FOOD SECURITY AND NUTRITIONAL STATUS OF CHILDREN IN A FISHING COMMUNITY

BY

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A Thesis submitted to the Department of Nutrition and Food Science, University of Ghana
in partial fulfilment of the requirement for the award of a Master of Philosophy degree in Nutrition (NUTR: 600)

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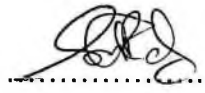
June 1999

CERTIFICATION

I certify that this research was conducted by me as presented under supervision in the Department of Nutrition and Food Science, University of Ghana, Legon and the Institute of Nutrition, University of Bergen, Norway.



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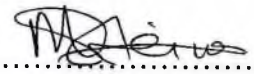

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Principal Supervisor

ACKNOWLEDGEMENT

In the execution of this work various people have contributed in diverse ways and I plead for pardon from all whose names I may not remember.

I would first of all express my sincere gratitude to my supervisor Dr. (Mrs) Matilda Steiner-Asiedu for her patience, encouragement and guidance in the execution of this work.

For Professor G. S. Ayernor (whom I had never met), I would not have gained admission to the university for the Master of Philosophy (M Phil.) programme in Nutrition due to late submission of admission forms and I think it is right to express sincere gratitude for his effort as well as his invaluable contribution to this work. Dr. W. B. Owusu, Dr. E. Asibey-Berko, and Mr. Francis Tayie of the Department of Nutrition and Food Science also deserve mention for their various contributions.

To the Norwegian Team led by Professor Einar Leid and all the others: Prof. Leif Njaa, Marian Stave, Anita Birkenes, Marainne Skov, Harald, Gerd, Livar, Bjorn, Hanne, Torril, Edel, and George Tuwor at the Institute of Nutrition, Directorate of Fisheries/ University of Bergen, Tureed Tinning of the Center for International Health, I say "Tusen Takk" for your immense support during my visit to Norway.

I extend heartfelt thanks to my mentors Mrs Nabilla Williams, Professor E. Laing, Dr. Elom Dovlo and Professor Fianu, for emotional support. There were also some friends who offered technical support and I appreciate their contributions. Mr. Eddie Quansah, Mr Kumah, Fred Vuvor and Frank Otchere, I thank you all for that special role. Ms Abena Asamoah-Ani and Dr. N.N.N.N. Nuamah also deserve sincere thanks for statistical support.

Sincere thanks also go to the location crew who gave me access to the Kpone community and for their constant support. Here, I would like to mention Auntie Christy of the Tema Municipal Assembly, Mr. Nartey, Mr. Nortey, Ms Elizabeth Sarpong of the Kpone Traditional Council, the Assemblymen of Kpone: Mr. Joseph Tetteh, Mr. Samuel Antie and Mr. Atiapa, parents and their children who participated in this study and all friends of Kpone.

I am also indebted to Mrs Salomey Ansong of the Fishery Resource Centre of the Food Research Institute for introducing me to the Fishmongers Association of Gbegbeise who permitted me to pre-test my questionnaire in their community.

To my wealth of friends in the Ministry of Food and Agriculture, I would want to express sincere appreciation for the warmth I received. To this end I would like to mention Mr. Osei Frimpong, Nii Quaye-Kumah, Charles Etse, Emmanuel Dormon, Kweku and all my good friends in the Ministry especially the Department of Agricultural Extension Services.

Sincere thanks also go to Becky, Anita and Sammy for good friendship and also to all my colleagues and pals of the University of Ghana.

I am indeed grateful to all whose contributions both great and small have made this work a success not forgetting my parents, siblings and niece for their ineffable love.

Last but not the least, I would extend utmost thanks to my sponsors the Ministry of Food and Agriculture (MOFA) for granting me study leave, the National Agricultural Research Project (NARP) for financial support and the Norwegian University Food and Nutrition Project (NUFU) who made it possible for the biochemical assessment to be done.

TABLE OF CONTENTS

Content	Page
Certification	i
Dedication	ii
Acknowledgement	iii
Table of contents	vi
Listof Tables	x
List of Figures	xii
List of appendices	xiii
Abstract	xiv
Chapter 1	1
1.0 Introduction	1
1.1 Background to the Study	1
1.2 Rationale	3
1.3 Main aim	4
1.4 Specific objectives	5
1.5 Research questions	5
1.6 Significance of the study	6
Chapter 2	7
2.0 Literature review	7
2.1.0 The concept and framework of food security	7
2.1.1 Food insecurity	9
2.1.2 Characteristics of the food insecure	10
2.1.3 Prevalence of food insecurity	11
2.1.4 Location of the food insecure	11

Content **Page**

2.1.5 Monitoring access and sustainability of access to food.....12
2.1.5.1 Measuring food insecurity.....13
2.1.5.2 Dietary related indicators of food insecurity.....14
2.1.5.3 Coping strategy related index.....15
2.1.5.4 Economic indicators.....15
2.1.5.5 Other indicators of food security.....18
2.2.0 Nutritional Status.....19
2.2.1.0 Basic indicators of undernutrition.....19
2.2.1.1 Anthropometry.....20
a Underweight.....21
B Stunting.....21
C Wasting.....22
2.2.1.2 Anthropometric trends.....23
2.3.0 Sanitation and infection.....24
2.3.1 Sanitation.....24
2.3.2. Diarrhoea.....25
2.3.3 Respiratory infection.....26
2.3.4 Malaria.....27
2.3.5 Measles.....27
2.4.0 Micronutrient malnutrition.....29
2.4.1.0 Iron.....29
2.4.1.1 Impairment of iron status.....30
2.4.1.2 Causes of iron deficiency.....30
2.4.1.3 Effects of iron deficiency.....31
2.4.2.0 Serum ferritin.....32
2.4.2.1 Some attributes of serum ferritin determination.....33

Content **Page**

2.4.2.2 Determining serum ferritin.....35
2.4.2.3 Cut off levels for serum ferritin.....35
2.4.2.4 Serum ferritin and infection.....36
2.5.0 Vitamin A.....38
2.5.1 Prevalence of vitamin A deficiency.....39
2.5.2 Causes of vitamin A deficiency.....39
2.5.3 Evaluation of vitamin A status.....40
2.5.4 Serum Retinol Binding Proteins.....42
2.5.5 Cut off levels for serum retinol binding protein 43
2.5.6 Methods for retinol binding protein determination.....44
Chapter 3.....45
3.0 Methodology.....45
3.1 Study design.....45
3.2 Study locale.....45
3.3 Sample population.....45
3.4 Estimating sample size.....46
3.5 Sampling protocol.....47
3.6.0 Tools and techniques.....47
3.6.1 Obtaining community and household information.....47
3.6.2 Dietary assessment.....48
3.6.3 Anthropometry.....48
3.6.4.0 Biochemical assessment.....49
3.6.4.1 Blood collection and storage.....49
3.6.4.2 Serum ferritin assay.....49
3.6.4.3 Serum retinol binding protein assay.....52
3.7 Statistical analysis.....53
3.8 Limitations of study.....54

Content **Page**

Chapter 4.....55
4.0 Results and Discussions.....55
4.1.1 Community characteristics.....55
4.1.2 Household sanitation health and situation.....57
4.2.0 Dietary assessment 60
4.2.1 Energy.....60
4.2.2 Protein intake.....63
4.2.3 Iron intake.....65
4.2.4 Vitamin A intake.....67
4.2.5 Food security status.....69
4.3.0 Anthropometry.....71
4.3.1 Stunting.....71
4.3.2 Underweight.....76
4.3.3 Wasting.....76
4.4.0 Biochemical assessment.....79
4.4.1 Serum ferritin.....79
4.4.2 Serum retinol binding protein.....80
Chapter 5.....82
5.0 Conclusions and recommendations.....82
5.1 Conclusions.....82
5.2 Recommendations.....83
References.....84

LIST OF TABLES

Content **Page**

1. Serum ferritin concentration in common acute Infections in children..... 37
2. Serum ferritin concentration in iron deficiency and overload in children.....37
3. Retinol binding protein levels in healthy Australian children.....43
4. Age and sex distribution of study subjects..... 45
5. Table of calculated sample sizes.....46
6. Ferritin standards preparation.....50
7. Preparation of rbp standards 52
8. Occupational profile of parents of children studied.....56
9. Sanitation index of households.....57
10. Frequency of loose stools per day.....58
11. Percentage of children meeting various levels of RDA for energy (lean fish season).....62
12. Percentage of children meeting various levels of RDA for energy (major fish season).....62
13. Percentage of children meeting various levels of RDA for protein (lean fish season).....64
14. Percentage of children meeting various levels of RDA for protein (major fish season).....64
15. Percentage of children meeting various levels of RDA for iron (lean fish season).....66
16. Percentage of children meeting various levels of RDA for iron (major fish season).....66

Content **Page**

17. Percentage of children meeting various levels of RDA for Vitamin A (lean fish season).....68
18. Percentage of children meeting various levels of RDA for Vitamin A (major fish season).....68
19. Percentage of children meeting more than 80% RDA for energy (both seasons).....70
20. Lean fish season anthropometric data.....73
21. Major fish season anthropometric data.....74
22. Mean and range values of ferritin.....80
23. Mean and range values of retinol binding protein.....81

LIST OF FIGURES

Content **Page**

1.Stunting at baseline.....75

2. Wasting in children (lean and major fish seasons).....78

LIST OF APPENDICES

Content **Page**

i. The enzyme linked immunosorbent assay.....100
ii. Checklist.....101
iii. Household composition questionnaire..... 102
iv. Household characteristics questionnaire.....103
v. Health and sanitation.....104
vi. Twenty four hour recall questionnaire.....105
vii. Anthropometric questionnaire.....106
viii. Statistical applications.....107

ABSTRACT

This study was done to ascertain the food security and nutritional status of children aged between two and five years in Kpone, a fishing community in the Greater Accra region of Ghana. The objectives were to assess (i) some household and child health characteristics, (ii) dietary adequacy for energy, protein, iron and vitamin A, (iii) the food security status of the children, (iv) growth by anthropometry and (v) serum iron and vitamin A status of the children. In the major fish season, 336 children were involved in the study while the number reduced to 274 due to attrition in the lean fish season.

Results of the study showed that, 12% of the children had malaria, 6% coughs and 5% measles. The immunization status was encouraging as 73% had completed all vaccinations against the childhood killer diseases. Sanitation was rather poor with 74% of the households found to be in poor living conditions. Diarrhoea prevalence was very high with as many as 70% of the children having very severe diarrhoea.

For energy intake, as many as 60% could not meet their recommended dietary allowance (RDA) in the lean fish season but there was an improvement in the major season as this level reduced to 51%. Protein requirements were met by 87% of the children in both seasons while iron needs were satisfied by 40% and 57% of the children in the lean and major fish seasons respectively. Vitamin A needs, were met by 58% of the children in both lean and major fish seasons. There were no significant differnces in the mean intakes for energy, protein and vitamin A for the two seasons but there was a significant difference in the mean intake for iron ($p < 0.001$).

Using the Dietary Energy Adequacy Ratio (DEAR) of 0.8 for food security status, 68% of the children could be classified as food insecure in the lean fish season while in the major fish season, the level reduced to 59%.

With growth determination using anthropometry, prevalence of stunting (both moderate and severe) was 49% at baseline. Prevalence of underweight was 46% in the lean season, dropping to 29% in the major fish season. Wasting prevalence increased from 5% to 8%. The results show that about a third of the children are not getting enough to eat and and this has translated into poor growth, hence the rather high prevalence of undernutrition shown by anthropometry.

The prevalence of iron deficiency in the form of prelatent iron status showed that as 75% of the children had serum ferritin levels below 50 µg/l, representing a vulnerable state. In the case of vitamin A status using retionol binding protein, 12% of the children had serum retinol binding protein levels below the lower cut off point of 18µg/l.

Children in this community are at risk of poor nutrition and the community at large can be mapped as one vulnerable to food insecurity.

FOOD SECURITY AND NUTRITIONAL STATUS OF CHILDREN IN A FISHING COMMUNITY

Is the goal of childhood nutrition to produce musclemen, giants, dwarfs, geniuses, or Methuselahs? (Bauies. and Gyorgy, 1962).

