NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: NSS 302

COURSE TITLE: Nutrition in Health & Disease

Course Code	NSS 302
Course Title	Nutrition in Health & Disease
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COURSE GUIDE

NUT-302: Nutrition in Health & Disease

- **What you will learn**

In the next series of lectures, you will learn about the following topics:
An **Introduction** to the entire course, followed by the **Historical Perspectives and General Definitions** (Nutrition, Health, Disease, Food, Food Groups, etc.). This will be followed by the **Food Classification** (Why and How, Which), **Food Presentation, purchasing and preparation**, **Formulation of Special Diets**, **Nutritional Diseases** and how some of these are prevented: (Energy-related Diseases, Vitamin-related Disease, Mineral-related Diseases, and Nutritional Excesses). This will be followed by a discussion of the **Principles of the Management of Nutritional Diseases**.

- **Aim of this Course**

The aim of this course is to provide the basic understanding needed for a full appreciation of the importance of human nutrition in public health. Consequently, the objectives of the course will be the realization of this goal.

Course Objectives

- to create an awareness on principles of formulating diets to meet different nutritional needs (weaning and therapeutic diets).
- to explain nutrition terms which are often misunderstood by the lay person.
- to teach the basic concepts of the course, in the light of the current societal health issues and problems.
- to explain and illustrate how proper food selection can contribute to optimal nutrition, especially when food is scarce (out of season) or its price is expensive.
- to explain how inadequate or poor nutrition can lead to poor health or disease condition.
- to explain the problems associated with nutritional excesses.

- to explain and illustrate how proper food selection (good nutrition) can change the course and duration of an illness or disease.

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Set textbooks for this course

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Fleck, H. (1976). Introduction to Nutrition, 3rd Edition, Macmillan Publishing Co., Inc., New York, USA.

3. Schneider, HA, Anderson, CE and DB Coursin (1977). Nutritional Support of Medical Practice, Harper & Row Publisherssss, MD, USA.

4. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

5. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins, Baltimore, Maryland, USA.

6. Sizer, FS and EN Whitney (2003). Nutrition: concepts and Controversies, 9th edition, Thomson Learning, Inc., Belmont, California, USA.

7. Townsend, CE (1980). Nutrition and Diet Modifications, 3rd edition, Delmar Publishers, Albany, N.Y, USA.

Tutor-Marked Assignment

Unit 1

In spite of the current wide knowledge of nutrition, there are still many myths about foods in the Nigerian culture. Discuss

Unit 2

Describe in not more than 100 words any **4** of the following nutritional diseases

(a) Beriberi
(b) Goiter
(c) Marasmus,
(d) Kwashiorkor
(e) Obesity;

Unit 3

Write briefly on the following:

- High nutrient density food
- Breast milk,
- Utilizable proteins in legumes

Unit 4

Describe in clear terms the following common forms of food contamination/poisoning

- Salmonellosis,
- Staphylococcal poisoning,
- Dysentery.

Unit 5

Describe how the nutritional status of a child impinges on his future health status.

Unit 6

Differentiate between Primary Nutritional Deficiency and Secondary Nutritional Deficiency.

Unit 7

Describe the causes and measurement of Obesity in a human population.

Unit 8

B. What are some of the methods currently employed by the WHO to stem down the dangerous trend in the prevalence of keratomalacia and rickets?

Unit 9

Iron-deficiency anemia is one of the commonest nutritional diseases among women. Discuss this statement with relevant examples..

Unit 10

Briefly describe the different forms of excessive intake of nutrients commonly encountered in Nigeria.

Unit 11

Briefly describe the principle which determines the construction of a prescribed diet.

Unit 12

What is Food Security?

Suggest viable and realistic measures that can be taken to feed the food-deficient populations around the world.

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Unit 1: Introduction and Historical Perspectives

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1.0 Introduction

Human Nutrition touches on virtually every aspect of human endeavor, as it is of central importance to health. Where studies have been carried out (and observations made), it has been found that differences in growth and well-bring often result from diets consumed. When a man is in good health, nutritionally, he feels good. He has vitality (he does not tire easily) and he is healthy. He is emotionally stable and enthusiastic about life. When one is well-nourished, it reflects in one's appearance and behaviour. Generally, his posture is good; his muscles are firm, with only a small amount of fat covering. His complexion is clear, and his eyes sparkle and he is intelligent.

On the other hand, when one is undernourished, he is inclined to tire easily (he lacks stamina), to be irritable and to get easily anxious. In general, such people are much more susceptible to illness. Such people frequently are unaware of the fact that poor eating habits may be the root of their difficulties. Furthermore, there are long-term effects of such habits on their lifespan and productivity. Within a nation, the long term effect of poor nutrition may

reflect in the overall height, weight, productivity and longevity of the nationals. As one can observe, even at the community level, the children of the rich most often look better and do better in life than the children of the poor whose poverty is often reflected in what they eat. The children of the rich usually grow faster and taller than the children of the poor. Also, urban dwellers, who do less work, on account of their exposure to modern facilities, are most usually more attractive, fatter and more robust than their rural counterparts, who do not enjoy these facilities. The latter often age prematurely

The conclusion that can be drawn from all these, is that the kind and amount of food consumed by a person have a great influence on his well-being. Thus, the appearance of a man is a reflection of what he eats.

2-0 Objectives

At the end of this unit you will be able to:

- appreciate the history and importance of nutrition to man.
- Describe the historical perspectives of human nutrition.

3.0 Main Content

3.1 Introduction

If man must succeed in his quest to overcome the problem of hunger, he should start by taking a retrospective view of his past as a guide for the future. An author once remarked,

> *"what little we know, what little power we possess, we owe to the accumulated endeavors of our ancestors."*

The oldest human records indicate that there was an awareness of the relationship between what we eat and what we are - and that food supplies the energy of life, becomes a part of us as well as change us. Indeed, it takes little science to learn that we feel good when we eat and bad when we go hungry. Man also learnt early to know that those who have plenty of food are likely to have fewer episodes of sickness. Furthermore, man learnt which foods can be consumed and which ones are poisonous. For example, our local people know which mushrooms can be eaten, and which ones are not to be eaten. However, if one knows that certain potato tuber is safe and nourishing, he might not be able to tell if the potato leaves are

poisonous. Thus, such knowledge is valuable for human existence, but it may not provide the basic understanding of how foods function. Yet the primitive people endowed foods with magical powers and believed that qualities of the food could be transmitted to the eater. This is why certain primitive people believed, for example, that if they ate the genitals of the hunted animals they would become more sexually potent. Others believed that if their pregnant women ate certain animal foods, they would bear children who would resemble these animals.

Activity 1

Select the best statement among a-e that completes the sentence in question:

1. The overall physical appearance of a man is mostly a reflection of
   (a) the clothes he wears;
   (b) the kind of car he rides;
   (c) what he eats;
   (d) his speech;
   (e) his ethnic background.

2. A well-nourished individual has the following characteristics:
   (a) good posture;
   (b) clear complexion;
   (c) sparkling eyes;
   (d) all of the above;
   (e) none of the above

3.2 Historical Perspectives

More than 10,000 years ago, before agriculture came into existence, man lived in a hunting-gathering society. He survived mostly on fruits, vegetables and nuts, and very little or no animal foods. Today most of the few remaining hunting-gathering societies left in the world still live largely on vegetables and fruits, with little animal foods. Among the Kung Bushmen of Northern Botswana, for example, there is very little contact with modern civilization. In

this hunting-gathering society, hardly can one find an obese individual among the people. Indeed, they tend to be undernourished and energy-deficient particularly at the end of the dry season. Their infants do not experience malnutrition as they are breast-fed exclusively. Their adults, too, hardly experience malnutrition except after illness or injury. Due to the lack of salt in the diet of the Bushmen, age-dependent hypertension and high blood pressure are nonexistent, unlike in civilized societies. Their plasma cholesterol levels are also very low, averaging 120 mg per ml. Their supply of meat is intermittent. Their animal protein sources, chiefly from wild buck and small wild animals such as hare, have little fat (which are predominantly PUFA) in their muscles. They depend mainly on vegetable foods, which account for more than half of their food energy, and are mainly mangongo nuts, rich in linoleic acid. Dental caries do not occur among them, as sugar consumption is nil. Their only sugar source is an occasional wild honey. The main causes of death, especially among the younger population are infections and accidents. They often walk long distances, with heavy loads. Their numbers are often small and stable. Thus, modern nutrition must therefore take off from these reference points.

Until the birth of writing, some 3,300 B.C., by the Sumerians of the Fertile Crescent, there had been no records of drugs and their corresponding ailments, or even the location of symptoms. The Egyptian hieroglyphics which came a little later, established these records. By the 4th century, what we may now regard as scientific medicine had begun in Ionia on the island of Cos. In these early periods, physicians were the nutritionists. For example, Hippocrates (460-364 B.C.), known as the “Father of Medicine” advanced the idea that sickness is best understood if one considered the whole patient and his environment and that successful treatment could be expected only if one used the beneficial experience of similar cases. But scientific experimentation was not the way of Greek philosophers, including Hippocrates; rather, it was logic. Hippocrates, in his typical Greek manner of logical reasoning, propounded some beliefs and made some remarkable observations which later researches depended on till today. For example, Hippocrates aphoristically believed, even at that early period, that

"persons who are naturally very fat are apt to die earlier than those who are slender."

He also noted that

"growing bodies have the most innate heat; they therefore require the most food, for otherwise, their bodies are wasted. In old persons, the heat is feeble and therefore,

they require little fuel, as it were, to the flame, for it would be extinguished by much...."

Hippocrates was said to have paid strict attention to the diet of his patients as a feature of his therapeutic regimens. In spite of the fact that Hippocrates was very much concerned with the diet of his patients, nutrition writers and physicians of his day usually paid very little attention to nutrition concerns and the uses of food in medical treatment. Furthermore, the anecdotal observations of Hippocrates were not given much regard in scientific circles. Indeed, from his writings, it was obvious that foods were to him what one can now categorize as items of pharmacology. Thus, in spite of his concern for the therapeutic nature of foods, Hippocrates was not to be regarded as the Father of Nutrition. It is indeed clear to modern nutritionists that Hippocrates had little understanding of the nature of nutrition, and he held some groundless opinions about quality in foods.

Nevertheless, the Hippocratic view that there was but "*a single essential in all foodstuffs, with foods varying only in the amount of this single aliment*" that they might contain, lasted until the 18th century. In the meantime, Aristotle summarized the Hippocratic view in the following words:

> *Either because of the quality of things taken or through their diversity or because the things taken happen to be strong and difficult of digestion, residues are thereby produced…And when the things that have been taken are of many kinds, they quarrel with one another in the belly, and … there is a change into residues … From the residues arise gases, which having arisen, bring on disease.*

For more than 2000 years, nutrition has been viewed as a dominant force in medicine. The Hippocratic view of a single aliment gave way to the forceful chemico-analytic era of Liebig, Mulder, Lavoisier and Magendie. Their endeavors culminated in the discovery of four chemically-defined categories of substances: proteins, carbohydrates, fats and minerals.

It was Antoine Laurent Lavoisier (1743-1794), with his experiments in guinea pigs and his laboratory assistant, who was able to demonstrate the similarity between animal and man and thus became known as the Father of Nutrition. He repudiated the earlier theory of phlogiston, propagated by Stahl (1660-1734). He brought together the findings of his predecessors to

explain the phenomenon of respiration. Later in the same era, it was Magendie who first distinguished between the different kinds of foodstuffs. Although these advances were made possible by agricultural chemists, Western medicine quickly embraced the biologic era, with the univalent concept of etiology of diseases (i.e. one dietary deficiency, one disease) as with the univalent etiology of infectious diseases (i.e. one pathogenic microorganism, one disease). Thus, the idea that a disease could be caused by a lack of something as well as by the noxious and pathogenic presence of something was a revolutionary idea and was first clearly demonstrated for human beriberi in 1897. The demonstration of human beriberi was followed by Funk's broader generalization of 1912 that not only beriberi, but also scurvy, pellagra and rickets were caused by a lack in the diet of "special substances which are of the nature of organic bases, which we call vitamines." Other scientists of this era include F.G. Hopkins (1861-1947), J.Drummond (1891-1952) and McCollum, 1879-1967) among others. It is to be noted that the most basic nutrition research had been concluded since 1900. However, the first protein structure was not fully described until 1945. In spite of the current wide knowledge of nutrition, there are still many myths about food in the Nigerian culture. For example, is there any health advantage of consuming honey instead of refined sugar? Your class will be requested to supply as many myths as you can bring to class. Nutrition has come of age, having being recognized as an independent field of study since 1926. Kruse later remarked that

"there is no branch of medicine that does not have some aspect of nutrition within its domain."

Activity 2

3. Within a nation, the long term effect of poor nutrition may result in all **but one** of the following:
   (a) the overall height of individuals;
   (b) their average weight;
   (c) productivity;
   (d) population explosion;
   (e) longevity of the nationals.

4.The following statements aptly describe the primitive hunting-gathering societies, **except** :

(a) the people thrive on fruits, vegetables and nuts, and very little or no animal foods;

(b) hardly can one find an obese individual among the people;

(c) their infants usually experience malnutrition as they are not breast-fed exclusively;

(d) they tend to be undernourished and energy-deficient particularly at the end of the dry season;

(e) due to lack of salt in their diet, age-dependent hypertension and high blood pressure are nonexistent.

4-0 Conclusions

The history of man is intractably linked to his food, his feeding habits and the role that these play in his health. This relationship is modified by food availability and his state of health. When food is in short supply his health suffers and when food is abundant, his health is robust.

5.0 Summary

Human Nutrition touches on virtually every aspect of human endeavor, as it is of central importance to health. When one is well-nourished, it reflects in one's appearance. The individual has vitality (he does not tire easily). He is emotionally stable and enthusiastic about life. On the other hand, when one is undernourished, he is inclined to tire easily (he lacks stamina). He is irritable and gets easily anxious. In general, such people are much more susceptible to illnesses. Furthermore, there are long-term effects of poor feeding habits on the lifespan and productivity of a people and a nation. Within a nation, the long term effects of poor nutrition may reflect in the overall height, weight, productivity and longevity of the nationals. Thus, the kind and amount of food consumed by a person have a great influence on his well-being, since his appearance is a reflection of what he eats.

6.0 Answers to Exercise/Activity

1-(c)

2-(d)

3-(c)

4-(b)

7.0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Fleck, H. (1976). Introduction to Nutrition, 3rd Edition, Macmillan Publishing Co., Inc., New York, USA.

3. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

4. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins, Baltimore, Maryland, USA.

Unit 2: General Terminologies and Definitions (Nutrition, Health, Disease, Food, Food Groups, etc.).

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1-0 Introduction

Definitions, by nature, tend to establish frame-works for understanding a body of knowledge. They can be likened to the open windows/doors to a house. Therefore, this unit will concentrate on the minor and major definitions. As the rest of the entire course depends on a proper understanding of this segment, it establishes the relationship between man's health status and what he eats.

2-0 Objectives

At the end of this unit you will be able to:

- define the commonly used terms and terminologies in human nutrition,
- differentiate between malnutrition and nutritional disease,
- recognize specific nutritional diseases.

3-0 Main Content

3.1 What is Nutrition?

The most acceptable definition of nutrition is the one given by Robinson at the Congress of the American Medical Association in 1966 as

> ***the branch of science which deals with food, the nutrients and other substances therein; their action, interaction and balance the processes by which an organism ingests, digests, absorbs, transports, utilizes and excretes food substances in relation to health and disease .***

It has also been observed that *"nutrition must also be concerned with the social, economic, cultural and psychological"* factors relating to food consumption, food production and distribution. However, for an individual, nutrition represents an accumulation of the eating habits formed throughout a life-time. They vary from individual to individual and from one culture and geographical environment to another. Thus, they are molded by the availability of food, food preferences and culture. In this text, nutrition may be defined simply as *"the science that interprets the relationship of food to the functioning living organism."*

3.2 What is Health?

The WHO has defined health as **"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity**." On account of the fact that this WHO definition is virtually unattainable in a real world, the definition of health today is turning towards the idea of *an optimum state of living effectiveness*. Thus, we have another definition of health which, in measurable terms, is *a state characterized by anatomic integrity, ability to perform personal valued family, work and community roles; ability to deal with physical, biologic and social stress; a feeling of well-being; and freedom from risk of disease and untimely death*. It is a state of equilibrium between humans and the physical, biologic and social environment, compatible with full functional activity. Thus, in the language of nutrition, the attributes of an optimally healthy (well-nourished) individual are predicated on correct eating-habits which result in a well-built body (right weight and height for age, barring the hereditary traits), which is energetic, good-natured and mentally alert.

Such individuals have clear skin, good eye-sight, and a head with plenty of hairs and a good appetite.

3.3 What is a Disease?

A disease can be defined as an interruption, cessation or disorder of body functions, systems, or organs. N**utritional disease** is a state of health which arises from the deficiency (inadequacy), an excess or an imbalance of the supplies of nutrients and/or calories. It can be classified into two namely primary and secondary diseases. For example, a disease which directly results from a lack of a certain nutrient is called a deficiency disease, e.g. beriberi, which is due to the lack of thiamin (vitamin $B_{1)}$. This differs from malnutrition in that in the malnourished state, the expression of a disease condition may or may not become so obvious as in the disease state. Simply, malnutrition means bad nutrition. The nutritional diseases commonly encountered include Beriberi, Pellagra, goiter, Ariboflavinosis, Dental caries, rickets/Osteomalacia, Kwashiorkor, Marasmus/Starvation, Nutritional Anemias, Xerophthalmia/keratomalacia and obesity.

