most powerful variables that influence nutritional status.*

Variables---- Pap, meat, malaria, income, B/fed, <5, and literacy.

Multiple Regression	0.97079
R^2 Value (R^2)	0.94244
Adjusted R^2	0.71218
Standard erro(SE)	0.35269

Variable	B	SEB	BETA	T	Sig T
Pap	0.074415	.033904	1.595420	2.195	.1594
Meat	0.723507	.151979	1.048807	4.761	.0414
Malaria	0.047625	.026644	1.651498	1.787	.2150
Income	0.045894	.041792	1.195793	1.098	.3867
B/Fed	0.014988	.022368	0.4236232	0.670	.5718
A/Prod.	0.063381	.043983	0.554298	1.441	.2863
>5	0.719518	.271143	0.978934	2.654	.1175
Litracy	0.071486	.083700	1.479028	0.854	.4830

Legend.
A/Prod. =Animal products.
B/Fed =Breastfeeding.
<5 =Children <5 years old.

Appendix 11: *Predicted changes in body weight for a 1% difference in selected parameters in Kebbi state.*

1 % change in a parameter in a given location	**Predicted change in** weight (g)
Family size	287*
Number of children >5 years	719*
Number of children 5-18 years	504
Monthly Income <3000 Naira	46*
Monthly Income >6000 Naira	07
Mothers literacy rate	71
Mothers illiteracy rate	19*
Weekly consumption of fruits	96
" " fish	495*
" " meat	723
Breastfeeding	15
Supplementing breast feeding -with animal products	63
- " pap and sugar	74*
Introducing family meals in >12 mo.	86*
Introducing family meals in <12 mo.	20*
Frequency of illness	29*
Frequency of malaria	47*

Legend.
mo = month.
* = Negative correlates of weight.

Appendix 12. *Mean weights and heights: Nigerian mean and Ibadan elite.*

Age Yrs	NIGERIAN (mean)+ Wt.(kg)	Ht.(cm)	IBADAN(elite)++ Wt.(kg)	Ht.(cm)
2	11.9	85.1	13.1	89.0
3	13.9	94.2	15.3	97.8
4	14.8	100.0	17.2	105.5
5	17.2	106.7	18.8	111.3

Legend.
+ = Derived from Addo, 1984
++ = Source Addo, 1984

Appendix 13: *Correlations between different indices of assessing nutritional status.*

Indices of assessment	**r values**
Weight/height	+ 0.74
Albumin/haemoglobin	+ 0.40
Weight/albumin	+ 0.30
Height/albumin	+ 0.30
Stunting/Underweight	+ 0.38
Stunting/washing	+ 0.85
Stunting/arm-circumference	+ 0.71
Underweight/arm-circumference	+ 0.76
Washing/arm-circumference	+ 0.74
Wasting/Albumin	+ 0.81
Underweight/Albumin	+ 0.64
Stunting/Albumin	+ 0.77