CHAPTER 1

1: 0 INTRODUCTION

1: 1 Background to the study

Food and nutrition security is of supreme importance in improving the nutritional status of many millions of people who suffer from persistent hunger and undernutrition in many parts of the world, and still others who are at risk of facing the same situation. Food availability, both physical and economic access to food and the sustainability of such access is the epitome of food security. This has various dimensions including global, national, household and individual food security (Sharma, 1992).

Food insecurity is the prime cause of undernutrition all over the world. It is estimated that in about 20 - 30% of the population in countries where the per capita supply of food is at or more than 100% of nutrient needs many persistently subsist on inadequate diets (Timmer *et al.*, 1983; FAO, 1992). Consequently, they are unable to meet their nutritional requirements for normal physiological functioning and this has adverse implications particularly for childhood nutrition (FAO, 1992). On the global scene, food production has increased and the rates of undernutrition fallen, culminating in a decrease in infant and childhood mortality. However, in most parts of

Africa, hunger, poverty and undernutrition are problems in staggering proportions (ACC/SCN, 1997).

Children, especially the under-fives, are most vulnerable to undernutrition in developing countries, and in Africa, one out of every three children is underweight (FAO, 1992). In Ghana, the picture is not different with 28% of children (under five) being underweight. The Greater Accra region of Ghana has a profile of 17% underweight, 16% stunted and 8% wasted, (GDHS, 1993). The sequel of childhood undernutrition, which may not be reversible depending on the age of the child include retarded physical growth, reduced immunity, lowered cognitive capabilities, neurological dysfunction, and delayed motor development, to mention a few. These threaten child survival and invariably national development.

Closely associated with the problem of macronutrient deficiency (i.e. protein and energy deficiency) which is believed to be the main cause of undernutrition is micronutrient (vitamin and trace element) deficiency. This is referred to as hidden hunger because there is no craving or incipient hunger for micronutrients and inadequate intake is subtle. Iron, iodine, zinc

and vitamin A deficiencies are the main micronutrient deficiencies of public health significance, among others.

Major strategies to address these problems have featured at various national and international fora some of which are the World Food Conference held in 1974, the World Summit for Children (UNICEF, 1991), the International Conference on Nutrition (ICN, 1992) and at the World Food Summit in 1996. The 1998 edition of the State of the World's Children Report by UNICEF also focused on Nutrition. In Ghana, as a follow up to the ICN, the government has drawn up an action plan, the National Plan of Action on Nutrition (NPAN, 1995 - 2000). It has eleven objectives one of which is improving food security.

1: 2 Rationale

Around the African continent, millions of fishermen (artisanal) subsist on the fish they catch while many more make a living from trading in fish and its products. The proceeds from these activities have been the main determinant of economic access to food for these people and their families and more especially for those without any farmlands. The livelihood and nutritional sustainability this implies is however, at an ever-increasing risk.

This is due to the over-exploitation of the marine ecology: Large fishing-vessels, some of which use highly invasive methods compete with the smaller canoes, resulting in a general decline in capture fishery, a finite resource (De Vries, 1997). Thus, with dwindling catches, the fishing community faces a threat to food security and children living in such areas will be the most at risk. The situation is further aggravated by the rather poor sanitation conditions that prevail in most of these communities. Furthermore, most of the available information on food security has been agrarian-oriented with very scarce information about the fishery sector.

Boutrif (1997) has also suggested that governments periodically develop and update National Food Insecurity and Vulnerability Information Mapping Systems (FIVIMS), indicating areas of the population affected by or at risk of hunger and undernutrition. It is against this background that this study was undertaken.

1: 3 Main aim

The main aim of this study was to assess the prevalence of undernutrition and micronutrient status of preschool children living in a fishing community.

1: 4 Specific objectives

1. To collect background information on household and child health characteristics,
2. To assess dietary adequacy in these children,
3. Determine their food security status,
4. To assess the growth of children by anthropometry and
5. To determine iron and vitamin A status of the children (serum ferritin and retinol binding protein).

Research questions

- Is my assumption that children living in a fishing community will have access to adequate food because their parents have economic access to food right?
- Is the sanitation condition so poor negating the effect of good eating (ie. rsulting in a poor health outcome)?
- Are the children in the fishing community taking large amounts of fish for protein?

1: 5 Significance of the study

It is hoped that the results of this study will have implications for effective policies on nutrition intervention especially in the fishing community. This can be achieved by communicating the findings of the study to policy makers in the area of nutrition for the coordination of nutrition-related issues and in the enhancement of food security among others as documented in the National Plan of Action on Nutrition (NPAN, 1995-2000).

CHAPTER 2

2. 0 LITERATURE REVIEW

2.1.0 The concept and framework of food security

The concept of food security as an alternative to the one dimensional food production oriented approach was developed in the 1970s as a panacea to the food problems facing most developing countries (Schultes, 1994). It included the means of food production, credit, food storage, health and water facilities, intrahousehold food distribution, food processing and preservation among others as decisive factors in achieving food security (Schultes, 1994; Hussain and Herens, 1997).

Food security is broadly defined as "the intake of safe and nutritious food needed to maintain an active healthy life" (FAO, 1996). Food security has various dimensions, i.e. global, national, household and individual food security (Sharma, 1992). Globally, there is enough food to feed everyone but not everyone has access to adequate food at all times, the basic requirement for food security. National food security depends on a country's ability to import food commercially to balance domestic

production. National food security can be monitored by the total food supply relative to the total food requirement (Sharma, 1992).

Within a household, food security is determined by physical and economic access to food. The food in turn should be adequate in terms of quantity, of good quality, should be safe and culturally acceptable for a healthy life, irrespective of the age and sex and also the members should not be at an undue risk of losing such access. Increasing food production contributes to food security within communities and nations by increasing food availability and in some cases generating employment (income) but that alone does not guarantee food security. For instance, food may be available on the market but because of poverty, it may not be accessible (UNICEF, 1998). The ability to sustain one's access to food depends on a steady source of income, which hinges on a secured employment especially for those in the urban areas (Sharma, 1992). In the subsistence economy, access to land and proper storage of food could ensure a sustained access to food (Sharma, 1992).

The main objective of food security has been individual food security because of the close relationship between the individual and the

household. Household food security has extensively been focused on because it is a condition for individual food security (Sharma, 1992). While access to adequate food at the household level is needed to satisfy the nutrient needs for all members of the household, individual nutrition security also depends on non- food factors such as satisfactory health and hygienic conditions so that the individual can benefit nutritionally from the food consumed (FAO, 1996). Thus, household food security is one but not the only condition for achieving the overall nutritional well-being of an individual (FAO, 1996).

2.1.1 Food insecurity

The causes of food insecurity according to Gittinger et al. (1991) arise from variations in the amount of food provided by the work and wealth of the household. The level of food consumption can vary because of shocks in work: reduced activity due to illness of wage earner or loss of a job, output or production shock: when rains cease to fall after planting or in a no catch fishing expedition, food shocks: food may be available or only sporadically available on the market and prices may abruptly rise due to rapid inflation or devaluation, and also asset shock: sudden fall in quantity of assets e.g. death of livestock or sale of possessions in order to buy food

(Gittinger *et al.* 1991). The greatest impact on the household is felt when these shocks occur in different combinations simultaneously (Gittinger *et al.* 1991). Food insecurity may affect households constantly, transitorily, periodically or deteriorate into a food crisis (FAO, 1992).

2.1.2 Characteristics of the food insecure

Those who are food insecure are determined by factors such as agro-ecological characteristics, access to land, diversity of income sources, state of development of the economy, among others (FAO, 1992; ICN, 1992). Households with large numbers of dependants, female headed households particularly those without a steady source of income, households with less income diversification, those who spend a large part of their money on food, etc. are classified as food insecure (ICN, 1992). According to Guthrie (1983), the poor have been identified in many dietary surveys as a group of people with generally less adequate diets. This is attributed in part to their limited resources for all necessities of life including food and partly the fact that low income families have less education and less sound nutritional knowledge on which to base their food choices (Guthrie, 1983). Their problem is further compounded by the fact that in an era of rising food costs, the cost of less expensive food is rising faster than that of more

expensive food, usually the reserve of the affluent (Guthrie, 1983). Finally, households that are not connected to important growth centres have been found to be prone to food insecurity (ICN, 1992).

2.1.3 Prevalence of food insecurity

Due to definitional and measurement problems resulting in inadequate data, poor country coverage and data quality, among others, a precise figure of how many people are food insecure has not been documented. A recent World Bank study estimated about 340 million to 1 billion people in developing countries as not having enough to eat (Gittinger , 1991). During seasonal changes, these numbers increase above the average (Gittinger , 1991).

2.1.4 Location of the food insecure

A study by the International Food Policy Research Institute (IFPRI) has shown that those who are food insecure are distributed as follows: 38% in Sub Saharan Africa, 35% in Asia, 26% in South America and 23% in Central America. In Africa, the arid zone had the highest number as compared to the wet areas (Gittinger , 1991). A nutritional survey on fishing communities in several countries have revealed that people in a

fishing community may also be counted among the most ill-nourished of the rural poor with their situation in tandem with the fortunes of small scale fisheries (Winarno, 1994).

At the Intenational Food Policy Research Institute (IFPRI), a set of relatively simple indicators in the locating the food and nutrition insecure were identified. These indicators included household size, location, dependency ratio, number of people in a room, incidence of illness, vaccination status, unique foods consumed, drinking water and health facilities, among others (FAO, 1996). These indicators were used either singly or combined with the ideal combination depending on local characteristics (FAO, 1996).

2.1.5.0 Monitoring access to food and sustainability of access

There are two main ways by which access to food can be monitored.These are physical and economic. Physical access is ensuring adequate amounts of food are within the reach of vulnerable households (i.e. whether through their own production or through the market) (Sharma, 1992). Economic access depends on production, income (wage, employment or trade), ownership of assets and transfers such as gifts, etc (Sharma, 1992).

These sources vary relatively and a household's command over the total resources is what enables it to acquire food on a continuous basis and this is referred to as a household's entitlement to food (Sharma, 1992). A food secure household may therefore lose access when one of the components breaks down (Sharma, 1992). Furthermore, he perceived the monitoring of sustainability of access to food as an issue often neglected and which seeks to find out whether there is overexploitation of assets or the sale of assets for short-term security. On a long- term basis, it is the household's ability to obtain food at the expense of their future security (Sharma, 1992). This involves continuous monitoring of household assets to determine whether livestock and other assets are being used at unsustainable rates thereby causing health, education etc to be neglected (Sharma, 1992). Indebtedness is also used as an indicator, and studies have shown that this worsens over time (Sharma, 1992).

2.1.5.1 Measuring food insecurity

Although the concept is clear, an ideal measure of food insecurity particularly at the household level is difficult in practice since there are problems with the measurement of food availability, consumption, and need itself (ACC/SCN, 1997). No single indicator can accurately reflect

the situation (FAO, 1996). However, the following have been used or suggested for the assessment of food insecurity. They can be classified as dietary related, economic, a coping strategy and an outcome variable (anthropometric trends).

2.1.5.2 Dietary related indicators of food insecurity

The ICN (1992) suggested direct surveys of dietary intake over a span of time, usually one month, as a measure of food security/insecurity. The degree of adequacy of dietary energy intake with adequacy norms for health, growth and activity of all individual household members was also suggested by Gillepsie and Mason (1991) as an indicator of food insecurity. This is similar to the Household Dietary Energy Adequacy Ratio (HDEAR), computed from the mean total household intake and the mean total household requirement, (NMIMR/IFPRI, 1997). A household was rated food secure if its HDEAR was greater than 0.8 and food insecure if the HDEAR was less than 0.8. Furthermore, in areas affected by seasonal changes, households meeting 90% of their energy needs in both seasons were classified as food secure, those meeting 80% of their energy needs in one season as seasonally food insecure and those meeting only

60% of their energy needs as chronically food insecure (Armah-Klemesu *et al.* 1995).

2.1.5.3 Coping strategy related index

Dietary patterns and food choices have also been suggested as coping strategies since households tend to spend more money on cheaper and less preferred staples when prices are high or when the main staples are not in season (ICN, 1992).