Activity 1

Select the letter that precedes the best answer among the following statements:

1. The most acceptable definition of nutrition includes **all but one** of the following:
   (a) the branch of science which deals with food, the nutrients and non-nutrients in the food;
   (b) the actions, interactions and balance of nutrients in relation to health and disease;
   (c) the processes by which an organism ingests, digests, absorbs, transports, utilizes and excretes food substances;
   (d) ethnic composition of a country;
   (e) factors relating to food consumption, food production and distribution.;

2. The modern definition of health should include **all but one** of the following:
   (a) an optimal state of living effectiveness;

(b) a state characterized by anatomic integrity, ability to perform personal valued family, work and community roles;
(c) ability to avoid physical, biologic and social stress;
(d) a feeling of well-being and freedom from risk of disease and untimely death;
(e) a state of equilibrium between humans and the physical, biologic and social environment.

3. The attributes of a well-nourished individual are predicated on **all but one** of the following:
   (a) correct eating-habits of three well-spaced meals per day;
   (b) being energetic;
   (c) consuming meals having more than 50% proteins;
   (d) having clear skin, good eye-sight, and a head with plenty of hairs;
   (e) having a good appetite.

3.4 What are Nutrients?

Nutrients are chemical constituents of food which must be supplied to the body in suitable amounts. They include the **carbohydrates**, **fats/oils**, **proteins**, **vitamins**, **minerals** and **water**. Carbohydrates, fats, proteins and water can be referred to as **macro-nutrients** since they are required in relatively large amounts. However, only carbohydrates, fats and proteins can provide energy. Proteins are chiefly responsible for growth, tissue repair and maintenance, while the vitamins and minerals mainly help to regulate chemical processes in the body. Water affords the body a means of transportation of most substances to and from the cells and for all cellular activities. In summary, nutrients can be said to function in three major ways: firstly, by providing the body with fuel for the release of energy; secondly, by providing the building materials for growth and upkeep of the body; and thirdly, by providing the materials necessary for the regulation of body processes, so that the body can use these to synthesize its own regulatory substances. On this basis, the above-named nutrients can be divided into three groups:

(b) Energy-giving nutrients, which are the proteins, the fats and oils and the carbohydrates;

(c) the body-building nutrients, which include the proteins, fats, carbohydrates, minerals and water; and

(d) the body processes regulatory substances, include proteins, minerals, vitamins and water only.

Under laboratory conditions, the essentiality of a nutrient can be established when

(i) a deficiency state occurs on a diet considered adequate in all respects except the nutrient under study,

(ii) the deficiency state correlates with sub-normal levels of the nutrient in the blood or certain tissues, and

(ii) there is a significant growth response in growing animals, in repeated demonstrations, after supplements of the nutrient under study

The interrelationship of nutrients may be compared with the molding of a cement block in which the best result is obtained when cement, sand, gravel and water are mixed in the right proportions. Thus, nutrients work best when teamed together, which can only be assured when an individual consumes a wide variety of foods. There are no less than 50 different nutrients known. It is the failure to consume adequate amounts of these nutrients that result in malnutrition (under-nutrition). Excessive consumption or an imbalance in their consumption can also results in overnutrition. When consumed in correct amounts and proportion, one is placed in the best position to maintain the highest level of health. On the other hand, a deficiency, an excess or an imbalance in the intake of these nutrients results in an aberration in health. A brief discussion of each of these nutrients, together with their functions and clinical applications now follows.

3.5 What is food?

The understanding of what food is has become so fundamental to the understanding of nutrition and dietetics, as many members of the health team often misrepresent it. Consequently, we shall devote a great deal of time to it. Food has generally been equated with body fuel since the time of the primitive man; and fuel was understood to be that which is burnt by the body to produce heat or power. Even today, the lay Nigerian makes reference to food in terms of its caloric content. In Nigeria, meals are named by its most preponderant carbohydrate content. For example, an American would eat ‘beef’, ‘lamb’, ‘pork’ ‘chicken’,

‘turkey’ or ‘fish’ for lunch, while his Nigerian counterpart would tell you that he eats rice, *amala, eba*. In this case, the protein-rich foods in the meal are not emphasized.

A food may arouse feelings of love, protection, strength, gladness, sadness, femininity, masculinity, poverty, prosperity, pleasure, power, sophistication, revolt or comfort. These feelings and associations arise from the cultural setting in which an individual lives, and from the experiences of daily living. The food that one eats is a very personal matter. Thus, most people resist eating a diet outlined completely and specifically by someone else. This may explain why negative comments and complaints about food are so common among students and inmates of institutionalized settings, and also illustrates the emotional and personal values people place upon selecting their own foods. Menus planned for groups of people may be nutritionally adequate in every way, and yet these menus may fail to allow for the fact that one or more of the foods included may not be eaten for cultural or personal reasons. Planned but uneaten foods serve no purpose. On the other hand, the foods that one eats may reveal a great deal of the origin of an individual.

Scientifically however, ***food is any substance (solid or liquid) which when ingested, provides the necessary raw materials for the structure and functions of life, thus enabling the body to carry out its life's functions***. Foods are the complex substances that make a variety of nutritive contributions to the diet of an individual and should be evaluated in terms of their total composition and not only for single nutrients for which they may be outstanding. The term *foodstuffs* includes any article which nourishes the body. No single foodstuff, except perhaps the breast milk in the first few months of life, can provide a complete diet. Man must therefore consume a variety of foods in order to consume all the nutrients needed by the body. It is generally believed that *when foods are selected from three or more food groups so as to satisfy the protein and energy requirements, all other nutritional requirements will be met*. On account of this, foods need to be classified in order to meet selection criteria. But you must remember that foods are not nutrients, although they contain nutrients.

On the basis of the above criteria, the following are the food groups recommended for all tropical regions of the world, including Nigeria: (a) the milk group, (b) the meat group, (c) the cereal group, (d) fruit/vegetable group and (e) tuber/fleshy fruit group. Detailed discussion of each of these food groups will be taken up in the next unit.

4-0 Conclusion

The bedrock of adequate nutrition and optimum health is the consumption of foods which donate their nutrients for body utilization. When foods are well-selected from a variety of food groups, there is every likelihood that an individual will be able to meet his/her requirements which can guarantee optimum health. However, under normal circumstances, an individual may not have access to more than three different food groups from a menu. It is generally believed that when foods are selected from three or more food groups so as to satisfy the protein and energy requirements, all other nutritional requirements will be met.

5-0 Summary

A number of definitions were discussed These include nutrition, health, disease, nutrients and foods. Nutrition ties up the remaining four subjects, as it interprets the relationship of food to the functioning living organism. Nutrients, which are the constituents of foods, must be supplied to the body in suitable amounts. The nutrients include the carbohydrates, fats/oils, proteins, vitamins, minerals and water. When there is a deficiency or excessive intake of any of these nutrients, a disease results. In Nigeria, a meal is named by its most preponderant carbohydrate content. But the contribution made by each food in the meal is as important as the other. These nutrients work best when teamed together.

6-0 Answers to Exercise/Activity

1-(d) 2-(c) 3-(c)

7-0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.
2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.
3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins, Baltimore, Maryland, USA.

Unit 3:Foods and Their Classification

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1-0 Introduction

The statement is often made that eating well means eating “a balanced diet”. But many people who use these words often do not know the basis of what constitutes a balanced diet. However, this understanding is so crucial such as to deserve a serious consideration. Basically, a balanced diet is one which includes all six nutrients in adequate amounts so as to preserve and promote optimal health. This understanding indicates that when one picks a set of foods, one is ensuring that these six nutrients are present in the required (recommended) allowances. Thus, the Recommended Dietary Allowance (RDA) for each nutrient ensures that when an individual consumes the specific amount of nutrient, he can be assured of optimal health.

2-0 Objectives

At the end of this unit you will be able to:

- Classify Nigerian foods by setting the criteria for a balanced diet.
- identify the five food groups,
- appreciate the various classification of foods.

3-0 Main Content

3-1 Food Classification

This is means by which foods are grouped according to their similarities. The grouping of foods in most health institutions in many parts of Africa, especially Nigeria, is based on the function(s) of the most preponderant component of such foods. Thus, foods are classified as "energy foods", "body-building foods", "protective foods" or "accessory food substances" very much in line with the earliest food classifications. This classification is obviously obsolete, inappropriate or even misleading in the light of our improved knowledge and understanding of foods and nutrition, for practically all common foods offer at least two or more nutrients (see table 1.1 below), and thus, each foodstuff contributes substantially to the overall nutritional balance of the individual. The value of any food depends on its nutrient content that is directly responsible for the value or functions assigned to it. In a community where the consumer's knowledge of nutrition and food and the resources for making a wise choice of the latter is rather limited, it is instructive to set out guidelines which can aid the consumer make these choices in order to meet the known nutritional needs. It is on the basis of these considerations that foods are classified.

The classification of foods is essential to the study of nutrition because by grouping together foods with similar nutrient content, it is possible to choose from a wide variety of alternatives if certain foods become scarce or money is in short supply. It includes choices that permit flexibility for seasonal, regional and budgetary considerations. Throughout the world, food groupings are used to translate nutritional needs into practical guidelines for food intake. These groupings are usually determined first and foremost, by their nutrient content. Thus, ***foods are grouped according to their similarity of nutrient content***. A food that has a high nutrient density is one that has a high proportion of nutrients to the amount of calories supplied.

In most tropical countries, the poor economy, the socio-cultural factors and geographical locations and distribution of food have combined to limit the food choices of families. In these places, people subsist on whatever food is available to them. While certain foods may be totally unacceptable in a particular culture, it may well be a means by which many subsist in another. Thus, snails, insects, squirrels, rats, lizards, camels, horses and dogs are consumed. However, several imported modified foods are finding their way to the

Nigerian/African table. Thus, *semovita*, macaroni and several other wheat and maize products are now available in local African markets.

Foods with high caloric densities have high proportions of calories for the amount of nutrient provided. In other words, such foods are high in fats, oils or sugar, but low in other nutrients, hence they are called "empty-calorie" foods. They are outside this classification.

This classification is a simple device used to outline the variety of foods that will provide a 'balanced diet' which include the essential nutrients. It goes without saying that no single food (not even milk) contains all the nutrients needed by the body in amounts sufficient to maintain life and promote a prolonged optimum growth. An individual must thus consume all the nutrients needed by the body from a variety of foods. Nevertheless, each food item supplies significant amounts of two or more nutrients. A cookie-eater who nibbles 10 chocolate chip cookies in a day, adds some 495 calories to his diet. He gets 5.7 g of proteins and almost 2 mg of iron (20% of male and 11% of female RDA for iron), a little vitamin A and some B-Complex vitamins. Therefore, most foodstuffs offer body building, energy and 'protective' properties depending on their quality (nutrient densities), quantity consumed and the physiological state of the individual consuming them. For example, while eggs, meat and milk might offer excellent proteins, with body building qualities, they, especially meat, also provide substantial amounts of energy, derived from their fat content as well as from the proteins. They may therefore provide greater amount of energy than the so-called energy (carbohydrate) foods. Furthermore, the proteins in the meat may not be used for tissue synthesis or for growth unless and until the energy requirements of the individual are first met. Moreover, fats which serve primarily as an energy reservoir or a concentrated form of utilizable energy is also required for the assimilation of several other nutrients, especially the fat-soluble vitamins, as well as for the synthesis of several essential compounds in the body. They serve as packing materials in the body to prevent heat loss and help to support the kidneys, eyes and other internal organs. They protect the ends of bones, giving shape to the body. Thus, fats are very important in terms of the structure and protection of the body from physical and physiological damages. Additionally, while milk may not supply a significant amount of iron, it could supply a significant amount of the daily requirement for proteins, calcium and niacin. Moreover, bread, rice and maize may each be contributing mainly carbohydrates, but each also contributes substantial proportions of the daily protein, vitamin and mineral requirement, especially when large quantities of each is consumed. Also, when each of these foods is combined with a legume (limiting only in lysine and the sulfur-containing amino acids), the resultant diet, together with the typical African sauce, constitutes

a very important source of vitamins, minerals and proteins of a reasonably high quality. It has been estimated that the so-called starchy "energy foods", such as cereals, provide more than 50% of the protein requirements of a normal adult human diet. Thus, it is the overall balance of the diet that is important; and this balance can accommodate a wide variety of foods. On the basis of these considerations, the following food groupings have been recommended for the tropical countries.

Activity/Exercises 1

1. Foods are grouped (classified) according to the similarity of
   (a) their chemical composition;
   (b) their nutrient content;
   (c) their physical appearance;
   (d) their digestibility;
   (e) water content.

2. In modern times, foods are usually classified as:
   (a) "energy foods",
   (b) "body-building foods",
   (c) "protective foods"
   (d) "accessory food substances"
   (e) All of the above.

3. The classification of foods is essential for all **but one** of the following reasons:
   (a) it provides a wide variety of alternatives;
   (b) it provides a choice when resources are in short supply;
   (c) it enables one to understand the chemistry better;
   (d) it permits flexibility for seasonal, regional and budgetary considerations
   (e) it facilitates food choices for a sick patient.

4. The following foods are correctly grouped together **except**:
   (a) egg, fish, beef and beans;

(b) rice, beans and fried plantains;
(c) fresh green vegetables, ripe mangoes and ripe bananas
(d) raw plantains, yams and cassava;
(e) rice, wheat bread and maize.

5. Modern opinion of what constitutes good nutrition includes **all but one** of the following:
   (a) The replacements of beef and pork with a greater use of beans, nuts, poultry and fish;
   (b) a reduction of the intake of saturated fat and refined sugars;
   (c) increased consumption of fruits and vegetables;
   (d) increased consumption of crude fiber and complex carbohydrates;
   (e) increased use of common salt and honey.

3.2 The Food Groups

On the basis of the above-mentioned rationale for grouping foods, the following five food groups are widely recognized around the world:

Milk Group: It is from this group that the human infant gets its first taste of a human diet. The group is made up of all dairy products including fresh milk, skim milk, condensed milk, powdered milk, local and foreign cheeses, butter, yogurt and ice cream. Individuals with varying degrees of lactose intolerance have a choice of cheeses, butter milk, butter and yogurt. However, for those who must watch their weights, the use of ice cream and other milk-containing beverages should be restricted. However, this group is especially valued for its content of calcium, magnesium, riboflavin, cobalamin and proteins of high quality. But it is notably low in iron and ascorbic acid.

"Meat" Group: This group includes such diverse food items as meats, poultry, eggs, fish, snails, shrimps, crabs and other sea foods; termites and other edible insects such as caterpillar, locusts, crickets and grass-hoppers; legumes (pulses), seeds and nuts. Although the nutritional contributions of each member of the group vary, they all provide valuable amounts of energy, proteins, iron and the B-complex vitamins. The proteins in the various cuts of meat do compare favorably well with the amounts of proteins available in poultry or

fish. While the utilizable proteins in legumes consists of only about 30% of the amount of proteins available in the animal protein foods, other valuable components of the various foods in this group compare quite favorably well with meats, particularly in light of the high cost and the variable prices of the latter. Furthermore, since large amounts are consumed, legumes are perhaps the most important sources of proteins in many African diets, partly because they are relatively cheap, palatable and keep fairly well. Thus, eggs and legumes can be used quite freely to replace the high-priced cuts of meat without sacrificing adequate nutrition. Furthermore, a greater use of legumes, nuts, poultry and fish would help to reduce the intake of saturated fat that is quite abundant in meats (beef is 20-30% saturated fat, compared with poultry and fish, which are 6% and 2-8% respectively).

Cereal Group: The cereal grains belong to the family of grasses and they include maize, guinea corn (sorghum), wheat, rice, barley, oats and teff. But the latter three are not popular in Nigeria. However, all cereal grains have a fairly similar structure and nutritive value: 100 g of whole grain provides about 350 kcal, 8-12 g of proteins, and useful amount of calcium, iron (though phytic acid may hinder the absorption of these), and the B-Complex vitamins. The separation of cereals from tubers and starchy fruits is based on the differences in their ease of storage and protein, vitamin and mineral contents. Although they are of plant origin, the cereals contribute not only carbohydrates, but also the B-complex vitamins, iron, magnesium and generous amounts of proteins to the diet. As a group, they have an additional quality of ease of conversion into several important products that easily lend themselves to enrichment. It is believed that there is hardly any village in Africa where one cereal or another is not used as a staple food. As a group, cereals constitute the most important food for peoples all over the world, with approximately half of the people in the world depending heavily on rice, wheat and maize. The survival of the peoples of the Sahelian regions has been attributed to the consumption of cereals, limiting only in lysine and the sulfur-containing amino acids.

Starchy Fruit/Tuber Group: The members of this group include yams, coco-yams, cassava, potato, sweet potato, plantain and bread-fruit. These food crops are usually easily cultivated and are the staples in the wetter, more humid regions of Nigeria. They contain large quantities of starch and are therefore fairly easily obtainable sources of food energy. However, they are readily perishable and cannot be stored for long periods of time. Because of this, they are highly seasonal. As sources of energy, they supply about 385 kcal per 100 g

of dry matter, but with very low amounts of other nutrients. They are inferior to cereals because they consist of about two-thirds water and contain much less proteins, usually less than 2% as compared with 8-12% in cereals. They also have lower contents of minerals and vitamins, and are thus limited in their contribution to the provision of a balanced diet.

In general, the cereal group and the fleshy fruit/tuber group constitute the largest portion of the typical African diet. These two groups of foods, especially the latter, because of their limited contribution to the provision of a balanced diet, should always be, and are in fact, usually, consumed with the typical African sauce. The African sauce is an extra-ordinary mixture of all sort of ingredients, including vegetables, tomatoes, peppers and spices, salt and *magi* (mono-sodium glutamate) cubes, meats, mushrooms, seed meals and several other condiments. This sauce thus serves as an important source of proteins, vitamins and minerals of reasonably high quality when consumed with the staple foods.