Experience of hunger has also been suggested as another indicator of food security where it is assumed that hunger drives food-seeking behaviour and victims make sacrifices in obtaining food which may control the reduction of activity when food is scarce and people are hungry (ICN, 1992). Psychological factors such as anxieties over food such as whether the household is anxious if the food will run out is also a possible indicator (ICN, 1992).

2.1.5.4 Economic indicators:

The percentage expenditure on food and the proportion of available resources required for achieving food security has also been used to measure food security (ICN, 1992). Households with adequate food

security but spending almost all their income on food and those who spend just moderate amounts on food have also been studied and this imply the level of stress on households' well-being and coping capacity (ICN, 1992). According to Sharma (1992) the best indicator for household food security status is the real income and as the poor spend a large part of their income on food, an increase in income could mean that the amount of money spent on food is getting steady. He further observed that when food needs are satisfied, income spent on food decreases and this implies food security. In conclusion, he intimated that for adequate food intake, food must be available as well as accessible and this is a reflection of income.

In another paradigm, an increase in income was found not to contribute directly to improved nutritional wellbeing of the household although improves access to food (ICN, 1992). The additional income could be spent on non-food items while better sanitation for instance could indirectly improve nutritional status than the increased income or increased food consumption ((ICN, 1992). In a study by Kennedy and Haddad (1992), on the effect of an increase in income on food intake, it was found that the extra income was not necessarily spent on food (ACC/SCN, 1989). The study found the doubling of household income to increase a

preschoolers' caloric intake by 9%, which in turn improved the average weight for height Z-score by only 4 % (ACC/SCN, 1989). Furthermore, by the time this mechanism went through increased income, translating into higher food expenditure (more expensive food often chosen), into food consumption at the household and into child growth, the relationship between increased income and child growth was weakly correlated (ACC/SCN, 1989).

Household income was found not to play an important predictive role in achieving food security but social change, rather correlated with improvement in the nutritional status of children (Whiteford, 1989). The effect of income on a child's nutritional status, according to a study by the NMIMR/IFPRI (1997), is expressed through caloric availability. The study also found that food insecurity is not only a factor of income but also associated with the type of employment and the household structure. Employment that lacked security was observed to be a threat to food security (NMIMR/IFPRI, 1997).

The proportion of income spent on staples over the overall food expenditure or from the contribution of less preferred foods to the diet could also be used (ICN, 1992).

Levels of, and changes in, socioeconomic and demographic variables such as real wage rates, employment, price ratios and migration have been suggested to serve as proxies to indicate the status of food security (ICN, 1992).

2.1.5.5 Other indicators of food security

Whereas the long term changes in anthropometry, is not related to food security but a general outcome, rapid changes (unless there is an epidemic) are likely to reflect household food security at the community level (ICN, 1992). The correlation between underweight prevalence and food price derived data support the argument (ICN, 1992). Information on monthly or quarterly changes in underweight among preschoolers is capable of providing reasonable and up to date assessment of changes in household food security (ICN, 1992).

2.2. 0 Nutritional status

Food intake and nutritional status are inextricably linked and the connection between food security and nutritional wellbeing is through the actual utilisation of food by individuals. (ICN, 1992). Nutritional status according to the ICN (1992), is the outcome of a wide range of social and economic conditions and is a sensitive indicator of the overall level of development. In another paradigm, Timmer *et al.* (1983) also defined nutritional status as the outcome of a complicated biological process in which food intake is but one of the many variables. Nutrition has also been described as an outcome and a result of access to food, dietary intake, care and health of the individual (ACC/SCN, 1991a)

2.2.1.0 Basic indicators of undernutrition

Inadequate nutrition encompasses a set of issues with biological and social dimensions. In the child, if concerns survival, growth, health or sickness, activity level and cognitive development. In a well-nourished population, it is expected that one in every thousand (0.1 %) will be severely undernourished (GDHS, 1993). Attention is to be given to mild to

moderate as well as severe undernutrition as non -clinical undernutrition has been found to account for two thirds of child deaths (FAO, 1996).

Nutritional status can be assessed by a number of outcomes with the most common being the use of anthropometry (ACC/SCN, 1991a). Guthrie (1991), intimates that childhood is a period of active growth, and a well nourished child (a reflection of dietary adequacy), can be expected to have a growth pattern characterised by predictive increments in both height and weight as well as physical growth. This has become a standard by which nutritional status is assessed (Guthrie 1991).

2.2.1.1 Anthropometry

The nutritional status of an individual can be assessed through the use of one or more anthropometric measurements which generate objective measurements of body dimensions and composition as a proxy indicator for nutritional status (Guthrie, 1991). Stunting, wasting and underweight are some of the anthropometric indicators.

a. Underweight

Underweight 9i.e. low weight for age) is defined as a weight for age z-score < -2 standard deviations of the National Center for Health Statistics/ Center for Disease Control/ World Health Organisation (NCHS/CDC/WHO) reference population (GDHS, 1993). The prevalence of underweight is considered an important indicator of most nutrition-related problems at the individual and population levels (ICN 1992). Underweight is a combination of the previous indicators and generally used to assess nutritional status (GDHS, 1993). It is not recommended for use as a short-term index of nutritional status as it is affected by weight recovery which tendS to occur when prices of staples fall (ACC/SCN, 1997).

b. Stunting

Stunting i.e. being short for one's age is defined as a height for age z-score < -2 standard deviations of the NCHS/CDC/WHO reference population (GDHS, 1993). Stunting is a process that can begin early in life (in-utero) and continue to about three years after birth (ACC/SCN, 1997). Stunting is an indicator of long-term or chronic nutritional status (GDHS) and some of its consequences are reduced adult size and reduced work capacity, which

invariably affect economic productivity (ACC/SCN, 1997). Obstetric complications due to small pelvic size is the result of early stunting in female children (ACC/SCN, 1997). With small women low birthweight infants are most likely to be born and the vicious cycle of small stature is started. Stunting is also implicated in impaired mental function (ACC/SCN, 1997).

A reduction in the percentage of stunting in children 0-5 years to less than 20% both at the national and within subgroups by the year 2020 has been proposed by the ACC/SCN (1997). Grange (1994) reported that children adapt to stunting in a way that protects their mental functioning (positive deviance) which is a form of adaptation suited for traditional agricultural societies.

c. Wasting

Wasting (i.e. low weight for one's height) is defined as weight for height z-score <-2 standard deviations of the median NCHS/CDC/WHO/ reference population. It is a reflection of acute or current nutritional status (GDHS, 1993) and also can be used as a proxy indicator for food security status (ICN, 1992). The GDHS (1993) found that, wasting improves in the third year of life.

2.2.1.2 Anthropometric trends

The prevalence of stunting or chronic undernutrition has been observed to increase rapidly from 3-21 months of age, reaching a peak at about 50% and stabilising throughout the third year (GDHS, 1993). Wasting or acute undernutrition rises during infancy, peaks at a level of 20% by the age of 12 months and stabilises throughout the second year of life, then declines to about 7% (African Nutrition, 1995). It is concluded that children's acute but not chronic nutritional status improves in the third year of life (African Nutrition, 1995).

In Ghana, undernutrition has not improved since the 1988 demographic survey. More children are wasted now than in 1988 and it is in only the urban areas that stunting declined by a third (GDHS, 1993). To support this trend, the NMIMR/IFPRI (1997) reported that there was a general improvement in nutrition between 1988-1993. However, a deterioration occurred between 1993-1997 which also included a significant decline in the average height for age (GDHS, 1993).

By residence, urban areas showed 18% underweight, 16% stunting and 9% wasting while in the rural areas, there was 32% underweight, 30% stunting and 13% wasting (African Nutrition, 1995).

2.3.0. Sanitation and infection

2.3.1. Sanitation

Good health and sanitation depends on the mother's knowledge transformed into practice (NMIMR/IFPRI 1997). Poor sanitation, which promotes infectious diseases, coupled with the intake of an inadequate diet over a span of time, triggers the synergy of the Malnutrition Infection Complex (ICN, 992). Undernourished children usually, have prolonged illness, which tend to be frequent and severe while chronic infection also make it impossible to maintain an adequate diet (ICN 1992). Infection negates the effect of better eating (ACC/SCN, 1989).

To determine the sanitation conditions in a household, Merchant and Udippi (1997) used on-the-spot observations of the conditions of utensils, food and water storage and floor conditions which were graded (Appendix 2). The NMIMR/IFPRI (1997) study used a similar approach where good practices were associated with better nutritional status.

Studies have shown that the environment in which a child lives may have an effect beyond that associated with particular bouts of illness. Such children are prone to constant, low level challenges to their immune system which impairs growth (UNICEF, 1998).

With apparent infection (no clinical signs) high levels of immunological indicators and nutrients go to support the immune system instead of for growth (UNICEF, 1998).

2.3.2. Diarrhoea

The chronic and recurrent type of diarrhoea is the classic example of the malnutrition infection complex (MIC) and the commonest cause of deaths in young children (ACC/SCN, 1993). Statistics show that 80% cases of diarrhoea is of the acute watery type while 10% is the persistent type and the rest acute dysentery (ICN, 1992). A history of four or more loose stools per day was considered very severe (Bloem, 1990). In a study by Rowland *et al.* (1988) on the role of infection in determining the nutritional status of Gambian children, diarrhoea significantly correlated with height gain among infections such as fever, malaria, superficial as well as deep infections, upper and lower respiratory infection and giardiasis. Diarrhoea alone accounted for 20% of the difference in linear growth using

International reference standard (Zumrawi *et al.*, 1987). Diarrhoea episodes have been found to be associated with pathogens transferred to the children from contaminated water, food and animal faeces by contact (Black *et al.*, 1989).

Filteau *et al.* (1995) also reported that the epithelium is sensitive to vitamin A deficiency with the greatest effect on the gastrointestinal tract (GIT) in humans. In rodents, the effect on the respiratory tract was greater than the GIT, followed by the conjuctival epithelium in that order (Filteau *et al.*, 1997). Most of these deaths were due to poor nutrition and unsafe environment, particularly polluted water, which contributes to nearly one million cases of diarrhoea every year (ICN, 1992).

2.3.3. Respiratory infection

Respiratory infection is defined as a history of clinically significant respiratory complaints accompanied by fever, respiratory difficulties, coughs, and running nose (Bloem *et al.* 1990). It is associated with growth faltering as a result of anorexia, breathlessness, fever or pain, vomiting and associated diarrhoea (Bloem *et al.* 1990). The risk of developing respiratory infection increases with vitamin A deficiency (ACC/SCN, 1993).

2.3.4. Malaria

Malaria is a child killer disease in Africa resulting in the death of some 500,000 children annually, despite the considerable research and control efforts (ACC/SCN, 1991b). It is also the most devastating parasitic disease in the tropics (ACC/SCN, 1991b). The impact of malaria on nutritional status varies according to age, immunological status and the intensity of the infection (ACC/SCN, 1991b). An inverse relation was found between diarrhoea and malaria in Mexican children (ACC/SCN, 1993a).

2.3.5. Measles

Measles is a banal, self-limiting disease of childhood. In 1989, 4.5 million children were affected, out of which 1.4 million died, in spite of the availability of vaccines (ACC/SCN, 1992a). Case fatality rate is 20 times more in the developing than in the developed countries (ACC/SCN, 1992a). Deaths usually result from complications with diarrhoea, pneumonia etc and further worsened with low levels of vitamin A (ACC/SCN, 1992a). Measles can precipitate undernutrition in situations where food intake is reduced due to rehydration and painful mouth lesions (ICN, 1992). Undernutrition often precipitates vitamin A deficiency and

when the two occur together, the risk of blindness increases. Pneumonia and persistent diarrhoea frequently complicate measles and often cause growth faltering and micronutrient deficiency (ICN, 1992). Measles and fever have also been found to affect growth significantly (Cole *and* Parkin, 1977).

2.4.0. Micronutrient malnutrition

Vitamins and minerals are substances that cannot be synthesized by the human body. They must be provided in the diet and are necessary for regulating systems in the body (ACC/SCN, 1993b). Because they are needed in small amounts (micrograms or milligrams) daily they are called micronutrients (ACC/SCN, 1993b). Of public health importance are iron, iodine, zinc and vitamin A among others (ACC/SCN, 1993b).

Micronutrient malnutrition persists even when consumption of energy foods and protein foods seem adequate and it is much more widespread than protein energy malnutrition (ACC/SCN, 1993b).

2.4.1. Iron

Iron deficiency is the most prevalent micronutrient deficiency in the world affecting over 2100 million people including preschoolers and school going-children living in tropical and sub tropical areas of the world (Combs *et al.*, 1996). Iron is essentially for blood formation and a deficiency occurs if the amount of iron absorbed by the body is insufficient to meet the body requirements (Brock, 1989). If prolonged, it leads to iron

deficiency anaemia (IDA) which causes morbidity and if severe enough, death (Combs, 1996).

2.4.1.1 Impairment of iron status

Iron deficiency can be divided into three overlapping stages. These are

a) the pre-latent stage of iron deficiency: depletion of storage iron, where iron reserves are lost but the supply of iron to the developing red cell is adequate,

b) latent iron deficiency, that is with inadequate erythroid iron supply but haemoglobin level is within the reference range and

c) overt iron deficiency or manifested iron deficiency anaemia (Romslo 1990).

Although iron deficiency is synonymous with anaemia, only about 50% of people with iron deficiency develop this condition which is a manifestation of prolonged deficiency (ACC/SCN, 1995)

2.4.1.2 Causes of iron deficiency

Iron deficiency results from consuming diets with insufficient iron, reduced bioavailability of dietary iron, increased iron requirements to meet reproductive and developmental needs as well as losses due to parasitic

infections (ACC/SCN, 1991a). Vitamin A deficiency has also been implicated in the disruption of iron metabolism and may aggravate the consequences of iron deficiency (ACC/SCN, 1991a).

Meat, fish, vitamin C-rich foods as well as fermented foods enhance the absorption of (ACC/SCN, 1993). Meat is the best source of highly absorbable iron but not easily affordable in most developing countries. Most iron in the diet comes from grains, legumes and vegetables whose absorption is usually less than 5% (ACC/SCN, 1993a). Absorption can be increased three to seven fold by the consumption of acidic (fermented) foods and those rich in vitamin C (ACC/SCN, 1993a). The low absorption can however, double the requirement for iron intake (ACC/SCN, 1993a)

2.4.1.3 Effects of iron deficiency

Iron deficiency is associated with decreased immune function as measured by changes in several components of the immune system during iron deficiency. In infants and young children, iron deficiency leads to impaired language and motor development, impaired coordination and scholastic achievement, in-attentiveness and fatigue, decreased physical activity and retardation of physical and mental development (ICN, 1992).

Iron has been found to play an important role in the function and synthesis of myelin and the neurotransmitters dopamine, serotonine, cathecholamines and the gamma amino butyric acid (Baghurst, 1994). A decrease in iron stores is not usually associated with adverse physiological consequences but does represent a vulnerable state (ACC/SCN, 1997). Iron deficiency without anaemia occurs when iron depletion is severe enough to affect the normal production of haemoglobin but without haemoglobin falling below the clinical criteria defining iron deficiency anaemia (ACC/SCN, 1997).

2.4.2.0 Serum ferritin

Serum ferritin is a protein in which a reservoir of iron can be stored for subsequent metabolic use (Brock, 1989). Serum ferritin is in equilibrium with body stores and present in the serum in very small amounts: (0 - 400ng/ml) (Madanat *et al.*, 1984). Its source is believed to be the reticulo-endothelial cells (RCs) and the rate of synthesis and secretion depends on the quantity of iron stored in the RCs (Madanat *et al.*, 1984).

At birth, the concentration of serum ferritin is about 10 ng/ml, higher than in childhood (Siimes *et al.* 1974). Thereafter, there is a stepwise increase in the first month of life to 356 ng/ml. This is followed by a decrease 7-

142 ng/ml which is maintained between the ages of 6 months to 15 years (Siimes *et al.* 1974). In children, no difference have been found between the sexes and the median concentration for male adults was found to be around 140ng /ml in contrast to 39 ng/ml in women (Siimes *et al.* 1974).

2.4.2.1 Some attributes of serum ferritin determination

According to Herbert (1992), serum ferritin is the only test that measures body stores of iron with each nanogram per millilitre equivalent to 10 mg of body iron stores. Serum ferritin appears to be a sensitive early indicator of iron deficiency and can be easily and relatively inexpensively determined using an immunoassay kit (Romslo, 1990). Since morphological changes are late in the development of iron deficiency, even modern counters have been found to have no impact (Romslo, 1990). A drop in serum ferritin and an increase in red cell protoporphyrin have considered consistently been associated with the development of iron deficiency. Serum ferritin has been found to have an efficacy of 92% while transferrin saturation was at 67% in diagnosing patients with anaemia (Romslo, 1990).

According to Salvioli *et al.* (1991), the estimation of serum ferritin is the only test, which allows the identification of at-risk subjects before symptoms appear, enabling rapid treatment of prevention. In developing countries, laboratories do not routinely screen for iron deficiency unless the patient presents with symptoms of anaemia; thus the need for the determination of serum ferritin (Hamedani *et al.* 1991). Dallman *et al.* (1980) has also stated that serum ferritin allows the evaluation of iron status within the normal range of deficiency and excess which is an invaluable information in nutritional surveys and cannot be provided by any other means.

Although decreased levels of iron stores are usually not associated with adverse physiological consequences, a vulnerable state is represented (ACC/SCN, 1997).

To ascertain whether or not to prescribe iron tablets to patients with simple iron deficiency, serum ferritin is presently the most useful practical test (Romslo, 1990). Furthermore, in anaemia of chronic disorders, none of the presently current available biochemical tests adequately separates patients with and without accompanying iron deficiency (Romslo, 1990).

2.4.2.2 Determining serum ferritin

Several methods have been used to assess iron status in humans. These include haemoglobin level determination, red cell indices, peripheral smear examination, staining of bone marrow, measurement of transferin saturation, free erythrocyte protoporphyrin and serum ferritin (Madanat *et al.*, 1984). The enzyme linked immunosorbent assay (ELISA) and radioimmunoassay (RIA) are the main immunological methods for the determination of serum ferritin (Fidanza, 1991). According to Fidanza, (1991), the assessment of serum ferritin in populations is o f interest in recent times with the required volume of about 10µg/l of serum permitting measurement of capillary samples. He further indicated that the technique used in the design aims at maximum sensitivity in the iron deficient range of serum ferritin samples greater than 100µg/l which is within the working range of the standard curve.

2.4.2.3 Cut off levels for serum ferritin

There is a wide range of serum ferritin levels, and various authors have indicated various values for the lower and upper limits. According to Brock (1989), serum ferritin levels below 5 µg/l is indicative of depleted

iron stores and levels above 300 µg/l, indicative of iron overload. values of less than 10µg was reported by Green-Finestone *et al.* (1991) as indicative of depleted iron stores. A concentration of less than 12 ng/ml indicates a depletion of iron stores (Martti *et al.* 1974). Romslo (1990) however, set the cut off levels for ferritin at above 100 µg/l indicating adequate iron stores and below 50 µg/l as inadequate or exhausted stores. A cut off of 164 µg/l, indicating adequate iron stores was also proposed by Hussein *et al.* (1978).

2.4.3 Serum ferritin and infection

According to Wickramasinghe et al. (1985), high levels of serum ferritin is sometimes a manifestation of a previous infection. He observed that even a brief episode of fever causes a rise in serum ferritin concentration, which may persist for as long as ten days. In children with active inflammation or infection, serum ferritin level below 50µg/l do not exclude iron deficiency instead of the less than 10-20µg/l proposed by other authors (Harries *et al.* 1984). With a condition like upper respiratory tract infection, ferritin levels were reported as ranging between 18-510ng/ml (Table 1). With a condition such as Thalasemia major, ferritin levels were as high as 590- 1830ng/ml (Table 2).

Table 1. Serum ferritin concentration in common acute infections in Children 6 months to 15 years

Infection	Numbe	Median (ng/ml)	Range (ng/ml)
Upper respiratory tract infec (URI)	12	167	18.0 – 510
Lower respiratory tract infec (LRI)	7	115	28.0 –320
Gastroenteritis	6	79	28.0 –195
Normal	486	30	7.0 –142

(Martti *et al.* 1974)

Table 2. Serum ferritin concentration in iron deficiency and overload in children 6 months to 15 years

Infection	Numbe	Median (ng/ml)	Range (ng/ml)
Iron deficiency	13	3.4	1.5 - 9
Latent iron deficiency*	6	10.6	4.5 – 41
Thalasemia major	7	850	590 - 1830
Sickle cell anaemia	14	163	49 – 180
Chronic Haemolytic Ana	19	242	96 - 920
Normal	486	30	7 - 142

*Transferrin saturation <16 %

(Martti *et al.* 1974).

2.5.0. Vitamin A

Vitamin A is essential for a variety of biological processes, many of which are related to growth, cellular differentiation and interactions of cells with each other in the extracellular matrix (Robert and Sporn 1984; De Luca 1991). The molecule is well conserved in the body and as it maintains the integrity of cells, is referred to as the anti-infective vitamin (Robert and Sporn, 1984). Vitamin A is required for vision, maintaining the integrity of membrane structures, reproduction, growth and development, and for immune function (Karr *et al.*, 1997). Even in its relatively early stages, vitamin A deficiency results in impairment of linear growth, cartilage and bone development and epithelial cell differentiation and function, and in reduced vision in dim light. Furthermore, no nutritional deficiency is more consistently synergistic with infectious diseases than vitamin A (Robert and Sporn, 1984). Marginal status of vitamin A is often worsened by infection and reciprocally poor vitamin A status is likely to prolong or exacerbate the course of illness (Scrimshaw, 1968). Mortality may be related to changes in the immune system and hence to a breakdown of the defence system or mechanism which counteract environmental pathogens (Scrimshaw, 1968).

2.5.1 Prevalence of Vitamin A deficiency

According to Combs (1996), about 250 million people are at risk of vitamin A deficiency and in 1991, approximately 14 million preschool children had xerolphtamia, (clinical manifestation of acute vitamin A deficiency). Between 250,000 and 500,000 children go blind every year and approximately two thirds of these children die within months of going blind due to increased susceptibility to infection, which is also caused by Vitamin A deficiency (Combs *et al.*, 1996). Even subclinical vitamin A deficiency, which affects some 40 million children in 60 countries has been shown to increase child morbidity (Combs *et al.*, 1996).

2.5.2. Causes of Vitamin A deficiency

Essentially, the primary cause of vitamin A deficiency is low dietary intake, underutilisation and reduced absorption of the vitamin. This is worsened by factors such as measles, diarrhoea, and parasitic infections, which can also play a significant role in micronutrient deficiency diseases (Buyck, 1993). Vitamin A deficiency is often found in preschoolers and symptoms show up after liver reserves are depleted (ICN, 1992). These symptoms can result from protein deficiency (i.e. protein needed to transport the vitamin or the absence of zinc which is needed to mobilise it

from the liver) (ICN, 1992). Symptoms could also result from low dietary intakes, interference with absorption and storage or interference with the conversion of carotene to vitamin A (ICN, 1992). Vitamin A status reflects an outcome of a continuous process from dietary intake, digestion, absorption, mechanisms of transport for meeting tissue demands for various functions (Udomkesmalee, 1994).

Vitamin A is preformed in animal products especially liver and milk. The precursors are primarily found in plant products such as leafy green vegetables, yellow and red fruits and vegetables and red palm oil, which can be converted to vitamin A in a ratio 6:1 (ACC/SCN, 1993). Intake can be inadequate due to seasonality of food sources and early abandonment of breastfeeding (for infants). Low fat diets impair vitamin A absorption (ACC/SCN, 1993).