Fruit/Vegetable Group: The term ‘vegetable' is used to include some fruits (e.g. tomatoes and pumpkins), leaves (e.g. spinach and cabbage), roots (e.g. carrots), and even stalks (e.g. celery), and flowers (e.g. cauliflower). A wide variety of fruits grow wild or are cultivated. The contribution of this group of foods is the provision of nutritionally important quantities of water-soluble vitamins, especially folic acid and ascorbic acid, carotene (the pre-cursor of vitamin A), and minerals. Furthermore, many members of this group make substantial contribution of roughage to the diet in the form of cellulose. But the fruit members have low protein content which, though often ignored, may not be negligible. When Hippocrates formulated the maxim, ‘*thy food shall be thy remedy*,’ he certainly must have had in mind the medicinal qualities of vegetables. The common fruits include mangoes, papaw, guava, coco-nuts, oranges, grape-fruit, tangerines, bananas, pine-apples, African pear, wild mangoes (*oro*, *agbono* or *apon*), pitanga cherry (*agbalumo*), local and imported apples, cashew fruit, avocado pear, cantaloupe and water melon. On the other hand, the common vegetables include spinach, pumpkin leaves, bitter leaves, water leaves, collard greens, sweet potato leaves, cassava leaves, mushrooms, onions, okra, carrots, tomatoes, cabbage and lettuce. Unfortunately, many of these are still regarded only as optional supplementary foods, perhaps because of their seasonality and relatively high cost and low caloric density.

In concluding this segment of the discussion, it is pertinent to state that there is currently no food grouping in use that does not have its own limitations. For example, foods like alcohol and alcoholic beverages (mostly used at social gatherings but which should not be allowed to replace or crowd-out proper food intake), carbonated drinks (consisting of sugar,

water and flavorings), sugar, cooking oils, margarines and several other components of the African soup, which are either high in fats and oils or sugar, but low in other nutrients have not been classified and have been left out of this classification. Some of these items are sometimes referred to as "empty-calorie" foods. They are said to be empty-calorie foods because they do not meet our definition of a food that must contain other essential nutrients even when it has a preponderance of a particular nutrient.

Thus, the classes of foods available to a particular population or in a community may not easily be amenable to any one-classification method, as in this case. It should also be noted that not all food items available in a complex multi-national country like Nigeria are accommodated by this classification since these do not usually follow the nutrient pattern of any one of the Five Food Groups. This classification has not been designed to accommodate such food items. The foods of certain ethnic groups within the society may not meet any reasonably simple classification, and these have been left out. Despite these limitations however, this classification is simply a rough but good system which allows consumers and health workers make a quick and easy evaluation of the intake of essential foods in order to plan a diet or the food needs of a nation or a community which offers the basic nutrient requirements for optimum health.

4-0 Conclusions

Making food choices is the bedrock of adequate nutrition. The knowledge needed to enable one make appropriate choices can be acquired only through a proper understanding of the basis of such choices. When money is short or there is a scarcity of a particular product, the consumer should have alternatives to choose from, without compromising good nutrition. Furthermore, in a country where the consumer's knowledge of nutrition and food and the resources for making a wise choice of the latter is rather limited, selection guidelines which can aid the consumer make reasoned choices in order to meet the known nutritional needs becomes imperative. Thus, the consumer is presented with choices that permit flexibility for seasonal, regional and budgetary considerations.

5-0 Summary

Basically, there are five food groups, which are based on the geographical distribution of the tropical foods. These include (a) the milk group, (b) the meat group, (c) the cereal group, (d) the vegetable/fruit group, and (e) the fleshy fruit/tuber group of foods. Members of each group have similar nutritional value, such that one member can be substituted for another, within the same group. However, what is considered food in one part of the world may not be food in another. For example, pork is a delicacy is China, but Muslims, the world over, are not permitted to touch pork, talk less of eating it. Similarly, a greater percentage of Indians (the Hindus) do not eat beef; but it is highly valued in most parts of the world. Furthermore, food choices facilitate planning of nutritious meals, especially for patients, whose eating habits need to be accommodated.

6-0 Answers to Exercises

1-(b)	5-(e)
2-(c)	3-(c)
4-(b)	

7-0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.
2. Townsend, CE (1980). Nutrition and Diet Modifications, 3rd edition, Delmar Publishers, Albany, N.Y, USA.
3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.
4. Sizer, FS and EN Whitney (2003). Nutrition: concepts and Controversies, 9th edition, Thomson Learning, Inc., Belmont, California, USA.

Unit 4: Food Presentation, Purchasing and Preparation

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1.0 Introduction

Processing and preservation of foods are traceable to the earliest civilization. For example, the use of fire to "cook" food is traceable to 8,000 BC. A major breakthrough occurred in the 18^{th} century when Nicolas Appert demonstrated that when food was heated in sealed containers, spoilage was virtually eliminated, giving rise to the canning industry. Later, Louis Pasteur demonstrated that microorganisms were the major cause of food spoilage and heat application was the most effective means of preserving spoilage. Currently there is an apprehension about the quality and or safety of food supply, which often leads people to seek unconventional approaches to personal nutrition. At the moment, the public is being bombarded with nutrition misinformation. However, one must distinguish between debatable issues, which have sound scientific basis, and those, which represent personal philosophies. While some believe that all chemicals used in foods are unsafe and unnecessary (more of a personal philosophy than the truth), others believe that science must be the arbiter.

2-0 Objectives

After studying this unit, you should be able to

- name the factors which can guide you, the consumer, to make appropriate choices of food at the market place, given the limited amount of money available.
- able to know why and how these foods are presented and prepared for consumption, and the dangers posed by not giving careful handling to them.
- describe food presentation and processing
- appreciate the importance of keeping our foods in hygienic conditions.

3.0 Main Content

3.1 Food Quality, Handling and Presentation

A consumer should have the basic knowledge of quality, preparation and storage of foods in order to buy wisely. It is of little use to purchase a food item just because it is rich in a specified nutrient if the food cannot be properly stored or prepared.

A common means of preserving foods is by the use of food additives, which are chemical substances added to foods during processing, storage or packaging. These are of two types – the intentional additives which are added to perform specific functions in foods, and the incidental additives, which were not intentionally added, but may be there as a result of some stage of production or packaging. Normally, all additives which are chemicals, are added to foods to enrich nutrient content, retard spoilage, enhance flavor or to maintain appearance, consistency and texture. The common salt is one of the earliest known additives. However, there are equivocal beliefs that additives are added to foods to preserve them, while on the other hand, others believe that additives may cause disease. Nevertheless, there are documented evidence that additives:

i) imparts and maintain desired consistency (emulsifiers, stabilizers and thickeners).
ii) improve nutritive value (iodized salt, vit.D, niacin).
iii) enhance flavor (spices, synthetic flavors).
iv) control acidity or alkalinity (leavening agents).
v) maintain appearance, palatability and wholesomeness (anti-oxidants, microcidal agents).

vi) give desired and characteristics color.

vii) mature and bleach

Milk and Milk Products

Milk is considered the most nearly perfect food among the food groups. Since bacteria (micro-organisms) thrive well on milk, there is need to observe proper hygiene when it is being handled. Pasteurization is a process by which fresh liquid milk is heated to at least 62.8^0C (145^0F) for at least 30 minutes and then immediately cooled to 10^0C (50^0F). The process kills all harmful bacteria and checks the growth of some harmful bacteria which can cause milk to sour. It is recommended that milk be refrigerated in clean covered containers to preserve its nutrient content and inhibit the growth of bacteria. It should be heated at low temperatures because it scorches easily. In order to ensure safety, most liquid milk is usually pasteurized.

When milk is allowed to coagulate, the curd formed is cheese. There are many hundred types of cheeses, but the commonest type of cheese is the local cheese (cottage cheese (wara)). Cheese is rich in proteins, minerals and vitamins. It is easy to digest and can easily be served to a patient during convalescence. It can be regarded as a meat alternate.

Eggs

Egg protein is the standard by which all other proteins are measured. It is rich in the Essential Amino Acids, minerals and vitamins. However, on account of their high cholesterol content, it is advisable to limit eggs to 4 per week. Eggs should be stored with the small end down as this keeps the air cell at the rounded end and prevents the yolk from slipping out of place. They should be refrigerated until used. Eggs, like most foods, become ‘tough’ when cooked at high temperatures.

Meat, Poultry and Fish

The combination of these members of the ‘meat’ group provides the greatest source of animal proteins in the diet of man. They are also rich in minerals and vitamins. The types most available in the Nigerian market include beef, veal, lamb, goat meat, pork and wild game meats (hares, deer and grass-cutters). Organ meats, including liver kidney, tripe, tongue, spleen and brain, are especially good sources of minerals and vitamins. But they are also good sources of cholesterol.

The commonest types of poultry available in Nigeria are chickens, turkey and seasonal game hen. In order to prolong the shelf life of these items, roasting and frying are used widely. They exist as friend dried meat. On the other hand, sea foods may be two types: fish and shell fish. The most popular are the fishes, most often, in the form of frozen, cured or smoked types. Although the full potential of the fish industry is only now being realized, the consumption of fishes is rapidly increasing in Nigeria.

Vegetables and Fruits

Vegetables are edible plants which provide vitamins, minerals, carbohydrates, and to a limited extent, proteins. On the other hand, fruits are the fleshy parts surrounding the seeds of plants. They contribute valuable vitamins, minerals, carbohydrates in the form of sugars and cellulose and water. Because they contain cellulose, water and fruit acids, they have laxative effect and are useful in overcoming constipation. Both fruits and vegetables are normally consumed fresh, but can be preserved if refrigerated.

Fruit juices should be kept cold, covered and stored in opaque containers which block out light, thus preserving their flavor and vitamin content. Fruit drinks (not juices) and carbonated beverages usually contain only calories in the form of sugar and sometimes additives. Fruits keep best when stored in the refrigerator.

Fresh vegetables should be stored in cool dry place and served virtually raw with little or no cooking. In most homes, vegetables are cooked. When vegetables have to be steamed, they should be washed several times to remove all dirt. This should then be cut into the soup directly. Vegetables should not be washed after cutting as this will lead to the loss of much of its nutritive value.

3.2 Food Purchasing: Food Appearance, Safety, Supply and the Senses

Food flavor is a blend of sensory responses to taste, odor or smell(aroma) and texture. The senses involved are tongue (mouth) nose and tongue/teeth (mouth). Children have about 9,000 taste buds and usually prefer bland foods. But at about the age of 10, the taste buds become less numerous and by the age of 20 are at the peak of efficiency. By the age of 45, there is a decrease and an elderly person may have as few as 3,000 taste buds. The sight of food can produce pronounced reactions, including suspicions. Off-colored foods tend to

produce unusual taste sensations, while orange juice served in a blue colored glass has less appeal than when it served in clear glass. The sense of touch affects the sense taste. The texture of food and its pressure in the mouth are contributing factors. Spices give a feeling of warmth, while crunching and crackling sounds, such as found in some cereals, have an effect on acceptance.

Thus, the issue of risk and benefit, relative to food chemicals, can not be debated solely on the basis of personal philosophy. For example, some people believe that foods grown without the use of pesticides or artificial fertilizers, but with the application of natural fertilizers (manures) and other organic matters are more nourishing and less likely to be hazardous. Others pay enormous amounts to purchase honey as a sweetner in preference to the plain simple sugar. They call these “natural foods”. The unwary are led to believe that vitamins are not vitamins unless they are derived or extracted directly from plant or animal products. Such statements often distort facts and exploit the unwary, who often pay dearly for such products. Chemicals with unequivocal risk to health must be separated from those with a little amount of hazard. Evidence of absolute safety of our food-chain system in a world environment that has become increasingly man-made and heavily soiled is therefore unrealistic and unattainable. What you must get out of this discussion is that statements read by the public must be based on scientific nutrition knowledge rather than on personal opinion.

Growing foods usually involves soil, which is usually made up, partly, of bacterial colonies, making the contamination of foods likely. In general, the high-protein or animal-derived foods are the most easily contaminated food items, by especially the *E. coli*. Foods consumed in public eating-houses are highly susceptible to food poisoning, as the high-protein foods they sell are not normally stored properly. Tinned foods, whose containers show evidence of bulging, leaking or are badly damaged should be discarded. Frozen foods, which have thawed, are unsafe. In certain severe cases, hemolytic uremic syndrome can develop, causing abnormal blood clotting, kidney failure, damage to the central nervous system and other organs, and death.

Food spoilage is caused by three major factors: microbial, chemical and enzymatic. Microbial contamination of food is impossible to eliminate because microorganisms originate in the soil, the water and the air in the environment where food is produced. Similarly, enzymatic activities cannot be eliminated. For example, ethylene produced by endogenous enzymes in

tomatoes is important to the ripening process. After harvest, this enzymatic activity continues, leading to over-ripening and softening of the fruit, which renders it undesirable. A frequently used method for minimizing this process is to inactivate the enzyme by heating. Furthermore, processing is used to enhance the nutritive value of foods. For example, the carotenoids in fresh tomatoes are poorly absorbed; but with thermal treatment (cooking/conversion to catsup) its bio-availability is enhanced. Chemically, when Calcium hydroxide (lime) is added to raw corn, the bio-availability and nutritive value of its niacin content is increased. Also, processing can improve the flavor and texture of many food products, and can provide convenience in preparation. The anti-nutritional factors present in foods such as phenolic chemical compounds can be reduced or destroyed by processing. Processing can also minimize the negative effects of some environmental factors (such as pH, temperature, light, oxygen level, carbon-dioxide level and physical damage) on the shelf life of foods thereby increasing their nutrient retention.

Microorganisms can cause food-borne diseases, either by infection or by intoxication. Harmful micro-organisms could be microscopic plants and animals, such as bacteria, viruses, worms and molds. Intoxication is mostly through chemical poisons, while infections are through infectious agents, such as *Salmonella* which multiply and infect the tissues of the body. In the case of intoxication, the intoxicating microorganisms in foods produce enterotoxins or neurotoxins, which are poisonous substances that are absorbed into the body, causing food intoxication. These microorganisms can multiply or create toxins in food during improper preparation or storage or within the digestive tract after a person has eaten contaminated food. When the digestive tract disturbance is the only one having the symptoms, chances are excellent and this indicates a food-borne illness. However, in the cases of the vulnerable groups such as children, pregnant, aged or sick people falling victims, a mild disturbance of food-borne disease can be fatal.

The overwhelming majority of food-poisoning cases result from mishandling by the consumers themselves, **after** purchase. For example, when dairy products, which rely on pasteurization (a process of heating milk to kill many disease-causing organisms and making the milk safe for consumption) gets into households where there is no cold storage to keep the milk safe, an infection sets in.

The human environment is full of micro-organisms such that the microbes could be present in the food sources, be it animal or plant carriers; other carriers are humans who could infect the food during their handling of the foods. Eating under-cooked or poorly processed foods could

also lead to food contamination, insects or dust rats (mice) are also carriers of infectious microbes, and can contaminate poorly stored cooked foods. Improper storage temperature can influence multiplication of these microorganisms in foods.
The most common forms of food contamination/poisoning are Salmonellosis, perfringens poisoning, trichinosis, staphylococcal poisoning, dysentery and botulism. The symptoms range from abdominal cramps, diarrhea, severe headache, fever and nausea to vomiting, acute inflammation of the stomach and intestines, double vision, inability to swallow, speech difficulty, progressive respiratory paralysis and death.

Salmonellosis or simply salmonella is an infection caused by *Salmonella* bacteria. It is most commonly found in raw meats, poultry, fish, milk and eggs. The most susceptible hosts are the very young, the very old, the weak or incapacitated. Although heating to at least 600C can destroy Salmonella bacteria, it could survive freezer or dried food conditions. One species of Salmonella causes typhoid fever.

Perfringens poisoning is caused by *Clostridium perfringens* bacteria found in soil, on food and in the intestinal tract of warm-blooded animals. Eating heavily contaminated foods transmits it. These are spore-forming bacteria that grows without oxygen and are thus very difficult to destroy. The spores can survive most cooking temperatures. The best method of controlling them is by refrigeration at or below 4.4^0C (40^0F) e.g.meat.

Staphylococcal Poisoning is caused by the *Stapyloccocus aureus* bacteria found on the skin and in the respiratory passages. They thrive best in meats, poultry, fish and egg dishes and potato-containing salads. This poisoning is transmitted by carriers and by eating foods containing the toxin. The growth of the bacteria is inhibited if foods are kept at temperatures above 60^0C (140^0F) or below 4.4^0C (40^0F). The toxin can be destroyed by boiling the food for several hours or by heating it in a pressure cooker at 115.6^0C (240^0F) for 30 minutes. However, on account of the economic cost involved, it is better to simply discard foods suspected of ‘staph’ contamination.

The toxin produced by the Clostridium botulinum bacteria causes botulism. Though rare, it is perhaps the most deadly of all food poisonings. The spores of these bacteria can divide and produce toxin without oxygen, especially in canned foods. The spores are extremely heat resistant. The symptoms of one neurotoxin poisoning that stands out most is that of botulism,

caused by the toxin of the *Clostridium botulinum* bacteria, which grows in improperly canned foods, improperly prepared or stored vacuum-packed foods, vegetables, especially when stored at room temperature. The microbes grow only in the absence of oxygen, in low-acid conditions, and at temperatures that support the growth of most bacteria – 40^0 to 120^0 F. Although botulism rarely occurs, its symptoms constitute an immediate medical emergency. So potent is the botulinum toxin that an amount as tiny as a single grain of salt can kill several people within an hour. However, the botulinum toxin is destroyed by heat, so canned foods than contain the toxin can be rendered harmless by boiling them for ten minutes. Boiling for 6 hours can destroy them, but boiling for 20 minutes can destroy their toxin. On account of these facts, care must be taken when canned foods such as sardines are consumed at home.

Trichinosis is caused by the parasite *Trichinella spiralis*. Eating inadequately cooked pork from pigs infected with Trichinella spiralis transmits trichinosis. However, cooking all pork to an internal temperature of at least 58.3^0C (137^0F) kills the organism. Freezing can also destroy it.

Dysentery is caused by a protozoa transmitted by carriers through foods or contaminated water. It may occur intermittently until the patient is properly treated.

Apart from the different cases highlighted above, natural food poisoning can occur. Ingesting certain plants or animals containing poison usually causes this. Examples are plants such as poisonous mushroom and fish from heavily polluted water. Poisoning can also result from ingesting cleaning agents, insecticides or an over-dose of a drug. This is most common among children. A cook could also mistakenly use poison instead of a cooking ingredient. Sometimes sprayed insecticides may not have been washed off fresh fruits and vegetables. Thus, fruits and vegetables should be thoroughly washed before storage and consumption.

Activity 1 T (True) or F (False)

1. *Clostridium perfringens* and *Clostridium botulinum* are two deadly spore-forming bacterial infections.

2. The overwhelming majority of food-poisoning cases result from mishandling by the producers themselves, **before** purchase.

3. Naturally-occurring nutrients in foods and those added to foods, are differently affected by physiochemical parameters that occur during processing and preparation of food.

4. Microbial contamination of food is impossible to eliminate because foods are produced in the same natural habitat of these microorganisms.

3.3 Food Preparation Nutritional Value of Foods during Processing

A major reason for processing foods is to make perishable foods available year-round by increasing their shelf-life. Another reason is to make relatively 'fresh' foods available thousand of kilometers away from where they have been produced, without losing much of their nutritive value. Furthermore, processing of foods almost invariably leads to cleaner, more hygienic foods. For example, important food ingredients such as flour, sugar and vegetable oils are refined to standardized products, with extended shelf-life. These ingredients and products add value to the formulated foods (e.g. bread) derived from them. For example wheat and corn flour can serve as excellent carriers of highly stable fortification nutrients (Iodine and Vitamin A).

Regardless of whether nutrients are naturally occurring in a food or are added to foods, they are affected by the same physiochemical parameters that occur during processing and preparation of food. These parameters include temperature, oxygen, light, pH, and the extent of the concentration and duration of one or a combination of these parameters. Foods can provide ideal conditions for bacteria to thrive or produce toxins. Disease-causing bacteria require warmth (40^0 to 140^0 F, moisture and nutrients. In order to defeat bacteria, one or

several of these conditions should be eliminated. For example, the exposure of a food to a high temperature of 140^{o}C for a short time (seconds) is less damaging to nutrient value than exposure to a moderate temperature of 90^{o}C for a longer time (minutes). Foods, which are cold or frozen, should be kept cold until used. Similarly, oxygen, even at very low levels can be destructive to specific micronutrients such as vitamins A, E, C and folacin (folic acid). Some others, such as riboflavin and vitamin A are extremely sensitive to sunlight or direct lighting for a few hours. Also, foods treated with sulfite to preserve (inactivate enzymes) and to enhance their color suffer thiamin loss, but retain their ascorbic acid content. Furthermore, fermentation of foods which usually lowers their pH will aid the retention of vitamin B6 and thiamin which are stable at acid pH. It is also noteworthy that the alkalinity of chocolate in a chocolate cake is destructive to thiamin. On the other hand, some nutrients (e.g. niacin, vitamin C and minerals) are stable to practically all types of treatment. However, some water soluble ones suffer from leaching which occurs when cooking water is thrown away or during thawing of foods.

For both adults and children, eating raw or lightly steamed sea-food is risky. Some micro-organisms lurk in these products and may not be detected, since the offshore waters are strongly polluted. These foods are often contaminated with viral hepatitis, worms, flukes and other parasites. Many worms depend on the blood of their hosts for food and reproduction. They attach themselves to the host's digestive membranes, sometimes causing life-threatening perforations. Flukes often attack and damage the liver. Although freezing fish will kill mature parasitic worms, but only cooking can kill all worm eggs of disease-causing microorganisms. Therefore, all sea-foods should be properly cooked.

Fruits and vegetables, which are normally grown close to the ground, must be washed properly before consumption. Other fruits, which are consumed raw, must be washed before consumption. Even bananas, which are eaten raw, must be washed before peeling. Most of us indulge in eating wild honey. Some of these can contain dormant spores of Clostridium botulinum, which can germinate and cause botulinum toxin. Thus, you should thoroughly rinse raw fruits and vegetables before peeling, cutting or eating. You should not use soap, detergents or bleach solutions. To clean rough-skinned produce, scrub while rinsing with water to loosen dirt and dislodge microbes. Cut away damaged or bruised areas, along with moldy fruits or vegetables that contain bacteria.

3.4 Food Safety .

An apprehension about the quality and or safety of food supply often leads people to seek unconventional approaches to personal nutrition. At the moment, the public is being bombarded with nutrition misinformation. However, one must distinguish between debatable issues, which have scientific basis, and those that represent personal philosophies. While some believe that all chemicals used in foods are unsafe and unnecessary (more of a personal philosophy than the truth), others believe that science must be the arbiter. Thus, the issue of risk and benefit, relative to food chemicals, can not be debated solely on the basis of personal philosophy. For example, some people believe that foods grown without the use of pesticides or artificial fertilizers, but with the application of natural fertilizers (manures) and other organic matters are more nourishing and less likely to be hazardous. Others pay enormous amounts to purchase honey as a sweetner in preference to the plain simple sugar. They call these “natural foods”. The unwary are led to believe that vitamins are not vitamins unless they are derived or extracted directly from plant or animal products. Such statements often distort facts and exploit the unwary, who often pay dearly for such products. Chemicals with unequivocal risk to health must be separated from those with a little amount of hazard. Evidence of absolute safety of our food-chain system in a world environment that has become increasingly man-made and heavily soiled is therefore unrealistic and unattainable. What you must get out of this discussion is that statements read by the public must be based on scientific nutrition knowledge rather than on personal opinion.

4.0 Conclusions

There is a need for consumers to have the basic knowledge of quality, preparation, handling and storage of foods. By virtue of the fact that growing foods usually involve the soil, which is usually made up partly, of bacterial colonies, contamination of foods is virtually impossible to prevent. These contaminations get into our food chain, causing food-borne illnesses. Thus, foods should be thoroughly washed before storage and consumption. Besides, certain endogenous enzymatic activities can cause food spoilage, which can also cause illnesses. In order to avoid these illnesses, the consumer should endeavor to minimize microbial contaminations and spoilage. This is partly the reason for treating our foods with exogenous chemicals, which can deter spoilage as well as prolong shelf life spoilage. Since nutrients are

chemicals, treatment of foods with chemicals can enhance not only their nutritive value, but their quality, freshness, cleanliness and hygiene.

5.0 Summary

The human environment is full of micro-organisms. Sometimes they are present in our foods because its animal-source contains them. Microorganisms can cause food-borne illnesses, either by infection or by intoxication. Harmful micro-organisms could be microscopic plants and animals, such as bacteria, viruses, worms and molds. Food spoilage is caused by three major factors: microbial, chemical and enzymatic. Microbial contamination of food is impossible to eliminate because microorganisms originate in the soil, the water and the air in the environment where food is produced. Similarly, enzymatic activities cannot be eliminated. The overwhelming majority of food-poisoning cases result from mishandling by the consumers themselves, **after** purchase. The most common forms of food contamination/ poisoning are Salmonellosis, perfringens poisoning, trichinosis, staphylococcal poisoning, dysentery and botulism. Fruits and vegetables, which are normally grown close to the ground, must be washed properly before consumption. They should also be thoroughly washed before storage and consumption. There are several reasons for processing foods, among which is to make perishable foods available year-round by increasing their shelf life. Another reason is to make relatively 'fresh' foods available thousand of kilometers away from where they have been produced, without losing much of their nutritive value. Regardless of whether nutrients are naturally occurring in a food or are added to foods, they are affected by the same physiochemical parameters that occur during processing and preparation of food. Processing of foods almost invariably leads to cleaner, more hygienic foods. Furthermore, food flavors are important to food acceptability. Fortuitously, some nutrients (e.g. niacin and minerals) are stable to practically all types of treatment.

6-0 Answers to Exercise

1 (T) 2 (F) 3-(F) 4-(T)

7-0 References

1. Townsend, CE (1980). Nutrition and Diet Modifications, 3rd edition, Delmar Publishers, Albany, N.Y, USA.

2. Sizer, FS and EN Whitney (2003). Nutrition: concepts and Controversies, 9th edition, Thomson Learning, Inc., Belmont, California, USA.

3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins Publishers, Philadelphia, USA.

Unit 5: Nutrition of the Child

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1-0 Introduction

Without doubt, the status of the nutrition of a child impacts on the future and subsequent generations. In recent years, the nutrition of a child has occupied the center stage of the economic development of a nation. This is because the nutritional requirements of infants and children reflect a population's unique needs for growth and development. On account of the fact that the metabolic rate of infants and children are greater and the turnover of nutrients more rapid than those of adults, these need usually superimpose upon, and do take precedence over, the maintenance needs of the child. Unfortunately, the provision of these greater needs is hindered by the baby's physiological limitations of lack of teeth and limited digestive and metabolic processes.

At birth, a baby has sufficient store of brown fat and glycogen that can be metabolized to produce heat for the maintenance of body temperature. Nevertheless, the nutritional importance of the food given within the first few hours of life is to maintain a safe blood glucose level and to initiate milk-flow. After the first few days, however, the provision of sufficient calories for growth purposes become more important. By the end of the first week, the rate of growth and weight gain of the infant is faster than at any other postnatal time, when the baby gains between 180 and 210 g per week. In order to achieve this, at least 1.5 g per kg per day of proteins are required with sufficient calories from carbohydrates (lactose) in the milk. At this time, approximately one-third of the total caloric intake is expended for growth. Therefore, an inadequate energy supply at this time will decrease weight gain, but brain growth may be spared unless energy intake is grossly deficient. However, the uncertainty that surround brain growth at this stage of an infant's development, coupled with the persistently high incidence of neuro-developmental deficits in surviving Low Birth Weight infants, suggests that better nutritional management not only might decrease mortality but also might improve neuro-developmental outcome.

Human milk contains appropriate amounts of all necessary nutrients, including the Essential Fatty Acids, arachidonic and linoleic acids needed for optimal brain development. The amount of food required by each baby depends on the rate of metabolism, how active the baby is and on the need to produce heat to keep him warm. Additionally, a baby whose intrauterine growth was reduced may need to make up by a 'catch-up growth', thus requiring additional nutrients. Fortunately, all healthy babies usually obtain the needed amounts of food by letting their mothers know when they are hungry or satisfied.

2-0 Objectives

At the end of this unit, you should be able to:

- define the nutritional management of the pre-term baby in order to meet its unique requirements;
- learn about the normal physiological needs of the mature term baby an how these are met;
- explain the absolute need to breast feed a baby;

- highlight the difficulties, challenges and benefits derived from exclusive breast feeding;
- highlight the militating factors against exclusive breastfeeding;
- learn about the possible complications engendered in weaning a baby.

3.0 Main Content

3-1 Feeding the Pre-term (Low Birth weight) Baby

The increasing number of surviving LBW infants that must be fed has heightened the awareness of the problems encountered in meeting their nutritional needs. The importance of adequate early nutritional management of the LBW infant can be illustrated by considering the energy metabolism of the fasted infant. In such infants, the ultimate determinants of the length of time they can survive depend on the adequacy of hydration, and the available endogenous stores of fat and protein.

The most generally accepted goal for nutritional management of the pre-term (or LBW) infant is to provide sufficient amounts of all nutrients to support continuation of the intrauterine growth rates. But there is currently a new problem of feeding the small pre-term baby. The common practice of feeding pre-term infants with human milk was abandoned some 50 years ago, following the demonstration that protein intakes that are higher than those provided by human milk resulted in a greater rate of weight gain. It is natural that once feeding has become established in a baby weighing 1 kg or less, it should be given sufficient food to enable it to grow at the same rate as it would have done had it not been born. It is also known that breast milk is best in most circumstances. But for the pre-term babies, however, breast milk is inadequate in several respects. The growth rates of these babies fed human milk are considerably lower than those of infants fed formulas. This can be ascribed, in part, to the relatively low protein concentration of human milk. There is also evidence to show that breast milk can not supply the infant with as much calcium and phosphorus as it would have obtained from its mother's circulation. Breast milk also has some short-comings as its sodium content is grossly inadequate. Fortuitously however, milk of mothers who deliver pre-maturely has an appropriately 20% higher protein concentration and supports desirable

growth rates in the premature babies. An infant weighing 2,000 g at birth has more extensive endogenous nutrient reserves than one weighing 1,000 g; and an infant weighing 3,500 g has more extensive reserve than one weighing 2,000 g. Thus, the smaller the infant, the more marked is his inability to withstand starvation. The term baby has sufficient reserve to survive a total starvation condition for approximately a month.

For pre-term infants weighing between 0.5 and 1.0 kg, the intake of sodium from breast milk does not meet the requirements for growth, and for infants between 1.0 and 1.5 kg, it barely does so, even if all the sodium intake is absorbed and retained. Furthermore, the amount of iron in human milk is nowhere near enough to meet the requirements, and the amount of copper is almost certainly inadequate. The large reserve of copper in the liver of full-term infant, amounting to more than there is in the rest of the body, accounts for the rising increment, which is needed to meet the copper requirement of the term infant during the first few months after birth. The small pre-term infant lacks these reserves.

3-2 Normal Infant Feeding

All babies thrive on their mothers' milk. While breast-feeding is universal in the rural areas of Africa, its importance has been diminishing in the cities, especially among the “affluent” mothers. In most communities, breast-feeding is universally accepted as the best means of delivering nutrients to the newborn. But a mother must be encouraged to feed adequately, exercise, rest and have freedom from anxiety in order to fulfil this function. Approximately 120,000 kcal are required for the synthesis and secretion of breast milk during the first 6 months of the infant’s life. The increased caloric allowance for the nursing mother, in effect, translates into her ‘eating for two’ human beings. On account of its ready availability, its relative safety and the promotion of enhanced resistance to infection and bonding between the mother and infant, human milk is usually the perfect food for the normal infant. However, infant feeding does not occur in isolation, but as a part of a complex of interlocking social and biological conditions. For example, if a woman must return to work almost immediately, or she dies soon after childbirth, the only practical decision may well be to feed the baby ‘artificially’. On the other hand, an infant who has a strong familial history of allergy may have no alternative to breast-feeding. The *human intestinal wall is more permeable to cow's milk than to breast milk*, thereby increasing the risk of allergy. Furthermore, since only about 1% of all women who decide to breast-feed experience any kind of failure, it is unfortunate

that, in spite of its many positive qualities, there is a general decline in its usage, thus constituting a loss of valuable natural resource that has been well-recognized as a major force in the prevention of malnutrition in children.

Nutrition after birth is a less efficient process than nutrition before birth for two reasons: firstly, there is inevitably more wastage when nutrients are absorbed through the intestines than when they are delivered directly into the blood stream through the placenta; and secondly, but more importantly, a great deal of the energy taken in the milk is used for maintaining body temperature in an environment that is usually cooler than the uterus. During the first two months of life, only about 25% of the total intake of energy goes towards producing new body tissues, and by 4-6 months, the percentage has fallen to 8 - both in breast-fed and bottle-fed babies. Health and nutrition education should be coupled with emphasis on adequate breast-feeding and safer and adequate supplementary feeding with locally available weaning foods. In this regard, it is necessary to convince parents and most Nigerian health workers that the unfortified *pap* is 90 to 95% water and low in total energy and proteins. Thus, breast-fed infants from populations at risk of PEM should be weaned with reinforced home-made *paps* **as soon as the growth curve begins to flatten (not on account of diarrhea or pyrexia), the baby cries more often than usual, is restless and sleeps less, often waking up intermittently.**

The period of neonatal life and early infancy is characterized by rapid growth. But the human infant grows less rapidly than the young of other mammals. For example, a calf doubles its birth-weight in one month; whereas an average baby doubles its birth-weight in 4 to 5 months, and triples it in about 12 months. Birth-weight doubling time is usually considered to take place around 5 to 6 months, but current data indicate a trend towards faster weight gain among babies. Some authors have reported an average birth-weight doubling time of 119 days (3.8 months) for American children. Formula-fed babies doubled their birth weight earlier than did breast-fed ones (113 versus 124 days). However, a general trend towards an increased rate of weight gain in infancy may contribute to later problems of obesity. This rapid growth is brought about by increased muscle mass, growth of organs, expansion of blood volume and linear increase in the long bones. The breast milk alone in the first 3 to 4 months of life supplies the nutrients required to sustain such a growth for practically all children. The composition of human milk therefore provides a clue to the physiological needs for these nutrients and for energy in the infant (see Table 5.1 below).

Nutritional Requirements During Infancy

For an infant, food is both a source of nutrients as well as a source of nurture. When a baby is bottle-fed or breast-fed, food and love become synonymous. But the needs of both the mother and her child must be taken into consideration in deciding which mode of feeding is best; and with breast-feeding; encouragement should be given wherever possible.

Soon after birth, but not later than 4 hours, a normal full-term healthy baby should be put to the breast. Such a baby is capable of being put to the breast immediately after birth, however, and this should be encouraged. If no breast milk is forthcoming, as in the case of a baby whose mother dies soon after child-birth, the baby may be put to 10% dextrose, or 5% sucrose or plain water. However, no effort should be spared to initiate breast-feeding.