2.5.3. Evaluation of Vitamin A status

Vitamin A levels in the blood can be assessed by the total body content of the vitamin, which can be viewed as a continuum from a deficiency to excess with obvious health consequences at both extremes (ACC/SCN 1997). Udomkesmalee (1994) asserts that vitamin A concentration in the

blood is under homeostatic control over a wide range of body stores and will reflect status only when stores are very low or high. He also stated that mild to moderate deficiency (i.e. subclinical or marginal) is however, more difficult to diagnose since clinical signs are not evident, while tissue concentrations are sufficiently low to result in adverse health consequences. Infection and infestation, protein-energy malnutrition and low mineral status also lower serum values.

Biochemical tests involving frequency distribution of serum vitamin A, serum retinyl esters, dose response tests, functional tests such as history of night blindness, conjuctival impression cytology and sometimes serum zinc levels have been used to determine vitamin-A deficiency (Udomkesmalee, 1994). Ecological patterns (both quantitative and qualitative) of intake of vitamin A rich foods have also been used (Udomkesmalee, 1992). Guthrie (1991) reported that the most sensitive indicator is the measurement of vitamin A stores in the liver but this is not feasible for population evaluation. Inadequate protein intake or possible zinc deficiency may prevent the release of vitamin A from the liver into the blood. Retinol binding protein, in addition to other markers of vitamin A have been used (Karr *et al.* (1997), Fiore *et al.* (1997), Bernard (1982) and Ingenbeck *et al.* (1975).

2.5.4. Retinol Binding Proteins

Retinol Binding Protein (RBP) is a protein synthesized by the hepatocytes (Mastroianni *et al.*, 1998) and other tissues such as the the eye which takes up most of the retinol (Green *et al.*, 1987). It transports retinol in plasma, binding two retinol molecules with a half-life of 12 hours (Mastroianni *et al.*, 1998), between 3 and 12 hours (Beetham *et al.*, 1985). It circulates in a 1:1molar complex with transtyretin (thyroid binding prealbumin) and the level of RBP is constant except in extreme cases of vitamin A intake. The concentration of rbp is stable despite a wide range of dietary intake (Malvy *et al.*, 1998). Conditions that decrease RBP concentration in the blood include vitamin A deficiency, malnutrition, renal disorders (Mastroianni, 1998) acute catabolic states, zinc deficiency and hepatic disease (Donnen *et al.*, 1996). In zinc deficiency, RBP is accumulates in the liver, making its secretion impossible (Donnen *et al.*, 1996). In retinol deficiency, RBP secretion is blocked whereas its rate of synthesis is unaltered (Mastroianni, 1998) and most retinol in plasma is bound to RBP (Donnen *et al.*, 1996).

2.5.5. Cut off levels for RBP.

The cut off level for serum RBP has been as reported differently by different authors. Bernard (1982) gave the RBP concentration in normal healthy subjects as fluctuating around 46.0 ± 10.4 µg/l. Plasma levels of RBP in normal Senegalese children ranged between 26 – 76µg/l (Ingenbeck *et al.* 1975). According to Donnen *et al.* (1996) the cut off is set at 30 µg /l (lower limit). Fiore *et al.* (1997) also found the cut–off for rbp as between 4.5 – 5.3 µg/dl in healthy controls. Karr *et al.* (1997) reported a range of 7.5 – 54.0 µmol/l with a lower cut off as 18µg/l and 45µg/l as the upper cut off point. In a study of healthy Australian children, the various RBP was reported to range between 23.6-28.0 (Table 3).

In the immunochemical determination of rbp in normal biological fluids, Peterson and Beggård (1971) reported a concentration of 46µg/l in serum, 0.11µg/24 hour urine and 0.35µg/l in cerebrospinal fluid.

Table 3. RBP levels in healthy Australian children.

Age (mos)	Range (µg/l)	Mean (µg/l)
9 –23	25.5 – 28.0	26.7
24 -35	24.0 – 26.5	25.2
36 - 47	23.9 –26.2	25.2
48 - 62	23.6 – 25.6	24.6

Karr *et al.* (1997)

2.5.6. Methods for RBP determination

Moody (1982) reported of a one dimensional 'rocket' immunoelectrophoretic technique as one of the methods of determining RBP. Other methods are radial immunodiffusion (of limited sensitivity), nephelometry, electroimmunoassay enzymoimmunoassay, radioimmunoassay, latex particle immunoassay (Beetham *et al.*, 1985) and the enzyme linked immunosorbent assay (Lucertini *et al.*, 1984; Topping *et al.*, 1996).

CHAPTER 3

3.0. METHODOLOGY

3.1. Study design

This study is mainly one of cross-sectional.

3.2 Study locale

The study was conducted at Kpone, usually referred to as Kpone-on- sea, in the Greater Accra Region. It is a suburban town located about 15km to the east of the Tema metropolis and linked by a good road network. The locality code is 22150000 (Ghana Demographic and Health Survey 1984), Topographical Sheet number 0500A3 (Survey Department, 1975), or Topographical Sheet number 8 (Survey Department, 1972). The setting is Suburban. It has an estimated population of 9,942 (1998) and situated on the leeward side of an industrial area.

3.3 Sample population

Children between the ages of two and five (2-5) years who had been weaned-off the breast and on their own diet were selected for the study.

3.3. Sample population

Table 4 Age and sex distribution of study subjects (%):

Sex	Age (years)			
	2	3	4	5
Male (%)	11	12	11	12
Female (%	11	13	12	13

3.4. Estimation of sample size

For statistical relevance, the sample size was calculated using a prevalence of 30% for undernutrition which was rounded up from the national prevalence of 28% (GDHS, 1993) and a margin of error of 5.

$$n = \frac{Z^2 \times P(100 - P)}{m^2}$$ (Moore and Mc Cabbe, 1993)

where:

n = sample size

Z =1.960

m = margin of error (5 was chosen)

P = Prevalence

Alternatively, a ready reckoner (Table 5) also provides various sample sizes with their respective margin of error and percentage prevalence (Steinar-Asiedu, 1999). A sample size of 336 was used in the study.

Table 5 Calculated sample sizes

	Prevalence percentage				
Margin of error	10 (%)	20 (%)	30 (%)	40 (%)	50 (%)
3	400	711	933	1066	1111
4	225	400	525	600	625
5	144	256	336	384	400

Source: (Steiner-Asiedu, 1999).

In calculating the sample size for the biochemical assessment, the formula:

$$n = \frac{(2 \times z \times \text{standard deviation})^2}{m^2}$$ (Moore and Mc Cabbe, 1993)

$$= \frac{(4z^2 \times \text{variance})}{m^2}$$

(in this calculation, m = 1 and variance was 10% giving n =154).

3.5. Sampling protocol

A total of 200 households were randomly chosen and 400 children below 6years were recruited. This figure was later reduced to the required sample size of 336 on the basis of a fair distribution of age, sex and locality, and choosing children from households in each of the three main sectors of the community. The same technique was used to select 180 children for the biochemical assessment.

3.6.0. Tools and techniques

3.6.1. Obtaining community and household information

For the introduction to the community, the assistance of the Traditional Council, Local Assembly and the Non-Formal Unit of Education were sought. Parental consent was reached (verbally) before the survey and apart from the biochemical assessment, which was done once, the anthropometric and dietary assessment were done two times (one in the minor fish season and the other in the major fish season). Preliminary information about the community was gathered through focus group discussions using a checklist (Appendix 2).

The main tool used to gather household data in this study was a structured questionnaire (Appendix 3-5), which was pretested in a similar setting at Gbegbeise (another fishing community in the Greater Accra Region).

3.6.2. Dietary assessment

Dietary assessment was done using the 24-Hour Dietary Recall questionnaire (appendix 6) to obtain recent food intake. For this work, a three-day 24 Hour Recall of food intake per child was done and the average taken. The days included Tuesdays, when there was no fishing activity and some cooking done (one weekend and any other weekday). Samples of some food items (vendor food) were bought and their weight/volume measured as purchased. The Food Composition Tables (FCT) by Eyeson and Ankrah (1974) and the Nutrition and Food Science Department's compilation by Tayie and Lartey (1999) were used to estimate nutrient intake of the children. The Recommended Dietary Allowances (RDA), for dietary sufficiency (energy, protein, iron and vitamin A) were computed from RDA tables (Donald and Burman 1976; RDA, 1989).

3.6.3. Anthropometry

Growth determination involved measurements of stature (standing height) using a Harpenden Stadiometer read to the nearest mm. Weight was measured by a previously calibrated Salter bathroom-type scale read to the nearest 50g. These measurements were done following standard procedures (Jelliffe and Jelliffe, 1989). Anthropometric information was based on the NCHS standard using the software ANTHRO, version 1.01(Sullivan and Gorstein, 1990) for the analysis.

3.6.4.0 Biochemical assessment

3.6.4.1. Blood collection and storage

Blood collection involved antecubital venipuncture where about 5ml of blood was taken (by haematological technicians) from each child (non fasting) using sterile steel needles between the hours of 9.00am-12.00 noon. The blood was placed in labelled plastic test tubes left for about 1hour and centrifuged (on the field) at 5000 rotations per minute (rpm) for fifteen minutes. The serum was decanted into labelled Eppendorf tubes using Pasteur pipettes, kept on ice in the field and transferred to a -18^0C freezer. To prevent freeze-thaw episodes, the sera were sub-divided into three. Before the assay the sera was slowly thawed and used for the determination of ferritin and retinol binding protein by the Enzyme Linked-Immunosorbent Assay (Appendix 1). A total of 180 children took part in the biochemical assessment. However, only 113 of the sera provided could be used as some of the blood separated poorly. This number fell within 75% of the required sample size of 154.

3.6.4.2. Serum ferritin assay

The Programme of Action Against Micronurient Malnutrtion (PAMM) recommended protocol (1994) was used for the serum ferritin assay.

Reagents:

Coating Buffer: Equal quantities of 0.1M Na_2CO_3 and 0.1M $NaHCO_3$ were mixed and adjusted to pH 9.6 with drops of 2M $NaHCO_3$ and refrigerated at 4^oC.

Washing Buffer: **Phosphate Buffer Solution (PBS)** was made up of 160g NaCl, 4g of KCl, 4g of KH_2PO_4 (anhydrous) and 23g $NaHPO_4$ (anhydrous) .

Stock was diluted with distilled water in a ratio of 1:10 and Tween 20 was added at 0.1% to make PBS with Tween (PBST).

Blocking Buffer (freshly prepared). 1g Bovine Serum Albumin (BSA) from Sigma: cat. No 7888 was weighed and made up to 100ml with PBST.

Diluting Buffer (freshly prepared). This was made from a 1/5 dilution of the Blocking Buffer with PBST. A pH of 7.2 was achieved after the dilution.

Equipment Used: pH meter: CG 840, Skanwasher version B, m207 – RENS (Heigar labs), Titerter Multiscan® MCC 340 MKII type 347, Genesis-Lite software.

Table 6 **Ferritin standards preparation:**

	Composition	Concentration	Standard
A	196ul of diluting buffer + 4µl of standard	2000µg/l	X
B	20µl of A + 1980µl of diluting buffer	200.0000 µg/l	1
C	1000µl of B + 1000µl of diluting buffer	100.0000 µg/l	2
D	1000µl of C + 1000µl of diluting buffer	50.0000 µg/l	3
E	1000µl of D + 1000µl of diluting buffer	25.0000 µg/l	4
F	1000µl of E + 1000µl of diluting buffer	12.5000 µg/l	5
G	1000µl of F + 1000µl of diluting buffer	6.2500 µg/l	6
H	1000µl of G + 1000µl of diluting buffer	3.1250 µg/l	7
I	1000µl of H + 1000µl of diluting buffer	1.5625 µg/l	8

A dilution factor of 10 was used for the sera.

Procedure

1. Universal microtitre plates (Coastar High Binding) were coated with 50 µl/well of antiferritin antibody (Rabbit anti human ferritin: DAKO cat. No. A0133) diluted 1:700 in coating buffer and incubated overnight at 4^0 C.
2. Plates were washed with PBST five times at 200µl/ well and blotted dry on piles of paper.
3. 150 ml of blocking buffer was added and plates were incubated at 37^0C for 2 hours.
4. Plates were washed two times and blotted dry on piles of paper.
5. 50µl of standards, controls and test sera each in diluting buffer were added to the appropriate wells (coded) and incubated at for 1 hour at 37^0C.
6. Plates were washed five times and blotted dry on piles of paper.
7. 50µl of peroxidase conjugated antiferritin (Rabbit anti human ferritin: DAKO catalogue no. P0145), diluted at 1:8000 in diluting buffer was added and incubate at 37^0C for one hour.
8. Plates were washed five times.
9. A solution of 4 o-phenylenediamine dihydrochloricacid (OPDD) tablets (DAKO catalogue no. S52045) in 12ml distilled water and 5µl of 30% Hydrogen peroxide was made and added to the wells at 50µl per well. The reaction was stopped after 15mins with 50µl of $1MH_2SO4$.
10. Absorbance was then measured on a plate reader and the various concentrations determined using the Genesis–Lite programme.