Eating is an activity in which babies play an active role, unlike bathing, clothing, etc. This activity involves three mechanisms: rooting (searching for the nipple), sucking (continuous or intermittent) and swallowing (well-coordinated with breathing, allowing milk to go to the esophagus instead of the lungs). Nutritive suckling behavior in the new born is affected by obstetric sedation, with the infant suckling at significantly lower rates and pressures and consuming less. This lack of responsiveness should be recognized quickly since this can interfere with nutrient intake and the developing mother-child relationship, as anxiety, tension or frustration, on the part of the mother, can negatively reinforce the infant's early feeding experience. In the first year of life, an infant progresses from a totally dependent (passive) feeder to that of an active participant with a fair amount of independence. This follows the sequence of head, trunk, gross and fine motor control as the infant's reflexive behavior becomes voluntary, e.g. chewing and swallowing rather than sucking solid foods, or drinking from a cup.

It is now well-established that the human milk is the best food for infants and will meet the nutritive requirements of early life when it is supplied in sufficient quantity. In general, the breast milk from a well-nourished mother alone is sufficient to meet the infant's nutritional needs in the first 3 to 5 months of life. Where infant formula must be used, sterilized formulas, which have been processed to simulate human milk, together with vitamins and iron supplements, can also meet the infant's needs. Growth is rapid and nutrient needs parallel

growth. Fortunately, the typical African breast-fed child shows good growth during the first six months which is equal to, or even better than, that of children in the highly-developed countries.

Thus, cow's milk or skim milk is not the most suitable food for infant feeding. With early attempts at formula-feeding, as much as 95% of infants fed mammalian milk died in the first two weeks of life, due to protein intoxication, diarrhea, dehydration, hyper-electrolytemia and death. Even present attempts are still producing high (50%) mortality rates among artificially fed infants in developing countries (in homes where bacterial contamination or incorrect formula preparations are common). Where there is refrigeration and little or no contamination of water, death from artificial formula feeding may be reduced to a level similar to that of breast-fed infants. In such cases, formulas are usually fortified with vitamins C and D, iron and other nutrients, decreasing the incidence of rickets, scurvy and iron-deficiency anemias such that there is little distinction between individual breast-fed and formula-fed infants. However, breast milk remains the preferred food for the human infants (though mothers who choose to feed their infants with formulas should not be made to feel guilty, once necessary precautions are taken). Human milk contains more lactose, iron, vitamins A and C per unit volume, but less protein, calcium, phosphorus, riboflavin and thiamin than cow's milk. One must conclude from these compositional differences, that each mammalian milk is adapted to provide the best nourishment for the young of each species.

3-3 When Should Weaning Begin?

The debate on when exactly to introduce other foods besides breast milk continues to rage on. Weaning has been defined as the period which extends from the time when the baby is solely breast-fed until he is feeding entirely on the adult diet. Several studies for and against an early introduction of other foods have been presented. Socio-cultural factors are often ignored when this debate is tabled. There is no doubt that the debate is not founded on physiological one but more on the socio-cultural practices. As pointed out in another section of this presentation, the aim of a more reasonable and scientific approach is to allow mothers to make informed choices on how to feed their infants and support them in their decisions. This scientific approach is to observe the following conditions as a guide to the introduction of other foods. When the growth curve begins to falter, and the child sleeps far less than usual because he has to wake up to feed frequently, it might well be a sign that breast milk is no

longer adequate. If such a child does not have a fever or a diarrhea, the mother should be encouraged and educated on how to introduce supplementary feeding.

3-4 Exclusive Breast-feeding in the first 6 months of Life

The belief that human milk has a fairly constant composition, especially in terms of its carbohydrate, protein, fat, calcium and iron content, and is little affected by the diet of the mother, and that human milk is the ideal food for the human infant needs to be qualified. A mother whose diet is deficient in thiamin, vitamin A and ascorbic acid, produces less of these nutrients in her milk, and in the case of thiamin, this can lead to infant beri-beri. Nevertheless, the effect of very poor nutrition on a lactating mother is to reduce the quantity, rather than the quality, of the breast-milk. However, many infants also grow well when fed cow's milk or formulas that are different in composition from human milk (see Table 6.2 below). Although the economic advantages and microbiologic safety of breast-feeding for less developed and less affluent societies are obvious, these factors are less important in affluent, developed societies in which the current generation was fed artificial formulas during infancy. Thus, a more reasonable and scientific approach is to allow mothers to make informed choices of how they wish to feed their infants and support them in their decisions. Although a baby is born with the full complement of oligosaccharidases, starch should not be given to new born infants because the small amount alpha-amylase produced by the pancreas can not be sufficient to hydrolyze the starches. Furthermore, the size of the baby’s stomach is rather too small to accommodate bulky starches.

Table 5.1 Composition of Colostrum, Human Milk and Cow's Milk**

Nutrients	**Colostrum** (1-5 d) (100 g)	**Human Milk** (100 g)	**Cow's Milk** (100 g)
Energy (kcal)	58	77	65
Proteins (g)	2.7	1.1	3.5
Carbohydrates (g)	5.3	9.5	4.9
Fats (g)	2.9	4.0	3.5
Calcium (mg)	31	33	118
Phosphorus (mg)	14	14	93

Iron (mg)	0.09	0.1	Trace
Vitamin A (IU)	296	240	140
Thiamin (mg)	0.015	0.01	0.03
Riboflavin (mg)	0.029	0.04	0.17
Niacin (mg)	0.075	0.2	0.1
Ascorbic Acid (mg)	4.4	5.0	1.0

****** Adapted from FJ State and M. McWilliams (1977)

Highlights of the Table:

(1) Cow's milk contains more than three times as much proteins as human milk;

(2) Human milk is two times as high in carbohydrates as cow's milk;

(3) Calcium levels are appropriately four times higher and phosphorus content, six times higher in cow's milk than in human milk; and

(4) Cow's milk is approximately four times higher in riboflavin content than human milk.

3-5 Breast-Feeding Versus Bottle-Feeding

It was the famous pediatrician, Paul Gyorgy who once remarked that the "cow's milk is best for the baby cow and the human milk is best for the human babies." Fortunately, it has been estimated that 90-95% of mothers are fit and capable of breast-feeding their babies. Although, science and industry have combined their skills to produce cow-milk products that contain nutrients in qualities that are similar to those in breast milk, statistical advantages of breast feeding persist. Nevertheless, formulas have been modified to approximate human milk such that little distinction can be observed between the breast-fed and the formula-fed infants. Thus, the overall **nutritional** superiority of breast milk (its ability to provide the nutrients) over cow's milk or its products is not in doubt, at least for those who can not afford these products or who do not live under modern conducive conditions. Thus, there is no doubt that none of these products or the milk of other mammals is, overall, as good as the human milk for the human infant. And the breast milk remains the preferred food for human infants; but in the former cases, as in the studies carried out in Boston, rural Sweden and Kuala Lumpur, where the formula has been properly selected and prepared, few differences were noted in the well-being of the breast-fed and bottle-fed infants. Therefore, mothers who

choose to feed their infants with formulas should not be made to feel guilty, if they can afford to do it properly.

3-6 Advantages of Breast-Feeding

(a) Breast-feeding gives a safe and protected feeling to the infant and a sense of satisfaction to the mother. It promotes a feeling of closeness to the baby, thus fostering good mother-child relationship. For some nursing mothers, the great satisfaction of providing food for a small new life from one's own body, coupled with a strong sense of feminine identity and capacity which may be evoked, are powerful incentives to maintain the nursing role for as long as possible. Paradoxically however, these same factors may lead to a wish to remain the sole source of the infant's food beyond the limits of nutritive reality. Thus, a well-intentioned prolongation of breast-feeding may unwittingly cheat the infant of needed nutrition.

(b) Secondly, there is a reduced likelihood of diarrhea. The stools of infants fed breast milk has lower pH (5.4) than those fed cow milk (6.9). The higher pH permits greater growth of pathogenic bacteria in the GI tract. In the lower socio-economic groups, breast-fed infants have a consistently lower mortality rate, perhaps because the problem of sanitation is eliminated. In addition, constipation occurs less frequently.

(c) Breast-feeding confers immunity on the child on account of the immunoglobulins(Ig) and other constituents of breast-milk. The human fetus obtains its IgG antibody before birth from its mother's circulation, but gets its IgA from the colostrum. This colostrum contains about 11.5% IgA; but by the 4th day, this has fallen to 0.75% and in the mature milk, the concentration of IgA is about 0.1%. IgA, among other agents, acts in the intestine and limits the multiplication of bacterial and viral pathogens within the digestive tract. Thus, it promotes a bifido-bacterial flora in the infant’s intestines that is antagonistic to certain pathogens.

(d) Human colostrum and, to a less extent, mature milk, contains other substances which are important for the infant. For example, they contain lactoferrin, which, by binding iron, makes it unavailable to E. coli in the intestine, thus inhibiting their growth. Colostrun also contains other nutrient binder proteins, which act similarly to lactoferrin for such micronutrients as zinc, vitamin B_{12} and folate.

Thus, the enzymes, hormones, immunological factors (IgA) and other substances in the breast-milk positively affect digestion, absorption and utilization of nutrients as

well as resistance to enteric and respiratory diseases and to allergy. Thus, as a rule, based on the foregoing, there are fewer and less serious illnesses and feeding problems among breast-fed infants.

(e) Breast milk is readily available and convenient. On a practical basis, breast-feeding eliminates preparation; it is available at a proper temperature and also avoids errors in calculation and in formula preparation.

(f) The human breast milk is nutritionally superior to any other infant food. For example, an enzyme which aids protein digestion has been found in greater supply in human milk than in cow milk, hence breast-fed infants are rarely constipated. Furthermore, taurine, a rare amino acid involved in the transmission of nerve impulses, particularly in the eye and the beating of the heart is present in the human but absent in cow milk. Also, lactose aids the absorption of Ca, Mg and amino acids. Upon its digestion, it yields galactose which is an essential structural component of the nervous system of the neonate. When the milk of other mammals is used in the formulation of some commercial foods, this lactose become diluted and inadequate. Furthermore some commercial formulas substitute syrup or sucrose for lactose. Since neither of these yields galactose on hydrolysis, a deficiency of galactose may affect the development of the nervous system of the neonate. In addition, the Poly-Unsaturated Fatty Acids (PUFAs) in the human milk is not normally used as a major source of energy, but are incorporated into cell membranes and are the precursors of prostaglandins which are involved in many functions, such as regulating the transmission of nerve impulses and controlling blood pressure and digestive processes. It is therefore undeniable evident that no other food is equal to that of the human milk for the proper nutrition of the child provided a mother has maintained adequate nutrition herself **during pregnancy**. The nutritional needs of the infant are better met by human milk than by any substitute, and breast milk is yet to be improved upon as a reference standard. Thus, efforts to duplicate human milk by alteration of the components of cow's milk have not yet been successful. Besides, children who are breast-fed have lower chances of becoming obese than bottle-fed children.

(g) Breast-feeding confers an economic benefit on the family and the nation since breast milk is the only low-cost high protein food of animal origin which is readily available, especially in times of economic recession and restricted importation of baby foods.

(h) Breast feeding has contraceptive effect on, and can delay the return of, ovulation by as much as 5 to 8 months. Thus, wider spacing of children, resulting from breast-feeding is perhaps having a greater influence on population growth than the pill or the IUD. In some cultures, sexual intercourse is forbidden during breast-feeding, thus having an added beneficial contraceptive effect on the mother.

Despite attempts by food chemists to modify the milk of the cow to feed the human baby, which have been largely unsuccessful, not withstanding the claims made by promoters of products, the history of artificial feeding of infants is full of examples of one mishap after another. Products which are promoted as 'ideal foods' are withdrawn from the market after a few years later when their short-comings are exposed, only to be replaced by another family of products, which are again, promoted with equal vigor. Nevertheless, epidemiological observations showed that the following health problems occurred following the feeding of such 'artificial' milk products:

- there were widespread outbreaks of rickets in the early part of the century;
- there were cases of neonatal tetany in the early 50s;
- there were reported cases of pyridoxine deficiency also in the late 50s and early 60s;
- hemolysis due to vitamin E deficiency were also recorded;
- risks of high plasma sodium (hypernatremia) have also been noted in recent years.

Furthermore, many of the dangers of artificial feeding arise from errors in reconstitution (quality of constituted milk varies by as much as 20-30% from that recommended by the manufacturers). In the affluent homes, over-concentration can lead to infant obesity. Thus, the factors responsible for the decline in breast-feeding include Western influence, medical advice and a strong advertisement and promotion of bottle-feeding. The latter being perhaps, the most potent of all. On account of an intensive promotion by manufacturers, and in the absence of a strong professional support for breast feeding, many mothers take to artificial feeding only to find that the family income is inadequate to support the cost of powdered milk (often, costing as much as one-third to one-half of the wages of the family to feed an 8-month old baby). The temptation therefore, is to 'stretch' the tin of powdered milk with consequent under-feeding - accompanied by a high incidence of marasmus.

The gut flora of the artificially fed infant is made up largely of E.coli, with some Streptococcus feculis, in contrast to the breast-fed infant in whom the lactobacillus predominates. The E.coli constitutes a reservoir of potential pathogen. The immune factor in breast milk keeps the population of E.coli low until the baby has developed his own

immunity (thus the breast milk protects as well as nourishes, and the mammalian gland performs functions similar to those of the placenta in the intrauterine life).

3-7 Militating Factors against Breast Feeding

Breast-feeding may not be encouraging if:

(a) for any reason, the mother's milk production is less than half of the infant's needs;
(b) the mother suffers from some chronic illnesses such as cardiac disease, tuberculosis, severe anemia, nephritis, epilepsy, leprosy, insanity/psychosis, chronic fevers and the internationally famous AIDS.
(c) another pregnancy occurs, although hormonal changes brought about by the pregnancy does not stop breast milk flow; it could lead to a maternal depletion syndrome.
(d) it is necessary for the mother to return to employment outside the home; or
(e) the infant is weak or unable to nurse because of cleft palate or hare-lip.
(f) temporary cessation of breast-feeding is indicated when the mother acquires an acute infection which the infant has not yet acquired.

The commonest ‘local’ cause of breast-feeding failure, however, are mastitis and breast abscess. In such a situation, the breast may become so painful that suckling becomes impossible, and unless the milk is drawn off, especially if the baby suckles the other breast, thereby stimulating milk secretion in both breasts, the condition may become worse. When this condition is promptly treated, it is seldom necessary to stop breast-feeding or nurse the fear that the baby might be infected through the breast milk. On the other hand, failure to institute therapy may result in serious breast abscess formation, which may lead to the death of the infant, either through direct infection or as a result of losing breast milk supply.

In spite of the contra-indications, bottle-feeding has become a major public health problem in the developing world for the following reasons:

(i) Over-dilution of formulas in these economically-depressed areas of the world usually leads to marasmus. Under-dilution can precipitate childhood obesity.
(ii) The poor environmental sanitation in such places leads to diarrhea. Thus, danger signals have been sent out by the WHO and other International Agencies regarding the dangers of artificial feeding, especially in the less developed parts of the world.

3-8 Common Complications of Breast Feeding

Suckling Failure

Since successful lactation is a joint endeavor between a mother and her baby, any failure that arises must come from maternal as well as neonatal causes or a combination. For example, failure could be due to severe maternal ill-health, malnutrition, abnormal nipple (retracted, or very large and pendulous), psychosomatic impairment, congenital abnormalities (cleft palate), cerebral birth trauma, severe general infection (septicemia, meningitis, tetanus neonatorum), dehydration fever or hunger diarrhea).

Mothers who keep their babies on the breast alone may subject their babies to "breast starvation". Now, weaning is the transitional process between breast-fed adequacy and the full adult diet - a time of accustomizing to new foods and to lessening dependency on breast milk. Unfortunately, the weaning foods commonly used in many parts of Africa range from gruel pap (2% low quality proteins), used in Western Nigeria, to boiled yam in the Eastern region of Nigeria and steamed plantain in Uganda. In other parts of the world, cereal- and legume-based weaning foods are the norm. Table 5.2 (shown below) indicates the proximate composition of certain weaning foods.

Gastric motility is poorly coordinated in the first few weeks of life, leading to poor antral mixing and therefore less digestion of solid foods. By the 12^{th} week of age however, intestinal peristalsis of a type seen in older children and adults develops, but it is about one-third slower. This slower transit time may serve to increase exposure time to the intestinal mucosa, thereby improving nutrient digestion and absorption.

Indeed, intestinal mucosa permeability is greatest during the neonatal period and many large molecules, including proteins, tend to be absorbed intact. The intestinal mucosa alpha-glucosidases (sucrase, maltase, isomaltase) are well developed by 32 weeks of gestation and are present at near adult level at term. Intestinal amylase needed for starch digestion may not reach adequate level until several weeks after birth. However, for the extremely premature infants (27-32 weeks gestation), formulas with less than 60 % of total carbohydrate calories as lactose are generally best tolerated. Although by six weeks, its ability to concentrate solutes is close to adult levels, yet the kidneys have limited ability to dispose of urea

produced by protein metabolism and an excess intake may result in increased morbidity and mortality associated with uremia in the baby.

The average daily requirements of some selected nutrients in the neonatal/early childhood periods are shown in Table 5.2 below.

Table 5.2 Approximate Protein Content and Amino Acid Deficiencies of Weaning Foods**

Type of Food	Amino Acid Deficiencies
Cereal Grains (Maize, G'Corn, Millet)	Lysine and Threonine
Legumes (Peas, Beans)	Methionine, Tryptophan
Soybeans, Rice	Methionine
Sesame, Sunflower seeds	Lysine
Groundnuts	Methionine, Lysine, Threonine
Green Leafy Vegetables (dried)	Methionine

** Adapted from Jelliffe, 1967 and Deutsch, 1976

3-9 Nutritional Aspects of Growth and Development

Growth is the increase in size, attendant upon development of an organism from embryo to adulthood, and involves changes in functions and body composition. Since the metabolic rate of infants and children is greater and the turn-over of nutrients more rapid than in the adult, the nutritional needs for growth and development are superimposed upon maintenance requirements that are higher than those of the adults. Meeting these requirements of the infants and children must take into account their unique nutritional needs for supporting both the inevitable increase in size (growth) and the changes in the organ function and body composition (development). Unfortunately, the provision of these needs is hindered by the lack of teeth and the limited digestive and metabolic processes.

Although it is useful to make comparisons with stated norms, such as height and weight, it is instructive to note that every infant and child does not, and need not, conform exactly to such norms. Each infant's growth and development are determined by

(a) the characteristics acquired from parents,
(b) the quality of nutrition of the mother during pregnancy, and
(c) the adequacy of breast-feeding or formula-feeding and the supplements offered throughout infancy.

Development of personality patterns begins at birth and relates closely to feeding habits. Infants who do not receive adequate calories and adequate mothering in the form of emotional warmth, social contacts, physical handling and sensory stimulation tend not to thrive or grow normally. Furthermore, each child is an individual and serves as the best control in the measurement of his own progress. Height and weight are generally compared to charts that depict a normal population. The best prediction (assessment) of normal growth should however be an integrated scientific measurement of body size (anthropometric), body composition and body cells. Anthropometry deals with an evaluation of body size during growth. Though useful to make comparisons with stated norms (height and weight), it is dangerous to expect every infant to conform exactly to such norms.

Although chronological age is used as a point of demarcation, it is the physiological age of a child that determines its nutrient needs. Physiological age is matched by the chemical index of growth, marked by urinary excretion of hydroxyproline (which is a structural component of skin, tendons, cartilage, blood vessels, connective tissue, organ capsule and bone matrix - a rapid synthesis of which takes place during growth and reflected in an increased rate of its excretion). There is no single criterion of physical status which is indicative of the quality of nutrition - only a series of measurements over a period of time are likely to be reliable indicators.

Growth takes place by three processes:

(i) by an increase in cell number, known as hyperplasia;
(ii) by growth in cell size, or hypertrophy, and
(iii) by an increase in size of the intercellular matrix.

Hyperplasia characterizes very early embryonic growth while hypertrophy begins in later fetal life. The growth of intercellular matrix begins post-natally. Most tissues enlarge through a combination of hyperplasia and hypertrophy. But some (muscle and fat) grow largely by increase in cell size, while others (bones) grow by an enlargement of the intercellular matrix. Patterns of increase in cell number and size in organs and tissues of infants provide an insight into the nature as well as the failure of growth. Thus, cell size and number are indicators of growth, while height is more of a measure of linear or skeletal growth. Increase in the amount of bones, in contrast to cartilage, indicates the degree of maturation.

Several criteria are used to determine whether an infant is well-nourished or not:

(i) steady gain in height and weight (but some weekly fluctuations are to be expected);
(ii) sleeps well;
(iii) is happy;
(iv) has firm muscles and a moderate amount of subcutaneous fat;
(v) teeth begin to erupt within 5 to 6 months;
(vi) is vigorous;
(vii) normally eliminates fecal waste for the type of feeding (2 to 3 soft yellow stools per day for breast-fed and 1 to 2 yellow somewhat firmer stools for formula-fed babies).

Infants grow and develop more rapidly during the first year than at any other time of life. This is exemplified by the fact that

1. weight at birth is 3×10^6 times the weight of the ovum;
2. weight-gain reaches its velocity peak for the entire life cycle just after early neonatal weight loss.
3. birth-weight is doubled in about five months, tripled by one year and quadrupled by three years;
4. weight gain is a composite of growth in all body tissues (muscles, bones, fat and organs).

This generalized growth is reflected in the Ponderal Index: Weight/ $\text{Height}^3 \times 100$. Ponderal Index relates weight to height, which is highest in infancy and early childhood (when weight is greatest, relative to body surface area, length^3). The relation of bone weight to body weight is fairly constant throughout life. Growth in length should increase from the birth length to about 50.8 to 55.9 cm by 20% at three months, 50% by one year and 75% at two years. Thus, the growth of a child tapers off after the first year. For example, there is

about 300% increase in weight gain in the first year, but only a 22% increase in the second year. The first year witnesses an increase of 23 to 25 cm (9 to 10 inches) in height, but only half as much in the second. By the fifth year, weight increase is down to about 12%. However, boys continue a child-like growth for perhaps 2 longer years than the age at which the girls reach their growth peak at about puberty.

An infant's body contains a much higher percentage of water than that of the older children and adults. Their muscles are poorly developed and the amount of subcutaneous fat is limited. Girls are 25% fatter than boys from birth. Weight gain by infants is generally about 38% fat between birth and six month of age, but only about 11% between six months and one year (an inverse relationship exists between fat and protein composition of weight gain at this age range). Since the skin surface area is high in proportion to the total body weight, the loss of body water and heat is relatively high.

Tissues are most vulnerable when their component cell numbers are increasing; and any disruption of this cell division may lead to a reduction in the basic cell population number. Any nutritional deficiencies during these periods (critical phases of growth) are highly significant and may be irremediable. Nutritional disruptions during periods when cell enlargement predominates are more readily reversible. At birth, the skeleton which is high in water content contains about 25 to 28 g of calcium, an amount which triples by the end of the first year.

The first requirement of a new-born is oxygen. Thus, its lungs must expand and its circulation begins to be re-routed. The next requirement is warmth, followed by food and water and the digestive organs have to come into operation. These organs have been developing from about the 4th week of gestation when the embryo weighs only a fraction of a gram and by term, are equipped with enzymes and are capable of digesting and absorbing the nutrients in the milk. Animal studies show that there is a vary rapid growth of all parts of the gastrointestinal tract in response to the first food after birth and it seems likely that a similar thing goes on in the human infants. The GI system of the **full-term** infant is able to digest proteins, emulsified fats and simple sugars (polymers of carbohydrates, glucose and even sucrose), but starches and most fats are poorly tolerated until some months later when the digestive system is fully developed. The kidneys reach their full functional capacity by the end of the first year. During the first few months, the glomerular filtration rate (GFR) is somewhat lower, and

excretion of high concentration of solutes is more difficult. Young infants excrete greater amounts of some amino acids on account of their lower ability to reabsorb them from the tubules.

Epidemiological findings however, show that solid or semi-solid foods ought to be part of the diet of the infant by the sixth month of age, even though there is little agreement as to the exact time when these become necessary. In the U.S., in the 1920s, solid foods were seldom given before one year of age. By 1963, 83% of infants between one and two months of age were eating them. Studies also indicate that **full-term** infants can tolerate cereals or cereal-based foods by the second or third day of life! There are no problems with vegetables at ten days, meat at 14 days, and fruits at 17 days! On account of the size of the stomach of the new-born, being about the size of its fist, the best food for the baby is undoubtedly the mother's breast milk. Fortunately however, there is no need for any other type of food so early in life. In realistic or practical terms however, the amount of solids fed at first should be very little, and such solid food feeding in the first few months of life should be viewed only as a form of training for them to accept and swallow such foods. It will also sensitize their taste buds for others tastes besides the `sugary', lactose-containing taste of the breast milk. Because this learning takes time, it is highly valuable and recommended that babies start on such weaning-taste exercise well before the six-month point of weaning. A delayed until the very sixth month of breast-feeding often leads to untold difficulties in weaning.

The hemoglobin level of the full-term infant at birth is about 17 to 20 g per 100 ml. The level gradually lowers as the infant grows and the blood circulation expands. The level remains satisfactory until the third month when iron-rich foods should be introduced.

The brain develops rapidly such that it completes its growth earlier than the rest of the body. By four years, its growth is 80 to 90% complete and 95% by ten years. The increase in the number of brain cells is most rapid during fetal life and in the first five to six months after birth. Severe malnutrition at any of these times leads to a reduction in the number of brain cells, with intellectual consequences in later life. These growth processes are controlled by a number of factors including genetic, hormonal as well as environmental or extrinsic factors. Among the extrinsic factors, nutrition is perhaps the most important.

Table 5.3 Average Daily Requirements or Recommended Dietary Allowances (RDA) for Normal Infants and Young Children for Selected Nutrients**

Nutrients	0 to 2 months	2 to 6 months	6 to 12 months
Calories (kcal)	kg x 120	kg x 110	kg x 100
Proteins (g)	kg x 2.2	kg x 2.0	kg x 1.8
Vitamin A (I.U.)	1,5000	1,500	1,500
Vitamin D (I.U.)	400	400	400
Ascorbic Acid (mg)	35	35	35
Folacin (mcg)	50	50	50
Niacin (mg)	5	6	8
Riboflavin (mg)	0.4	0.5	0.6
Thiamin (mg)	0.3	0.4	0.5
Vitamin B_{12}	1.0	1.5	2.0
Calcium (mg)	400	500	600
Iodine (mcg)	25	40	45
Iron (mg)	6	10	15

****** Adapted from Alade, 2001.

4.0 Conclusions

The nutritional requirements of infants and children reflect their unique needs for growth and development. With a pre-term baby, provision must be made to support and ensure uninterrupted intrauterine growth rates. On account of its ready availability, its relative safety and the promotion of enhanced resistance to infection and bonding between the mother and infant, human milk is usually the perfect food for the normal infant. But a mother must be encouraged to feed adequately, exercise, rest and have freedom from anxiety in order to fulfil this function. The debate on when exactly to wean a child has usually been based more on socio-cultural practices rather than on physiological need of the child. With extra hygienic precautions, breast-fed infants from populations at risk of PEM should be weaned, with reinforced home-made *paps* as soon as the growth curve begins to flatten (not on account of

diarrhea or pyrexia), the baby cries more often than usual, is restless and sleeps less, often waking up intermittently. The belief that human milk has a fairly constant composition, especially in terms of its carbohydrate, protein, fat, calcium and iron content, and is little affected by the diet of the mother, and that human milk is the ideal food for the human infant needs to be qualified. A mother whose diet is deficient in thiamin, vitamin A and ascorbic acid, produces less of these nutrients in her milk. Nevertheless, the effect of very poor nutrition on a lactating mother is to reduce the quantity, rather than the quality, of the breast-milk. In spite of the overwhelming advantages of breast feeding over artificial feeding, there could be certain compelling reasons why a mother may not be able to breast feed exclusively.

5.0 Summary

The most generally accepted goal for nutritional management of the pre-term (or LBW) infant is to provide sufficient amounts of all nutrients to support continuation of the intrauterine growth rates. For such babies the breast milk is inadequate in several respects. On the other hand, the nutritional requirements of infants and children reflect their unique needs for growth and development. On account of the fact that the metabolic rate of infants and children are greater and the turnover of nutrients more rapid than those of adults, these needs usually superimpose upon, and take precedence over, the maintenance needs of the child. However, the provision of these needs is hindered by the baby's physiological limitations of lack of teeth and limited digestive and metabolic processes. Fortunately, all healthy babies usually obtain the needed amounts of food by letting their mothers know when they are hungry or satisfied. On account of its ready availability, its relative safety and the promotion of enhanced resistance to infection and bonding between the mother and infant, human milk is usually the perfect food for the normal infant. But a mother must be encouraged to feed adequately, exercise, rest and have freedom from anxiety in order to fulfil this function. Since only about 1% of all women who decide to breast-feed experience any kind of failure, it is unfortunate that, in spite of its many positive qualities, there is a general decline in its usage, thus constituting a loss of valuable natural resource that has been well-recognized as a major force in the prevention of malnutrition in children. Also, breast-fed infants from populations at risk of PEM should be weaned with reinforced home-made *paps* as soon as the growth curve begins to flatten (not on account of diarrhea or pyrexia), the baby cries more often than usual, is restless and sleeps less, often waking up intermittently. Furthermore, if a woman must return to work almost immediately, or she dies soon after childbirth, the only practical

decision may well be to feed the baby ‘artificially’. Soon after birth, but not later than 4 hours, a normal full-term healthy baby should be put to the breast and no effort should be spared to initiate breast-feeding. In general, the breast milk from a well-nourished mother alone is sufficient to meet the infant's nutritional needs in the first 3 to 5 months of life. The debate on when exactly to wean a child has usually been based more on socio-cultural practices rather than on physiological need of the child. The scientific approach is to observe the following conditions as a guide to the introduction of other foods. When the growth curve begins to falter, and the child sleeps far less than usual because he has to wake up to feed frequently, it might well be a sign that breast milk is no longer adequate. The belief that, human milk has a fairly constant composition, especially in terms of its carbohydrate, protein, fat, calcium and iron content, and is little affected by the diet of the mother, and that human milk is the ideal food for the human infant, needs to be qualified. A mother whose diet is deficient in thiamin, vitamin A and ascorbic acid, produces less of these nutrients in her milk. Nevertheless, the effect of very poor nutrition on a lactating mother is to reduce the quantity, rather than the quality, of the breast-milk. In spite of the overwhelming advantages of breast feeding over artificial feeding, there could be certain compelling reasons why a mother may not be able to breast feed exclusively. Firstly, the mother's milk production may be less than half of the infant's needs. Secondly, the mother may be suffering from some chronic illnesses such as cardiac disease, tuberculosis, severe anemia, nephritis, epilepsy, leprosy, insanity/psychosis, chronic fevers and the internationally famous AIDS. Thirdly, another unplanned pregnancy could lead to a maternal depletion syndrome. Fourthly, it might be necessary for the mother to return to employment outside the home. Fifthly, the infant may be weak or unable to suckle because of cleft palate or hare-lip. Furthermore, temporary cessation of breast-feeding is indicated when the mother acquires an acute infection that the infant has not yet acquired.

6-0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins, Baltimore, Maryland, USA.

Unit 6: Protein-Energy Deficiency Diseases Found in Nigeria

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1-0 Introduction

The biological and socio-economic basis of certain nutritional diseases can not continue to be ignored in Nigeria as our ignoring them may explain why some of these diseases have not been overcome, despite decades of efforts to reduce mortality and morbidity of these diseases. Perhaps, a better understanding of their etiology would assist health workers to overcome them. This has become vitally important as it has become clear that many members of the health profession currently wallow in unbelievable ignorance about human nutrition. In a previous segment of this course, we defined a nutritional disease as one, which occurs as a result of an inadequacy or excessive intake of a nutrient. In this unit, we shall discuss the energy-related diseases, namely, protein-energy deficiency diseases, namely, Low Birth Weight, Kwashiorkor and Marasmus. In consonance with this, the objectives of this study shall be as follows.

2-0 Objectives

At the end of this unit you will be able to:

- present a keen understanding of the causes of each of the protein-energy related diseases commonly found in Nigeria.
- appreciate the principles of the nutritional management of each of these diseases.
- identify the preventive measures against each of the diseases.

3-0 Main Content

A full appreciation of the pathogenesis of a nutritional disease must begin with an understanding of what it is to be adequately nourished. Before an individual can claim to be healthy, he must be optimally nourished on a diet that contains a variety of foods. The attributes of an optimally healthy (well-nourished) individual is therefore predicated on correct eating habits, eating a variety of foods to meet the Recommended Dietary Allowances (RDA) of all nutrients. As indicated in the Unit Two, *malnutrition is a state of disease caused by the deficiency, an excess or an imbalance of the supplies of nutrients and, or, calories*. Thus, a nutritional disorder results from an imbalance between the body's requirement for these nutrients and energy and the supply of the substrates of metabolism.

There are two forms of nutritional deficiencies: Primary and Secondary (Conditioned) Deficiencies. A Primary nutritional deficiency occurs when there is an inadequacy in the intake of the particular nutrient concerned. A Secondary nutritional deficiency, on the other hand, is caused by consuming a diet that meets the RDA, but, on account of disease, physiological state (pregnancy or lactation) or medication, an imbalance is created and the actual requirement is increased. Often, a deficiency may result from a fault in digestion, absorption or metabolism or other cell such that tissue needs are not met even when the ingested diet would have been adequate, under normal circumstances. Physiological conditions, such as pregnancy, lactation, and growth, illnesses such as high fever, burns, diarrhea, or medication or other cell malfunctions usually increase the requirement leading to secondary deficiency. A nutritional deficiency begins with the inadequate availability of one or more nutrients to the body cells or organs. Also, inadequacy may be due to low dietary

intakes, poor or impaired absorption or high rate of losses from the body. Usually, an insufficient level of intake will be reflected in a decrease in serum level of the nutrient, followed by or coincidental with, a decrease in biochemical function for which the nutrient is required. Finally, the manifestation of a clinical deficiency disease will appear. Subsequently, biochemical deterioration occurs with altered biological and physiological functions and the appearance of clinical symptoms.

In 1798, Malthus predicted that since productive land and potable water are finite resources, population growth inevitably would outstrip the food and water supply resulting, at some point, in mass starvation. Today, a large segment of the world's population lives under conditions where the availability and intake of food are inadequate. One of the difficulties in assessing the prevalence of protein-energy malnutrition, world wide, has been the lack of practical methods that are universally acceptable. In Nigeria, food consumption is generally deficient both in quality and quantity among the poor. Although the terms malnutrition and under-nutrition are often used interchangeably, we will restrict malnutrition to that state of nutrition in which an individual consumes foods that are inadequate in quality and quantity. Protein-energy malnutrition (PEM) and its subsequent deficiency diseases result when the body's needs for protein, food energy or both are not met by the diet. Its manifestation includes a wide spectrum of clinical conditions, which depend on the relative intensity of protein or energy deficit, the severity and duration of the deficiencies, the age of the host, the cause of the deficiency and the associated nutritional or infectious diseases. Dietary energy and protein deficiencies usually occur together, sometimes one predominates, and if severe enough, may lead to the clinical syndrome of kwashiorkor or marasmus. Nevertheless, there is hardly any case of kwashiorkor, without a history of a previous infection. And rarely will a clinician see a nutritional deficiency of significant medical importance that is not associated with protein-energy malnutrition.