3.6.4.3. Serum retinol binding protein (RBP) assay

The reagents and equipment for the serum retionol binding protein assay were the same as those for serum ferritin except for the immunoreagents. This method is a modified form of that of Lucertini *et al.* (1984) and Topping (1996).

Table 7 **Preparation of RBP standards**:

	Composition	Concentration	Standard
A	196µl of diluting buffer + 4µl of RBP standard (Sigma cat. No. R9388)	2.72 g/l	X
B	20µl of A + 1980µl of diluting buffer	80.000 µg	1
C	500µl of B + 500µl of diluting buffer	40.000 µg	2
D	500µl of C + 500µl of diluting buffer	20.000 µg	3
E	500µl of D + 500µl of diluting buffer	10.000 µg	4
F	500µl of E + 500µl of diluting buffer	5.000 µg	5
G	500µl of F + 500µl of diluting buffer	2.500 µg	6
H	500µl of G + 500µl of diluting buffer	1.250 µg	7
I	500µl of H + 500µl of diluting buffer	0.625 µg	8

For the sera a dilution factor of 5000 (Lucertini *et al.*,1984).

Procedure

1. Universal microtitre plates (Coastar High Binding) were coatedwith 50 µl/ well of anti- RBP antibody (Rabbit anti human RBP: DAKO cat. No. A0040) diluted at 1:700 in coating buffer and incubated overnight at 4^0C.

2. Plates were washed solution with PBST five times at 200µl/ well and blotted dry on piles of paper.

3. 150ml of blocking buffer was added and plates incubated at 37^0C for 2hours.
4. Plates were washed two times and blotted dry on piles of paper.
5. 50µl of standards, controls and test sera each in diluting buffer was add to the appropriate wells (coded) and incubated at for 1 hour at 37^0C.
6. Plates were washed five times and blotted dry on piles of paper.
4. 50µl of peroxidase conjugated anti-rbp (Rabbit anti human rbp DAKO catalogue no. P0304), diluted at 1:500 in diluting buffer was added and incubated at 37^0C for an hour.
8. Plates were washed five times.
9. A solution of 4 o-phenylenediamine dihydrochloricacid (OPDD) tablets (DAKO catalogue no. S52045) in 12ml distilled water and 5µl of 30% Hydrogen peroxide was added to the wells at 50µl/well. Reaction was stopped after 15mins with 50µl 1MH_2SO4/well.
10. Absorbance was then measured on a plate reader: Titerter Multiscan® MCC 340 MKII type 347 and the programme: Genesis–Lite used to determine the various concentrations.

3.7. Statistical analysis

- Results are presented using both descriptive (qualitative) and quantitative expressions
- Stratification was based on age and sex
- Quantitative values are expressed as mean ± standard deviation and range
- To ascertain relationships, correlation analysis was employed.

- Comparison of two means (the minor and major fish seasons) involved the use of the student's t-test.

(The computer software used in the analysis was Microsoft Excel)

3.8. Limitations of the study

a) Haematological equipment arrived late hence blood collection could be done once and hence, a comparison could not be done

b) The attrition rate was high thus, not all the children could be followed up

c) Serum retinal and other biochemical markers could not be determined

CHAPTER 4

4.0. RESULTS AND DISCUSSIONS

4.1.1 Community characteristics

The main ethnic group in the town is made up of Gas with a few Adas, Fantes, Akan and Ewes. In this study the Ga households formed over 96%. The main occupation in this community is centred on fishing and trading of mainly fish. About 62% of the male occupation was fishing while the main female occupation was fishmongering (37%), a vendor food processor (16%) and in petty trading (16%) as shown in Table 8. The major fish season is around late July to early October. There is also a minor upwelling between January and February, which lasts for about three weeks. Thereafter, there is no significant fish catch for the rest of the year. In the Greater Accra Region, there is no fishing activity on Tuesdays (may differ in other regions).

There is electricity supply in the community but no pipe borne water, although pipelines have been laid years ago. In the rainy season, the low-lying areas get some tap water and a nearby stream serves as a source of water for bathing and laundering for some of the households. Potable water supply is therefore through tanker services, which is stored in concrete tanks and later sold by the owners. At the beginning of the study (March-April), a bucket of 5gallons was sold at ¢140,00 and towards the end of the study (August) the same volume was sold for ¢200.00.

There are two pit latrines in the community and 'free-range' is very common. Drainage of waste-water from the households is poor and

Table 8 Occupational profile of parents of the children studied (%):

TYPE OF OCCUPATION	MALE	FEMALE
Fisherman: Hook and line	30	-
Beach seine	20	-
Other gear	6	-
Crew on the high sea	5	-
Total male population in fishing	**61**	-
Fishmonger	-	37
Porter at beach	-	3
Total female population in fishing related activi		**40**
Trader: food vendor	-	16
Petty trading	-	16
Other business		5
Farmer	3	5
Driver	8	-
Seamstress, hairdresser, tailor,	1	6
Carpenter, mason,	2	
Refrigeration/auto mechanic	5	-
Unemployed, sick, student,	6	0
Deceased	<1	0
Factory worker	-	
Office worker	-	
Teacher, policeman, clinic attendant	1	<1
Labourer	<1	-
Driver's mate	<1	
Goldsmith	<1	-

rubbish disposal is not very well organised with households sited near dumping sites. Within and around the households, sanitation practices were observed to be very poor (Table 9).

Access to the main staples (maize and cassava) and vegetables, is through purchases from the Tema market and from table-top traders in the town. Fish is available in the community especially for those engaged in the fishery sector. The women trade mainly in fish, which they sell either fresh or smoked in Accra, Ada Foah, Suhum, Koforidua and other places. There is a rural bank and schools from kindergarten up to Junior Secondary level in the community.

4.1.2 Household sanitation and infection situation

Sanitation was found to be poor in the community as close to three quarters (75%) of the children (Table 5) came from households with poor surroundings using an index adapted from Merchant and Udipi (1997) and NMIMR/IFPRI (1997). It was therefore no surprise that the prevalence of severe diarrhoea among children was very high in the community (Table 10).

Table 9 Sanitation index of the households studied:

Grade	Very Good	Average	Poor
% of households	< 2	24	74

Infection, coupled with inadequate food intake triggers the synergy of the malnutrition infection complex (MIC). Infection, has been reported by several authors as having an inverse relationship with weight, as well as height gain (Zumrawi *et al.*, 1987; Black *et al.*, 1984). There was such a relationship in this study as diarrhoea correlated inversely with weight and also height.

Table 10 shows the diarrhoea prevalence among the children where as many as 70% had very severe diarrhoea and 16% had moderately severe diarrhoea. In the remaining 13% of the children, diarrhoea incidence was rare.

Table 10 Frequency of loose stools/day (%)

Age	None	Moderately Severe (less than 4 times/day)	Very severe (more than 4 times/day)
2	3	4	19
3	4	4	17
4	3	2	14
5	3	6	20
Total	13	16	70

This highly correlated with severe diarrhoea in the children ($p = < 0.001$). Some of the households were sited near rubbish dumps, rubbish disposal was not well organised and food was prepared in unclean surroundings. Faecal material from both animals and children had not been cleared in some of the households and this is a major source of transmission of infection agents to food and drinking water. Water used for dishwashing especially at the food vendors' was unclean and also in some of the

households. In some of the households, faecal material from animals and children had not been cleaned and this is a major source of transmission of infectious agents to food and drinking water. Water used for dishwashing especially at the food vendors' was not clean and with most of the children patronising such cooked foods, the chances of getting an infection is high. With no pipe-borne water in the community, the handling of water especially that for drinking is critical as contaminated water is highly associated with diarrhoea (Black *et al.* 1984; ICN 1992).

In the course of the study, the prevalence of other forms of infection was 12% for malaria, which also affects nutritional status, 6% had coughs, a form of respiratory infection and 5% had measles which can precipitate undernutrition because of the mouth lesions which causes a reduction in food intake. The levels of these infections were however, not alarming. This could be due to the rather encouraging immunization status of the children studied, as 73% had completed all vaccinations against the seven childhood killer diseases, 26 % partially vaccinated. Only about 1% had had no vaccinations.

4.2.0 Dietary assessment

4.2.1 Energy intake

Energy requirement is the level of intake from food, which will balance energy expenditure when the individual has a body size and composition at a level of physical activity consistent with good health (RDA, 1989). Meeting one's energy requirement is very essential and in the case of children this includes the energy needs associated with the deposition of tissue. Inability of children to meet basic energy needs could lead to both adverse physical and physiological consequences. In this study, over 40% of the children aged between three and five years met their requirement for energy; that is, they met more than 75% of the RDA for energy in the lean fish season (Table 11). For those aged two years, only 28% could meet their RDA for energy in the lean fish season (Table 11). Between 36% and 43% of the children met their energy requirements marginally, that is, between 50% and 75% of the RDA (Table11). With the exception of those aged three years, the rest of the children forming between 20% and 28% of the other age groups met between 25% and 50% of the RDA for energy while less than 3% barely met 25% their energy requirements. This means that about 60% of the children were not having enough from food for normal growth and physiological functioning during the lean fish season. The mean energy intake for this season was 1196.1 kilocalories.

In the major fish season, 58% - 69% of the children aged between two and three years, met their energy requirement, which is an improvement over the lean fish season figures (Table 12). There was however, a decline of

5% in the number of the older children (37%). Between 24% and 53% of the children in each of the age groups met their requirements only marginally, that is, between 50% and 75% of the RDA (Table 12). The interpretation to this is that food, is more available during the major fish season hence the higher energy intake (mean intake = 131.2.1 kilocalories).

In the major fish season, more of the children aged 2-3years (52% and 62%) met this requirement. In the older children, about a fifth could meet this requirement. It was observed that these children rely very much on vendor food that the same amount of food was purchased by the children irrespective of their age. With a much higher physiological requirement, the older children who are on a similar dietary energy intake as the younger ones will definitely not meet their energy requirement. The difference in the energy intake during the two was however not statistically significant ($p > 0.05$).

Table 11: Percentage of children meeting various levels of RDA for energy (baseline/lean fish season) (%)

RDA	AGE	< 25% of RDA	≥ 25% ≤ 50 % of RDA	≥ 50% ≤ 75% of RDA	> 75% RDA
1450	2	1	28	42	28
	3	3	5	43	49
1875	4	0	20	39	41
	5	1	20	36	42
TOTAL		1	18	40	40

n =336

Table 12 Percentage of children meeting various levels of RDA for energy (major fish season)

RDA	AGE	< 25% of RDA	≥ 25% ≤ 50 % of RDA	≥ 50% ≤ 75% of RDA	> 75% of RDA
1450	2	4	8	29	58
	3	2	4	24	69
1875	4	0	10	53	37
	5	0	26	37	37
TOTAL		2	12	35	51

n = 274

4.2.2 Protein intake

Contrary to expectations, the amount of fish consumed by these children was found to be very low for a fishing community in both seasons. There were instances where the children had no fish with their food especially when cooked food was purchased. In growing children, protein is required for growth as well as the maintenance of worn-out tissues.

The requirement for protein was met by a good number of the children (between 80% and 94%) in the lean season (Table 13). At least, none of these children fell in the lowest quintile. The percent protein from animal source ranged from 5 – 21 % (mean total protein intake = 25 grams). However, the plant sources of protein formed more than 70% of the total protein.

In the major fish season, most of the children met their protein requirements, but there was a decline in protein intake during the lean fish season among the children aged two and five years (Table 14). About 4% of the children aged two years fell in the lowest quintile. The mean percentage of protein from animal source however increased with a range of 12- 45 %, with the availability of fish at the time.