Early symptoms of protein deficiency are non-specific. They include weight loss, fatigue (due to loss of energy), and irritability. At times, symptoms of marasmus (wasting condition caused by insufficient food intake) and kwashiorkor exist in the same child. Since one syndrome easily changes into the other, it was believed that a term for both conditions be adopted. Thus, in 1959, Jelliffe proposed the term *protein-calorie malnutrition* which was later adopted by the FAO/WHO in 1970. The term covers the whole spectrum of protein and energy deficiencies, from distinct kwashiorkor at one end to distinct marasmus at the other.

The main predisposing factors of under-nutrition include poverty, ignorance and frequent infections. Therefore, its prevention and control require multi-sectoral approaches that include food production and distribution, preventive medicine, education and socio-economic development. Such approaches must entail a comprehensive program which involves both mother and child. It has been pointed out that the use of a growth chart can be a valuable tool for the surveillance of the at-risk groups in society. On account of limited resources, special attention must be paid to the most likely victims, including children under two years of age from low socio-economic strata, whose parents have misconceptions concerning the use of foods, who come from broken homes or unstable families, who live under poor unsanitary conditions, and whose societal beliefs prohibit the use of many nutritious foods. In addition to food production activities at community level, health and nutrition education should be coupled with emphasis on adequate breast-feeding and safer and adequate supplementary feeding with locally available weaning foods. In this regard, it is necessary to convince parents and most Nigerian health workers that the unfortified *pap* is 90 to 95% water and low in total energy and proteins. Thus, breast-fed infants from populations at risk of PEM should be weaned with reinforced home-made *paps* as soon as the growth curve begins to flatten, the baby cries more often than usual, sleeps less but does not have a diarrhea or a pyrexia. Studies carried out in Nigeria has demonstrated that when home-made *pap* is fortified with ground toasted beans and palm oil, it is capable of sustaining adequate growth in children. Food and personal hygiene should also be stressed in these processes. Furthermore, having children by choice, rather than by chance should be the basis of family planning program of the community. Additionally, immunization programs and the early treatment of diarrhea become a must. Indeed, parents should be convinced that weaning foods should not be withheld from a child when he has diarrhea since feeding during a diarrheal episode often shortens the duration of the diarrhea.

Of the nutritional deficiency diseases found in Nigeria, the most widespread and serious are low birth weight and the Protein-Energy Malnutrition (PEM) syndromes, including kwashiorkor and marasmus. On the other hand, a PEM disease that gained international repute in Nigeria, in recent times is obesity. Indeed, obesity has been recognized by the WHO, in recent times, as a new pandemic disease of affluence.

3-1 Low Birth-weight

Normal birth-weight of children has been shown to depend on the health status and the general socio-economic conditions of the mother. The very first evidence of nutritional growth failure is that which accompanies the birth of a new baby, born of a malnourished mother. In the past, this was thought to be due to actual genetic differences, and may indeed be due to this factor, especially among certain racial groups around the world. However, it is now quite certain that low birth-weights, in general, are not a genetic characteristic, but are due, in part, to maternal malnutrition, possibly associated with protein deficiency, particularly in the last trimester. Indeed, similar features have been found among poorly-fed tropical children, while the ill-effect of maternal privation has been clearly demonstrated in babies born in the Netherlands shortly after the liberation of that country, and in Leningrad, during the Second World War. For some time, the majority of Black American children also showed low birth-weight as compared with Americans of European descent. Furthermore, it has been demonstrated that Black children of well-nourished mothers showed no significant weight variation from normal Caucasian values. In multi-racial South Africa, it has also been shown that the differences found in the birth-weights of Europeans, Coloreds, Bantus and Indians were attributable to differences in economic status of the parents.

However, the condition of low-weight neonates may have various, often multiple, etiologies. For example, symptomless maternal malaria in hyper endemic tropical areas, while rarely producing congenital disease, is often associated with placental infection, which has been shown to result in small but significant lowering of birth-weights. Furthermore, maternal malnutrition prior to and/or during pregnancy is more likely to produce an under-weight newborn baby.

Birth-weight doubling time is usually considered to take place around 5 to 6 months, but current data indicate a trend towards faster weight gain among babies. It has been reported that an average birth-weight of American children has a doubling time of 119 days (3.8 months). Formula-fed babies doubled their birth weight earlier than did breast-fed ones (113 versus 124 days). However, a general trend towards an increased rate of weight gain in infancy may contribute to later problems of obesity.

3-2 Kwashiorkor

Kwashiorkor is a severe clinical syndrome caused by a deficiency of protein. Although Kwashiorkor can occur even when the intake of energy is adequate, it has been shown that diarrhea and infections were often the precipitating causes of kwashiorkor, as there is no case of kwashiorkor without a history of infections. Thus, the following mechanisms may be involved: Firstly, the infections may divert the meager amino acid pool to the production of *globulins* and *acute phase reactant proteins*, instead of albumin and transport proteins. Secondly, the increase of *acute phase reactant proteins* which are proteinase inhibitors, may impair muscle protein breakdown. Thirdly, an impaired production and utilization of ketone bodies for energy during infections might lead to the use of more amino acids for gluconeogenesis. Now, protein catabolism and nitrogen losses are enhanced by many viral and febrile infections, probably through increased epinephrine and cortisol actions. Regardless of the mechanisms involved, protein losses during severe infections can amount to as much as 2% of muscle protein per day. Kwashiorkor occurs mainly among children between the ages of six months and three years, with the second year of life being the most vulnerable period. This coincides with the weaning period in which, as indicated earlier, the baby's diet is low in total energy and good quality protein, at a time when he most needs protein for growth and the formation of muscle tissue.

The characteristic symptoms of kwashiorkor are painless, pitting edema, lack of growth, muscle wasting with the retention of some subcutaneous fat, and psychomotor changes. With these changes, the patients are usually apathetic and irritable. They cry easily and do have an expression of misery and sadness. It is well documented that edema is the cardinal sign of kwashiorkor and the syndrome should not be diagnosed in its absence. The accompanying fluid accumulation was once believed to be due to the fall in serum albumin that accompanies severe kwashiorkor. According to this belief, as the serum albumin drops, the osmotic pressure also drops, and so fluid passes from the blood into the tissues. However, this belief does not explain why children being treated for kwashiorkor lose their edema before their blood protein level rises.

Although the classic theory of dietary cause of kwashiorkor (a diet of low protein-to-energy ratio) is still valid, recent report shows that symptoms result from an imbalance between the

production of toxic free radicals and their safe disposal. Among the factors that increase free radicals production are infections, toxins, sunlight, trauma and catalysts such as iron. The toxic effects of free radicals would be responsible for cell damage, leading to the noticeable alterations such as edema, fatty liver and skin lesions. This theory has drawn attention to factors and processes in the pathogenesis of severe PEM and may have important implications for its treatment. Accordingly, when there is a severe lack of food, endocrine adjustments mobilize fatty acids from adipose tissue, and amino acids from muscle tissue, thereby maintaining normal plasma protein concentration; but hepatic gluconeogenesis is enhanced. An increase in carbohydrate intake without a concomitant increase in protein intake can produce a breakdown of these adjustments. Thus, carbohydrates intake induces insulin release and a reduction in the production of epinephrine and cortisol. A high-carbohydrate, low-protein diet is not the only iatrogenic cause of serious metabolic disruption in patients who have or are prone to develop edematous PEM. The abrupt administration of excessive protein to patients with edematous PEM can also have serious life-threatening consequences. Lipolysis (fat mobilization) decreases and the action of insulin is enhanced on account of the suppression of the inhibitory effects of free fatty acids on the peripheral action of insulin. Muscle protein breakdown is also decreased, thus lowering the body pool of free amino acids. The decreased synthesis of plasma proteins (especially albumin) in the liver reduces intra-vascular osmotic pressure. Plasma water decreases and accumulates in extravascular tissues; tissue pressure rises and cardiac output diminishes, thus contributing to the appearance of edema. The increased hepatic fatty acid synthesis from the excess carbohydrate impairs lipolysis, but increases fatty infiltration of the liver and consequent hepatomegaly.

The pathogenesis of edema in severe kwashiorkor is an important issue because of the key role of edema in its diagnosis, and because it may give clues to a patient’s dietary background and other precipitating factors of the disease. This phenomenon has been linked to hypo-albuminemia through a reduction in osmotic pressure of the plasma, leading to an outflow of fluid from the capillaries into the interstitial space. However, there is an overlap in serum albumin levels between edematous and non-edematous kwashiorkor in both adults and children. But since the edema of kwashiorkor is reduced on treatment with protein-free or low protein diets that contain potassium and other minerals and moderate amounts of carbohydrates, it suggests that hypo-albuminemia may be a necessary but not a sufficient cause of edema, at least in some cases.

An associated theory for the production of edema in kwashiorkor involves a reduction in renal blood flow (RBF) and glomerular filtration rate (GFR) due to decreased plasma volume and decreased cardiac output as consequences of hypo-albuminemia. This decrease in RBF and GFR results in sodium retention and production of rennin and aldosterone, which would increase tubular reabsorption of sodium and water, leading to edema. From these various theories, it is possible that the pathogenesis of edema in kwashiorkor is not a single entity, and that it may differ in accordance with the associated multiple nutritional deficiencies, the age of the patients, and other concomitant conditions.

Infections in undernourished children can precipitate the onset of kwashiorkor by the following proposed mechanism: (a) Infections may divert the meager amino acid pool to the production of globulins and acute phase reactant proteins, instead of albumins and transport proteins. (b) An increase in the production of acute phase reactant proteins inhibits proteinases that may, in turn, impair muscle protein breakdown. (c) An impaired production and utilization of ketone bodies for energy during infections might lead to the use of more amino acids for gluconeogenesis. (d) Additionally, protein catabolism and nitrogen losses are enhanced by viral and many febrile infections probably through an increased epinephrine and cortisol actions.

Patients with severe energy deficiency are usually unable to maintain their supply of tissue and cell energy supply and a serious decompensation occurs causing hypoglycemia, hypothermia and impaired circulatory and renal functions, which results in acidosis, coma and death. These events can occur within a very short time. Thus, a premature introduction of a high-energy or high-protein diet may be fatal to a severely malnourished patient.

3-3 Marasmus or Simple Starvation

This is an extreme form of under-nutrition in which due to the lack of calories and proteins. The consequences of this condition are generalized muscle wasting and the absence of subcutaneous fat, which gives the “skin and bones” appearance. The children often have marked retardation in longitudinal growth, a lack of physical wellbeing, abnormal behavior and poor mental development. The hair is sparse, thin and without the normal sheen. The

cheeks are sunken by the disappearance of the Bichat fat pads (which usually gives shape to the face), giving it the appearance of a monkey's or little old man's face.

After the ingestion of a meal, food energy is stored, mostly in the form of high-energy phosphates, fat and glycogen which are drawn upon to obtain energy during the daily regular and relatively short periods of fasting and during periods of increased energy expenditure. Marasmic condition usually develops rather slowly to allow for better adaptation to energy inadequacy. Normally, a decreased energy intake is quickly followed by a decreased energy expenditure, which account for shorter periods of play and physical activity in children, and for longer rest periods and less physical work in adults. When the decrease in energy expenditure cannot compensate for inadequate intake, body fat is mobilized, at a faster rate than lean body mass, with a decrease in adiposity and weight loss. Lean body mass diminishes at a slower rate, mainly as a consequence of muscle protein catabolism. The catabolic product of this process contributes to the body's energy sources, but causes muscle wasting. As the cumulative energy deficit becomes more severe, subcutaneous fat is mobilized and used by the body. These alterations in body composition initially leads to an increased basal energy consumption and increased basal metabolic rate, which later decreases in the more severe stages. In the meantime, blood glucose concentration remains normal at the expense of gluconeogenic amino acids and glycerol from fats.

In situations where dietary proteins are of poor quality, body proteins will not be synthesized. As the individual gets maximally adapted, the consequent sparing of body proteins preserves only the essential protein-dependent functions. The gradual and inevitable body protein losses resulting from this long-term dietary protein deficit come mainly from skeletal muscle breakdown. Some visceral protein is lost in the early stages, but soon stabilizes until the nonessential tissue proteins are depleted. The loss of visceral proteins now accelerates and death may be imminent unless nutritional therapy is quickly instituted.

Under normal circumstances, some 75% of the free amino acids entering the body pool from dietary and tissue proteins are recycled or reutilized for protein synthesis. The remaining free amino acids are broken down for other metabolic purposes. When protein intake is reduced there is an adaptive decrease in amino acid turn-over rate and a proportional decrease in amino acid catabolism. This markedly reduces urea synthesis and urinary nitrogen excretion. Furthermore, there is a shift of albumin from the extra-vascular to the intra-vascular pool,

which assists the maintenance of adequate levels of circulating albumin in the face of reduced synthesis. A failure of this adaptive process leads to a reduction in serum (albumin) proteins. This reduction in intra-vascular oncotic pressure and outflow of water into the extra-vascular space contribute to the development of edema seen in the kwashiorkor patient.

Hormones play a crucial role in the process just described above. They contribute to the maintenance of energy homeostasis through increased glycolysis and lipolysis, increased amino acid mobilization, preservation of visceral proteins through increased breakdown of muscle proteins, decreased storage of glycogen fats and proteins and decreased energy metabolism. Decreased food intake tends to reduce plasma glucose and free amino acid concentrations that reduce insulin secretion and increase glucagon and epinephrine release. The stress induced by the low food intake also stimulates epinephrine release and corticosteroid secretion. Some investigators have postulated that the evolution of PEM into either kwashiorkor or marasmus may be partly related to differences in adrenocortical response, whereby the better response will preserve visceral proteins more efficiently and lead to the better-adapted syndrome of marasmus. Nevertheless, there is need for a gradual adjustment to normalcy as a premature introduction of a high-calorie diet may be fatal to a severely marasmic patient.

Severely underweight individuals are more likely to be ill, and their recovery from illness, surgery or injury is apt to take longer than with normal persons. Indeed, infections that cause the undernourished person to become acutely ill often have only a minor effect on the well nourished. Diarrhea, which is the primary cause of death for under-five children in the less developed countries, occurs much more frequently among the marasmic children than among the well-fed and worsens the condition; the rapid passage of food material through the intestine allows for limited absorption of nutrients. Researchers have demonstrated that work capacity is lessened and physical strength and endurance is seriously lowered. Voluntary exercise also decreased. Also, protein-energy malnutrition results in deficiencies that the body is slow to restore, since it is limited by a total body protein turnover of approximately 4% per day. Restoration of body protein is particularly difficult due to the priority of energy over protein requirements.

4-0 Conclusions

Dietary energy and protein deficiencies usually occur together. A high prevalence of the energy-deficiency diseases in any society is a reflection of the over-all inability of that society to feed itself. And there is hardly any case of kwashiorkor without a previous history of an infection. This is because when a nation is unable to optimally nourish her citizens by meeting their protein and energy needs, on diets that contain a variety of foods, which is the most basic reflection of being healthy, that nation must regard herself as a very sick society indeed. This inability to feed herself, not only leaves the citizens weak and sick physically, but also psychologically. This affects individual productivity at work and, for the children, at school, thereby reducing the full potential of her citizens. In the end, a triad of under-nutrition, nutritional disease and early death is unleashed on the citizens. In Nigeria, food consumption is generally deficient both in quality and quantity among the poor, thus promoting increased disease burdens, inability, by the women, to produce healthy children that could compete favorably with the children in the highly competitive world. However, on account of limited resources, special attention must be paid to the vulnerable groups, including children under two years of age from low socio-economic strata, whose parents have misconceptions concerning the use of foods, who live under poor unsanitary conditions, and whose societal beliefs prohibit the use of many nutritious foods. In addition to food production activities at community level, health and nutrition education should be coupled with emphasis on having children by choice rather than chance, adequate breast-feeding and safer and adequate supplementary feeding with locally available weaning foods.

5-0 Summary

The three protein-energy-related diseases discussed here have taken serious toll on the Nigerian populace. In the case of the other three energy deficiency-related diseases, namely, kwashiorkor, marasmus and low-birth weight, there is no straightforward relationship between energy intake and energy expenditure. In the main, there are vast differences as regards the precipitating factors, as one moves from one community to another. The confounding variables among these precipitating factors make solutions to the respective diseases unique and different.

Actually, the only similarity in the etiology of these diseases is the intake of protein- and energy- deficient foods. But as one moves from one community to another, one may find that poverty may be the main cause of the diseases concerned, while, in another, it may be ignorance, and in yet another, it may the lack of potable water which exposes the children to diarrheal diseases. In one case, the fault may have arisen from the use of inadequate weaning foods, while in another, a result of too frequent pregnancies or having children when the maternal tissues have not fully matured.

Therefore, in order to stem the present trend, the prevention and control of these diseases require multi-sectoral approaches that include (a) adequate food production and distribution, (b) preventive medicine, within the ambit of adequate nutrition education and socio-economic development and rehabilitation. Such approaches must entail a comprehensive program that involves both mother and child. For example, the use of a growth chart can be a valuable tool for the surveillance of the at-risk groups in society. Thus, special attention must be paid to the vulnerable groups, including children under two years of age and others. Furthermore, food production activities at community level should be coupled with health and nutrition education which emphasis adequate breast-feeding and safer and adequate supplementary feeding with locally-available weaning foods.