The mean protein intake was 27.9 grams for the major fish season. As a fishing community, most of the children met their RDA for protein however, this was translated into poor growth as shown by the anthropometric results (Tables 20 and 21). This could be due to the fact that most of the protein came from plant sources. The high rate of infection mainly in the form of diarrhoea could also mean that the protein meant for growth could be used for immune purposes. There was no difference (Appendix viii) between the protein intake for the two seasons ($p > 0.05$).

Table 13 Percentage of children meeting various levels of RDA for protein (lean fish season) (%)

Age	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	16g	0	1	8	91
3		0	1	5	94
4	24g	0	6	14	80
5		0	6	10	84
Total		0	3	9	87

n = 336

Table 14 Percentage of children meeting various levels of RDA for protein (major fish season) (%)

Age (years	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	16g	4	4	6	85
3		0	2	4	93
4	24g	0	3	5	92
5		0	2	19	79
Total		1	3	9	87

(n = 274)

4.2.3 Iron intake

Micronutrients are concentrated in a few foods and one can suffer serious deficiencies if variety in food intake is minimal. Iron is essentially for blood formation and a deficiency occurs if the amount of iron absorbed by the body is not sufficient to meet body requirements (Brock, 1989).

In this study, about half of the children aged 4 and 5 years met their RDA for iron in the lean fish season while only 14% and 31% of the children aged 2 and 3 years respectively met their requirements for iron (Table 15). The percentage iron from animal source range from 1 - 8% of the total dietary iron, and as in the case of protein, most of the iron is from plant sources. Fruit intake to enhance iron absorption was observed to be negligible and this could precipitate poor iron utilisation.

There was an improvement, however, the in the major fish season (Table 16) over the iron intake of these children as more than half met their requirement for iron. The percentage iron from animal source ranged from 6 - 15% of the total dietary iron. The difference in iron intake for the two seasons was statistically significant ($p<0.001$) as shown in Appendix xiii.

Dietary iron intake was good in the children in the major fish season. A possible reason that can be assigned to this is the increased amounts of fish consumed by these children in the major fish season. As a fishing community, most of the children met their protein levels of RDA however this correlated weakly with growth shown as by anthropometry. This could be due to the fact that most of the protein also came from plant sources as shown by various percentages from animal as well as plant sources.

Table 15 Percentage of children meeting various levels of RDA for iron (lean fish season) (%)

Age	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	10mg	8	37	41	14
3		3	19	47	31
4		0	18	27	55
5		16	19	17	50
Total		4	24	32	40

(n = 336)

Table 16 Percentage of children meeting various levels of RDA for iron (major fish season) (%)

Age	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	10mg	8	13	27	52
3		0	16	27	58
4		0	11	31	58
5		2	14	23	60
total		2	13	27	57

(n = 274)

4.2.4 Vitamin A intake

Vitamin A is essential for a variety of biological processes, many of which are related to growth, cellular differentiation and interactions of cells with each other in the extracellular matrix (Robert and Sporn, 1984; De Luca, 1991). The molecule is well conserved in the body and as it maintains the integrity of cells, is referred to as the anti-infective vitamin (Robert and Sporn, 1984). Vitamin A is required for vision, maintaining the integrity of membrane structures, reproduction, growth and development, and for immune function (Karr *et al.*, 1997). Even in its relatively early stages, vitamin A deficiency results in impairment of linear growth, cartilage and bone development and epithelial cell differentiation and function, and in reduced vision in dim light. Furthermore, no nutritional deficiency is more consistently synergistic with infectious diseases than vitamin A (Robert and Sporn, 1984). Marginal status of vitamin A is often worsened by infection and reciprocally poor vitamin A status is likely to prolong or exacerbate the course of illness (Scrimshaw, 1968).

In the lean fish season, 42% of the children aged two years and 52 % of those aged three, met their RDA for vitamin A with 43% and 34% of the same age meeting their requirements marginally (Table 17). For those aged four and five, 68% and 71% respectively met the requirements for vitamin A and 25% and 18% respectively showed marginal intake of vitamin A.

Table 19 shows an increase over the lean season intake of vitamin A for the children aged two and three years (58% and 59% respectively) with a decline in those children aged four and five (52% and 63% respectively) years. There was no significant difference in the vitamin A intake for the two seasons (Table 24).

Table 17 Percentage of children meeting various levels of RDA for vitamin A(Baseline/lean fish season)

Age	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	400RE	4	11	43	42
3		3	10	34	52
4	500RE	2	5	25	68
5		3	7	18	71
total		3	8	30	58

(n = 336)

Table 18 Percentage of children meeting various levels of RDA for vitamin A (Major fish season)

Age	RDA	< 25% of RDA	≥25 - ≤50% of RDA	≥50 - ≤ 75% of RDA	>75% of RDA
2	400RE	3	13	26	58
3		5	8	28	59
4	500RE	2	6	39	52
5		4	5	28	63
Total		3	8	30	58

(n = 274)

4.2.5 Food security status

The concept of food security has been perceived by many as something grandiose, but that is not the case. Food security simply refers to one's access to adequate food whether physically (own stock) or through purchases on a constant basis to maintain good health and for children's positive growth. With children, access to food is regarded as what they obtain from their parents (either given them or purchased with money) to satisfy their food needs. This access is determined by the economic capability of the parent or size of available food stocks to supply food at all times to the child. Monitoring food intake over time can bring one as close as possible to physical access to food. What can guarantee sustainability of this access in the case of children is the level of income of the parent to maintain adequate dietary supply. In this study, access to the main staples (maize and cassava) was through purchases from the market, and with the occupation of the parents mainly in the informal sector (Table 4) the economic access to food for these children is already threatened.

Although a concise index for measuring food security is yet to be determined, proxies have been used to determine 'access to food'. The Dietary Adequacy Ratio (DEAR), a dietary related index for measuring food security was used by Armah-Klemesu *et al.*, (1995) and NMIMR (1997). Meeting 80% of RDA for energy was considered the yardstick for assessing caloric availability and hence food security.

In the lean fish season, less than half of the children met more than 80% of their RDA for energy (Table 19). In the major fish season, more than half of the children aged two and three met more than 80% of their RDA for energy, an increase over the lean season's. With those aged four and five years, there was a decline as about a fifth met their RDA for energy.

As a proxy indicator for food security, one can argue that meeting more than 80% of RDA for energy alone even on a continuous basis does not guarantee adequate intake of other nutrients. Therefore, adequacy of nutrients such as protein, and some micronutrients (discussed earlier) could also be included to give a more complete picture of access to food considering the attributes from food instead of just nutrients of supplements.

Table 19 Percentage of children meeting more than 80% of RDA for energy.

RDA	Age	Lean season	Major season
1160	2	21	52
	3	40	62
	total	38	57
1500	4	30	26
	5	35	19
	total	40	22
Grand Total		32	41

4.6. Anthropometric assessment

4.7. Stunting

Stunting is being short for one's age. According to the ACC/SCN (1997), the percentage of stunting in children 0-5 years should be reduced to less than 20% both at the national level and within subgroups by the year 2020. The anthropometric results (Fig. 1) and (Table 20) showed that at baseline, as many as 49% of the children living in this community were stunted. Stunting is a process that can begin in-utero and continues to about three years after birth (ACC/SCN, 1997). Stunting prevalence of the children was the highest among the indicators of undernutrition and more girls were affected by stunting than the boys for all ages (Fig.1). Stunting was also observed to increase from the age of two, fall after the age of three and rise again thereafter. This disagrees with the findings of the GDHS (1993) that stunting improves after the age of three. About half of the stunting is of the severe form (less than –3 standard deviations) in both male and female. This also imply that a lot of damage has already taken place in these children as stunting occurs early in life (ACC/SCN 1997) and after the age of three, catch-up growth is minimal. This leaves the children with serious incapabilities such as reduced adult size and work capacity, which invariably affects economic productivity.

Obstetric complications due to small pelvic size is the result of early stunting in female children (ACC/SCN 1997). With small women, low birthweight infants are most likely to be born and a vicious cycle of a small-stature generation is started. Stunting is also implicatd in impaired mental function (ACC/SCN 1997) but a recent study has shown that children under such circumstances mentally adapt to suit circumstances in their environment (Grange, 1994).

In addition, as many as 27% show severe forms of stunting which is high by any standard. In a well-nourished population, it is expected that 1 in 1000 (0.1%) will be severely undernourished (GDHS, 1993). However, in this study, over half of the stunted population showed severe stunting. In a study by Black *et al.*, (1984), diarrhoea affected linear growth by 20% and this could be compared with the results of this study.

An inverse relation was also between diarrhoea and height ($r = -0.157$).

Table 20: Baseline/Lean fish season anthropometric data:

AGE	SEX	HAZ: Stunting		WAZ : Underweight		WHZ: Wasting	
		%<-2sd	%<-3sd	%<-2sd	%<-3sd	%<-2sd	%<-3sd
2	M	31	14	26	9	8	2
	F	47	24	47	24	12	9
Total		36	17	33	14	9	3
3	M	23	14	16	5	5	2
	F	77	52	57	18	5	0
Total		50	33	36	11	5	1
4	M	44	23	36	10	3	3
	F	54	20	34	12	5	2
Total		49	21	35	11	4	3
5	M	54	22	30	12	2	2
	F	66	43	34	14	0	0
Total		60	36	32	13	1	<1
Grand Total		**49**	**27**	**34**	**13**	**5**	**2**

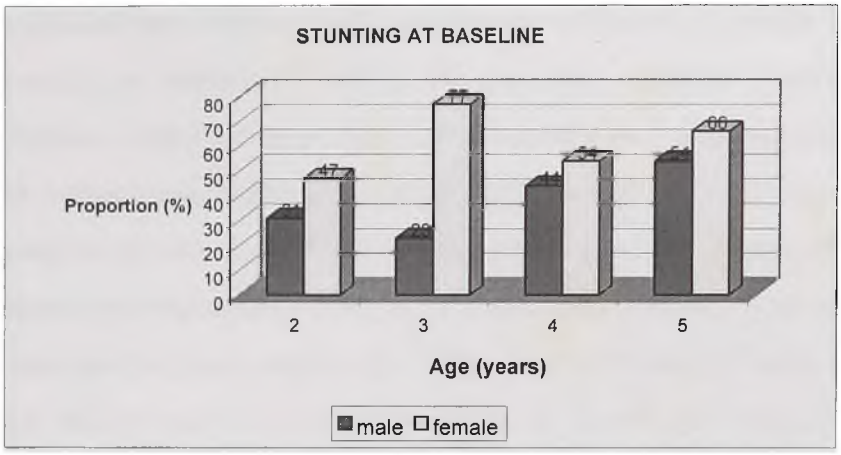
n = 336

Table 21: Major fish season anthropometric data:

AGE	SEX	HAZ: Stunting		WAZ : Underweight		WHZ: Wasting	
		<-2sd	%<-3sd	%<-2sd	%<-3sd	%<-2sd	%<-3sd
2	M	26	16	19	6	10	3
	F	33	16	27	11	16	0
Total		32	18	25	9	14	2
3	M	30	9	12	3	9	3
	F	59	47	34	19	6	0
Total		45	28	23	11	8	2
4	M	37	15	27	7	10	0
	F	38	24	26	12	9	0
Total		37	19	27	9	9	0
5	M	59	39	41	11	7	0
	F	65	40	32	8	3	3
Total		62	39	37	10	5	1
Grand Total		**46**	**27**	**29**	**10**	**8**	**1**

n = 274

Fig. 1



4.3.2 Underweight

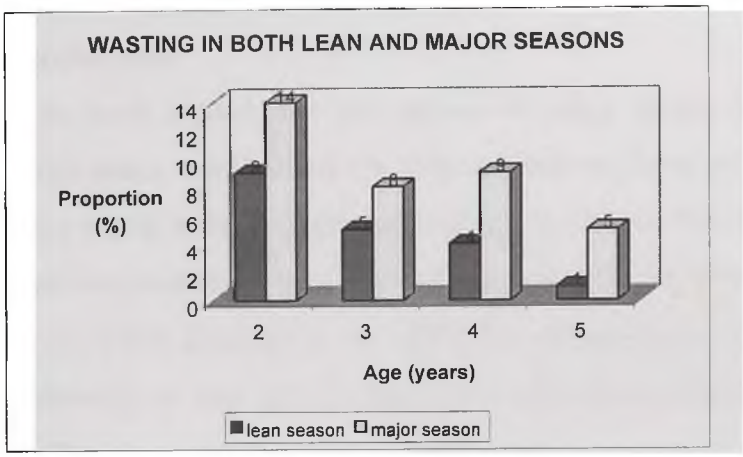
Underweight prevalence, which is used as the main index for undernutrition was high in this study, with 34% being underweight and about a third of that number (13%) showing severe forms at baseline (lean fish season) as shown in Tables 20 and 21. Moderate forms of undernutrition alone then mean that 21% are moderately underweight and with the rather large numbers involved, both the severe and moderate forms need to be addressed (FAO, 1996).in the major fish season (Table 21) underweight improved to 29% and 10% for both moderate and severe forms and severe alone respectively. This can be explained by the weight recovery, which tend to occur when prices of staples fall (ACC/SCN, 1997). There was no significant difference though in weight ($p > 0.5$) for the two seasons. Underweight prevalence was equally high in these children, with more female children being affected than males at the ages of two, three and four. More males were affected at age five than females. About a third of the children form all the age groups presented with severe forms of undernutrition (less than –3 standard deviations).

4.3.3 Wasting

Wasting, as an indicator, reflects current status of undernutrition and also a proxy for food security status. This study shows that wasting decreased with increasing age in the lean season and this agrees with what was found in the GDHS (1993). The report indicated that children's acutebut not chronic undernutrition improves in the third year of life. At this age, the children are on their own diet and can choose their own foods unlike earlier years when they had no influence over their food. After four

months, wasting was found to have increased in the children, showing almost the same trend except for those aged three years ($p = 0.001$). Since wasting is also affected by height as does stunting, it is no surprise that the prevalence rose above that of the baseline values. The index wasting, as an indicator of food security is desirable, as it indicates what the food is translated into i.e. a nutritional outcome. In this study more of the children showed wasting in the major season meaning the children are not food secure.

Fig.2:



4.4.0 Biochemical data

4.4.1 Serum ferritin

Most authors have argued that the choice of using serum ferritin to determine iron status is of limited use. Others however, have endorsed its use indicating that it is the only method that enables one to determine iron depletion and iron overload which cannot be provided by any other method (Salvioli *et al.*, 1991; Dallman *et al.*, 1980). Serum ferritin is a protein in which a reservoir of iron can be stored for subsequent metabolic use (Brock, 1989).

Although decreased levels of iron stores are usually not associated with adverse physiological consequences, a vulnerable state is represented (ACC/SCN, 1997) hence the importance of prelatent iron status determination. Using a cut off of <50μg/l proposed by Romslo (1990) as the practical guideline for depleted iron stores, as many as 75% of the study population present with exhausted iron stores (Table 22). Infection status using the positive acute-phase proteins (c-reactive proteins, $\alpha_1$glycoprotein or orosomucoid, etc) could not be done and this means that the interpretation of the ferritin results need to be done with some caution. High ferritin levels may be indicative of previous infection, which may persist for as long as ten days (Wickramasinghe et al., 1985). By the location of the community on the leeward side of a major industrial area /estate, the children were expected to show very high ferritin levels but this was not obvious using the cut-off proposed by Romslo (1990). They are at risk of exposure to factory exhaust and the use of other biochemical markers could have been useful in this case.

Iron intake was good but as to whether utilisation was optimum is very difficult to determine at this stage. Due to the wide variations observed, the standard deviations are rather high (Table 22).

Table 22 Mean and range of serum ferritin of children 2-5 years

Age	(n)	Mean (± s.d).	Range	% <50µg/l
2	24	31.5 (31.1)	4.5 - 154.3	88
3	36	36.5 (28.2)	7.7 - 146.5	86
4	26	46.1 (26.7)	4.5 - 103.4	54
5	27	43.0 (31.9)	4.5 - 144.6	67

4.4.2 Serum retinol binding protein (RBP)

The level of RBP is constant in the body except in extremely low cases of vitamin A intake. Conditions that decrease RBP concentration in the blood include ith retinol binding protein, low levels of this carrier protein can be found in vitamin A deficiency, zinc deficiency and hepatic disease (Donnen *et al.*, 1996), malnutrition and renal disorders (Mastroianni 1998). The most sensitive indicator of vitamin A is measurement of liver vitamin A but since this is not feasible, others have been used.

The result of this study reveal that as 12%of the children were below the lower reference limit of 18µg/l for RBP (Karr *et al.*, 1997) but no information on whether the figure is of public health significance could be found. Serum retinal determination in these children could have been an added advantage but this was not possible. This notwithstanding, the range of serum RBP found in these children could be compared to those of

normal; Australian children (Table 3). This could also be attributed to the good amounts of vitamin A consumed by these children in both seasons. Although the infection from diarrhoea was high, the serum levels of RBP in these children being within the good range could be due to the fact that the children were not on marginal vitamin A status and hence, not at risk of vitamin A deficiency.

Table 23 Mean and range of retinol binding protein of children 2-5 years

Age	(n)	Mean (± s.d).	Range	% <18µg/l
2	24	38.3 (15.6)	8.7 – 75.5	8
3	36	34.8 (26.7)	9.5 –125	19
4	26	37.4 (15.2)	14.5 – 81.9	7
5	27	29.8 (11.9)	10.3 – 62.8	4

CHAPTER 5

5.0. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

For sound nutritional well-being, one needs a constant supply of food and he/she must also be in good health to benefit from the food. In this study these conditions were not entirely met, although most of the children met their dietary requirement for protein, iron, vitamin A and in some cases energy. There was a shortfall in the minimum requirement for especially energy to declare one as food secure. With most of the children supported by parents having occupations in the informal sector, coupled with the dwindling fish catches, their nutritional status seem not to improve and the rather poor sanitation conditions could also compromise the nutritional status of these children.

The anthropometric results show very high prevalence of undernutrition which could have been aggravated by the effect of diarrhoea on nutritional status. More females than males were found to be stunted and this could lead to a progeny of not only short statured-children but children with other forms of non-physical incapabilities.

The children in this fishing community are not having enough to eat and the rather insecure jobs of their parents, seems to threaten the sustainability of constant food supply. The poor sanitation affects the food consumed and thus, is translated to a poor health outcome reflected by a high prevalence of undernutrition.

It can therefore be concluded that the children are not food secure and their nutritional status is poor.

5.2 RECOMMENDATIONS

The following recommendations have therefore been made:

- Children in other fishing communities could also be studied for comparison;
- An educational campaign be carried out in the community on the attributes of good sanitation;
- Further studies on the immunocompetence of these children should be done to ascertain the threshold of serum protein and other biochemical markers;
- Infants and young children should be targeted in a short-term nutrition intervention programme such as food supplementation;
- All women of child bearing age should also be targeted to forestall stunting in the community.

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Appendix

appendix i. The enzyme linked immunosorbent assay (ELISA)

For the assessment of serum ferritin status in populations is of interest in recent times. The volume of sample required is about 10 µl of serum to permit the measurement of capillary samples. The technique used in the design aims at maximum sensitivity in iron deficient range of serum ferritin levels thus serum ferritin samples > 100 µg/l within the working range of a standard curve

(Fidanza 1991). Enhanced sensitivity and reproducibility at low ferritin levels have been achieved by using monoclonal antibodies while using polyclonal antibodies reduced sensitivity by a factor of 4-2µg/l.

The ELISA procedure employs the use of microtiter plates which permits the efficient processing of large number of samples with the availability of an automatic plate reader. In the absence of a reader satisfactory results have been obtained by transfering the contents of each well from the plate to a cuvette (micro) for individual readings spectro-photometrically. Although there is limited experience with the use of ELISA, some advantages include the rather short time in obtaining results and the avoidance of radioisotopes, employed by other methods.

appendix ii. CHECKLIST

DEPARTMENT OF NUTRITION & FOOD SCIENCE
UNIVERSITY OF GHANA, LEGON

Name of community:
Location:
Setting:
Brief history of the community: (use separate sheet)
(origin, ethnic groups, etc)

1. Estimated population of the community:

2. % children (below 5 years) .....

3. Sex ratio (from total population)

4. % of population in fishing .....

5. Age group in active fishing :
6. Major fishing season (months) :
7. Minor fishing season (months) :
8. Main type of fish(es) and shell fish caught (list):

b Mode of processing fish for home consumption :
" " " " " sale :
Marketing points :

9. Crop production activities engaged in.:

10. Natural resources:

appendix iii. **HOUSEHOLD COMPOSITION**

DEPARTMENT OF NUTRITION & FOOD SCIENCE
UNIVERSITY OF GHANA , LEGON

FORM 1- Household Composition

House No: ..... Respondent..... Date .../...../.... Householdhead.....

Household no.	ID	NAME (of children 2-5)	DD MM YY	Sex 1=M 2=F	Birth Order*

*Birth order refers to children of the same mother

appendix iv. **HOUSEHOLD CHARACTERISTICS**

Household No: ..... Respondent..... Date .../...../....

1 What is the ethnic group of the caregiver?	1 Ga 2 Akan 3 Ewe 4 Other	-----	5 Do you own or rent your house?	1 Own 2 Rent 3 Other	----- ----- -----
2 Is caregiver away from home more than he/she is at home?	1 Yes 2 No	-----	6 What kind of fishing activity does this household engage in?	1 Ring net 2 Hooking 3 Seine net 4 Other	 -----
3 If yes where is the caregiver?	1 Local 2 Tema 3 Accra 4 Other parts of Ghana 5 Outside Ghana	-----	7 a. What is the primary occupation of head of household? b. What is the secondary occupation of the head of household? c. What is the primary occupation of caregiver if she is not the head of the household?	1 Fisherman 2 Manufacturing worker 3 Trader 4 Professional 5 Sick / Handicapped/ Retired 6 Unemployed 7 Other (specify)	a --- b -- c ---
4 Can caregiver read a letter or newspaper?	1 Yes 2 With difficulty 3 No	-----	8 a How many sleeping rooms are in this house? b With how many persons do you stay in your room?	a Indicate number b Indicate number	----- ----- -----

Appendix v. **HEALTH AND SANITATION FORM**

1 Did you immunize your children against all six childhood killer diseases	1 All 2 Part 3 None	---- ---- ----	6 How often do your child(ren) get diarrhoea?(Please specify)		
2 Is your child (ren) coughing now?	1 Yes 2 No		7 How many times a day does the child pass watery stools?		
How long has your child(ren) been coughing? (please indicate)		------ -	9 Does your child have measles now?		
4 when was the last time your child(ren)had malaria ?		-----	10 What is the location of the house? b. what are the floor conditions of the household?		
5 Does your child have malaria now?	1 Yes 2 No	------	What are the conditions of vessels for food and water? How is water and food handled?		

*Check weighing card

appendix vi. **24 HOUR RECALL SHEET** Date:..... . House no. Household ID.....

Child's ID:

	Day of week		Day of week		Day of week	
MEAL	FOOD	AMOUNT	FOOD	AMOUNT	FOOD	AMOUNT
BREAK-FAST						
MORNING SNACK						
LUNCH						
AFTERNOON SNACK						
SUPPER						

Is this the usual intake ? Yes..... /No..... If no, why ?.....

Is child/chidren on drugs? Yes..... / No.....

If yes what type ? Analgesics..... Iron..... Antimalaria.....

Multivitamin..... Anthelmintics..... Other.....

appendix vii. Anthropometry sheet

H/H No	Name	ID	Weight / Kg	Height / cm	Health status (s = sick, ns = not sick)

***Sick:** Malaria/ Diarrhoea / Measles/ Other

appendix viii. **Statistical applications: comparing various variable for lean and major fish seasons**

Variable	**T- test statistics**
Weight	0.268
Height	0.048
Energy intake	4.209
Protein intake	3.31
Iron intake	0.0002
Vitamin A intake	3.14