6-0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 7 Obesity: The Nutritional "Disease of Affluence" in Nigeria

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1-0 Introduction

Obesity, a pandemic disease of this century, is fast becoming one of the most important public health problems in Nigeria, as a recent study shows that one out of every sixth Nigeria may be carrying excess fat. Today, most people in the affluent world look upon obesity as undesirable; and obesity is regarded as a form of malnutrition, which is most prevalent among the lower socioeconomic groups, especially among women. In the poor countries, however, the reverse is usually the case as obesity is least common among the lower socioeconomic groups. Studies from Nigeria, so far, tend to support those from other parts of the African sub-region and from other less affluent societies where the incidence of obesity rises with an increasing degree of affluence. Among many Nigerian populations, until relatively recently, being fat, as characterized by excess accumulation of body fat, was considered an indication of affluence, beauty and health. Indeed, many Nigerians still view fatness (obesity) without any concern, as it is often believed to add to the prestige of an individual. But among the young educated Nigerians, especially among highly educated women, however, obesity us fast becoming a health concern, if even it is for esthetic or

economic reasons. Women generally are much more sensitive to obesity than men are - physical appearance is believed to be much more important to a woman than to a man.

2-0 Objectives

At the end of this unit you should be able to:

- discuss the subject from the following perspectives: historical perspectives, epidemiology, definition, measurement, causes of obesity and recommend the needed therapeutic treatment.
- Describe the causes, symptoms and measurement of obesity

3.0 Main Content

3.1 Historical Perspectives

The fact that excess weight has a deleterious effect on health had been noted as early as 400 BC by Hippocrates; but it was not until the 19^{th} century that there has been a gradual transition to an attitude that slenderness is ideal. Today, fashion designers and professional models are traditionally thin and beauty contest winners are rarely overweight. Furthermore, most people in the affluent world look upon obesity as an undesirable development and a form of malnutrition. In these societies, obesity is most prevalent in the lower socioeconomic groups. But in the poor countries, it is most prevalent among the rich. In the less developed transition countries of the world, obesity prevalence is beginning to show an alarming upward trend while in Nigeria, it is still considered an indication of affluence, beauty and health.

From the anatomic and physiologic view point, carrying excess weight may be desirable or even necessary, especially in societies where individuals are subjected to regular intervals of food scarcity. Indeed, for centuries, human survival depended on body fat accumulation and maximizing energy utilization. But in modern times when the supply of energy is constant throughout the year and the energy demand of daily activities has greatly decreased, that adaptation has become a severe handicap. Several major studies have shown that there is increased mortality with increasing overweight, with the higher mortality in men than in

women. Because it is highly correlated with an increased incidence of several diseases, it is important to understand its pathophysiology and the measure to prevent or treat it.

3.2 Epidemiology of Obesity

An extensive Norwegian study also showed that relative mortality increased as the BMI increased above 27. However, the Whitehall study of 18,000 English subjects showed that the relationship between weight and mortality changes at different times of life, and there seems to be a protective effect of increased weight in old age. Evidence has also shown that when obesity occurs at earlier ages (20-40 years), it has a greater influence on cardiovascular disease than later-onset obesity. The finding of a relationship between obesity and increased mortality at a young age, with no such relationship at an older age implies that it is continuous obesity over many years that affects health and can lead to death. Since many of these deaths arise from cardiovascular disease and diabetes, it would appear that there are different optima for different cause of death at different time periods and no single value of weight or fatness is optimal for all. Whereas the Framingham Heart Study showed a close relationship between obesity and diabetes, it also shows a predictable increase in cardiovascular risk factors as weight increases. For example, a 10% rise in relative weight brings about a 6.5 mm rise in systolic blood pressure, 12 mg per dl rise in plasma cholesterol and a 2 mg per dl rise in blood glucose. Consequently, hypertension occurs more often among the obese than among the non-obese, and the mortality rate of those who are obese hypertensives is higher than for those who are only obese or only hypertensive. Furthermore, extremely obese individuals develop respiratory difficulties, commonly called the Pickwickian syndrome, which produces lethargy and somnolence. Thus, although cause and effect have not been clearly established, obesity has a high association with coronary artery heart disease, hypertension and maturity-onset diabetes.

3.3 Definition and Measurement of Obesity

Obesity, as characterized by an excess accumulation of body fat, has become a major health concern of the modern man. When an individual’s energy intake consistently exceeds expenditure, weight gain occurs and this ultimately results in obesity. In Western societies, weight and body composition changes with age. In a normal adult male, subcutaneous fat is

about 11% of the body weight, while it is 18% for the adult female, with a gradual increase in women from 20 to 60 and a more gradual increase for men from 20 to 50, with a fall thereafter. A gradual accretion of fat and loss of lean body mass accompany these changes.

It is for this reason that the WHO classification for obesity has been found to be a practical clinical tool. The method is based on two simple measurements: height, without shoes and weight, with minimal clothing. This method is based on the weight/height^2, referred to as the Body Mass Index (BMI). A BMI of between 25 and 29.9 is regarded as overweight, followed by obesity grade I of a BMI of 30 to 34.5, grade II of 35 to 39.9 and grade III of over 40. Normal adults have a BMI of 18.5 to 24.9. On account of the fact that being overweight is not synonymous with being obese, it has become necessary to adopt the term, 'desirable' or 'ideal' weight, which is the weight that conforms to the longest life span. Since more than half of the fat in the body is deposited under the skin, and its percentage increases with age, triceps skin-fold thickness measurement has been proposed as a useful tool for measuring obesity in adults. It has also been proposed that the figures of 23 mm and 30 mm for male and female adults respectively as the minimum for defining the presence of obesity.

In general, an adult obese person is one (i) who, with the exception of the muscular athlete, is 9 kg or more above her desirable weight, (ii) who weighs 15-20% or more above her desirable weight or weight attained at the age of 20, under normal nutritional considerations (desirable weight being that which is compatible with optimum health and longevity), (iii) whose triceps skin-fold thickness is 23 mm or more for men and 30 mm or more for women at the age of 30 to 40, and (iv) whose BMI exceeds 29.9.

3.4 Causes of Obesity

Now it is important to understand the causes of obesity as these have serious implications for its management. There are many reasons why people get fat. But the underlying factor is ruled by the Law of Conservation of Energy, which states that energy can neither be created nor destroyed but can be changed from one form to another. The excess energy that is consumed gets stored as fat in the body, and can be likened to a savings account in which more money goes into the account than comes out of it. The excess energy consumed by an individual is stored in the tissues as potential energy in the form of fat. The causes of obesity,

which vary between individuals, may be due to one, two or more of the factors listed below. These causes are broadly discussed under genetic, behavioral, physiological, and environmental factors.

Although the evidence to determine the influence of heredity on obesity is inconclusive, there are a number of investigations showing a high incidence of obesity among the parents of the obese. Studies have provided circumstantial evidence to indicate that only 7% of the children of normal weight parents are obese, whereas it is 40% when one parent is obese and 80% when both parents are obese. In other words, if neither parent is obese, your risk of obesity may be less than 10%. But if you have one obese parent, the risk of fatness rises to 40%; and if both parents are obese, your chances of becoming so are some 80%. But the impact of family food and food consumption patterns, which are taught by parents is thought to have a great impact and can not be excluded or overlooked, for this might be a reflection of shared eating habits or activity patterns. In a study of 239 obese persons, 69% of them had obese (one or both) parents. With adopted children, a lower correlation was observed between the weight of the children and that of their parents than was observed between natural children and their parents. Some studies, while showing a greater difference in twins raised apart than in twins raised together, thereby implicating environment, also showed greater weight difference than did identical twins, with remarkable tendency towards similar fatness or thinness, suggesting a strong genetic component and a significant contribution of heredity to weight. The clear genetic effects of heredity are thus modified by environmental and behavioral factors. Furthermore, the shape of the body helps to determine the total body surface. A long, thin person will have much more body surface than will a short, plump person of the same weight. And the greater the body surface, the greater the heat loss - greater skin surface contributes to higher basal metabolism. It may also influence how many calories of energy are lost during activity. Thus, nature tends to exaggerate the problems of the heavy and perpetuate them. Ultimately, what is inherited "may result in different weights in different circumstances, since it is a product of both nature and nurture".

A related factor in the development of obesity is the body type or somatotypes. In general, there are three body types, namely, **endomorphic** (soft and roundish), **mesomorphic** (bony and muscular) and **ectomorphic** (lean, linear, fragile, thin or slender, usually with long thin fingers). The ectomorph has low fat storage capacity. The endomorph is almost an opposite. He has much fat storage capacity. The mesomorph is more-or-less in-between. They are the

stocky, muscular, heavy-boned types. Pure body types are rare, however, and the combinations are more common. Obesity is found more frequently among some body types than others. Studies have shown that obese adolescents girls tend to be more endomorphic, somewhat less mesomorphic but considerably less ectomorphic. But all these facts merely show genetic predisposition. What ultimately determine obesity, as indicated earlier, is the amount and or utilization of available food energy, especially when it is in excess of 'normal' needs.

In very obese adults, the spectacular cellular difference is in both the number and size of fat cells. However, when these adults lose weight, the effect is almost entirely on cell size; cell number changes very little, if at all. Adipose tissues are normally found in infants but the number and size depend on the nutrition of the mother during pregnancy and in the post-natal nutrition. In the pre-natal and early post-natal period, growth in tissue cells take place by an increase in the number and size of cells, but more predominantly by an increase in cell number. These authors have suggested that obesity, which results from an increase in the number of fat cell is an hyperplastic form of obesity, whereas that of fat cell size is hypertrophic obesity. Obesity that appears early in life is primarily hyperplastic in nature, whereas that which appears in adulthood is primarily hypertrophy. At age 10-11, there appears to be another critical period for the multiplication of adipocytes. But if a person becomes obese after age 20, the number of cells does not increase; individual cells merely enlarge. Thus, the first three years of life and adolescent period are the crucial periods of life that determine whether an individual will become obese or not. The importance of this is that overfeeding of infants and young children leads to an increased number of fat cells and predisposes the individual to adult obesity.

Whereas endocrinopathy is a rare cause of obesity, an over-activity of the adrenal gland, which produces Cushing's syndrome, is the main cause of central obesity. Thus, obesity may lead to abnormalities of hormone levels. Furthermore, there is concurrence on the existence of a food regulation center, which is located in the hypothalamus of the brain. A short-term regulation of daily food intake occurs by a regulation of the glucose-sensitive receptors found in the ventromedial nucleus (satiety center) of the hypothalamus. When blood glucose is high, the lateral nucleus (feeding center) is shut off and activated again when glucose levels are low. The obese compulsive eater seems to have lost this normal control mechanism and his appetite is controlled by external influences. Studies have shown that the obese do not know when they are hungry or when they are full. Thus, the obese, whose eating is mainly

externally controlled, finds it difficult to stop eating. Although many obese individuals are under the illusion that their endocrine glands are responsible for their obese state, research has shown that very few obese individuals show any clinical or laboratory evidence of difficulty with their endocrine glands. A small lesion in this center brings about dramatic changes in eating patterns. In severe hypo-thyroidism, there may be some increased adipose tissue mass, but most of the increased weight is water, and few obese patients suffer from hypothyroidism.

The resultant obesity, thus produced by an increased food intake, may create emotional or psycho-logical disturbances such as rejection, frustration, loneliness, separation from family, failure in school or in personal relationships or family conflicts, tension, fear and boredom. It could also generate the lack of affection, recognition or fulfillment, failure and the need for pleasure. Traumatic or less dramatic events in the lives of individuals (the loss of a loved one, subjection to war, crises or crime) may lead to the onset of obesity. Eating offers comfort to an individual who suffers from unwholesome self-concept and poor self image, feelings of inadequacy, inferiority and failure. Obese adolescents and adults whose excess weight emerged in childhood are especially vulnerable to rejection. Individuals who became obese as adults are inclined to be more objective and less self-derogatory. Thus, some psychologists have interpreted excessive eating, as a way of meeting emotional needs - a compensation for basic personality problem. Unfortunately, some of these feelings could result from childhood obesity, followed, in the adolescent years, by rejection and these other feelings operating in a vicious cycle. On the other hand, where food has been used as rewards, it may lead to dependence on food as source of comfort, affection or fulfillment, leading to heightened food consumption and overweight condition.

Besides, the physical activities of an individual constitute a measure of his lifestyle. The modern man is constantly looking for ways of reducing his level of physical activities. Usually, this is brought about through inventions of modern technology and mechanization. Such inventions include automobiles, television, elevators, dish washers, cooking-gas stove, and the pipe-borne (tap) water. These modern conveniences have shifted the energy equation positively, and have turned a large segment of our population into a sedentary people. Even the most popular sports tend to be the spectator-types. The spectator role in sports and the general disinclination to participate in physical activity contribute to the obesity syndrome. Also there is a concentration of populations in cities where there are no ample opportunities

for pleasurable exercise. Thus, where physical activity is not highly prized, the genetic potential for obesity has greater opportunity to be expressed. The contention that exercise increases appetite, and leads to increased energy intake, thus promoting weight gain, may promote a more sedentary life-style. On the other hand, there is evidence to support the belief that physical activity is the most important environmental variable affecting obesity. For example, the job prescription for a traffic police warden, a military cadet-in-training or a coal-miner requires much greater expenditure of energy than that for an office typist, who spends the same number of hours at work. Whereas studies have shown that obese school children may actually eat less than their normal weight controls, an astounding finding is that they spend much less of their time in activities involving exercise.

Self Assessment exercises 1:

Enumerate 4 causes of obesity----------

3.6 Treatment and Prevention of Obesity

Since obesity is an important health concern for which modern medical profession provides little or not effective cure, its best and most effective treatment is its prevention. Losing weight and keeping off the weight is extremely difficult, especially for individuals who are 25% or more overweight. A gain of 2 kg above one's ideal body weight (see table below) should be a signal to begin curtailing one's energy intake or increasing one's energy expenditure. The mode of treatment varies from one individual to another; but it can include diet and dietary advice, psychological counseling, exercise and drugs.

Table Showing How To Calculate Your Ideal Body Weight

Determine the height and weight in meters (m) and kilograms (kg). If they were in feet and pounds, then convert by dividing feet by 3.28 and the weight by a factor of 2.2.

For Women: Give 45 kg for the first 1.5 m. For each additional 0.03 m in height, add 2.3 kg to the weight. Then add or subtract 10% of the resultant figure to determine the weight range. For example, a 1.65-m tall woman should have an IBW calculated as follows:

1.65 m = 745 + (0.15 x 2.3)/0.03? = 45 + 11.5 = 56.5 kg.

At any one time, a woman's weight lies in a range of weight for her weight-height group, and this range lies ±10% of this median weight. Therefore, the woman's ideal weight lies in a range between 56.5 - 5.65 and 56.5 + 5.65, i.e. approx. between 51 and 63 kg.

For Men: Give 50 kg for the first 1.5 m. For each additional 0.03 m in height, add 2.3 kg to the weight. Then add or subtract 10% of the resultant figure to determine the weight range. For example, a 1.65-m tall man should have an IBW calculated as follows:

1.65 m = 750 + (0.15 x 2.3)/0.03? = 50 + 11.5 = 61.5 kg

At any one time, a man's weight lies in a range of weight for his weight-height group, and this range lies ±10% of this median weight. Therefore, the man's ideal weight lies in a range between 61.5 - 6.15 and 61.5 + 6.15, i.e. approx. between 55 and 68 kg.

This is only a quick but approximate method of determining an Ideal Body Weight. One should remember, however, that the ultimate ideal body weight for each individual is the weight that conforms to optimum health and longevity. And this will vary even between individuals carrying the same body weight and height. within the same cultural setting.

4-0 Conclusions

In the less developed transition countries of the world, obesity prevalence is beginning to show an alarming upward trend. Wherever obesity thrives, there is usually a reduction in the physical activity levels of the people. Usually, this is brought about through inventions of modern technology and mechanization. Such inventions include automobiles, television,

elevators, dish washers, cooking-gas stove, and the pipe-borne (tap) water. These modern conveniences have shifted the energy equation positively, and have turned a large segment of our population into a sedentary people. Unfortunately in Nigeria, obesity is still considered an indication of affluence, beauty and health. But the younger educated elements of the Nigerian society are beginning to detest carrying excess weight. Besides, as several major studies have shown that there is increased mortality with increasing overweight, with the higher mortality in men than in women, the Nigerian society must be educated on the dire need to become more weight-conscious.

5-0 Summary

When an individual's energy intake consistently exceeds expenditure, weight gain occurs and this ultimately results in obesity. Most people in the affluent world look upon obesity as an undesirable development and a form of malnutrition. Indeed, its occurrence is highly correlated with an increased incidence of several diseases. But in Nigeria, it is viewed as a sign of affluence or at best, robust living. Indeed, in many parts of the country, it is still considered an indication of affluence, beauty and health. From anatomic and physiologic view point, carrying excess weight may be desirable or even necessary, especially where individuals are subjected to regular intervals of food scarcity. But in modern times when the supply of energy is constant throughout the year and the energy demand of daily activities has greatly decreased, that adaptation has become a severe handicap.

By WHO definition and measurement, a Body Mass Index (BMI) of between 25 and 29.9 is regarded as overweight, followed by obesity grade I of a BMI of 30 to 34.5, grade II of 35 to 39.9 and grade III of over 40. Normal adults have a BMI of 18.5 to 24.9. Evidence has shown that when obesity occurs at earlier ages (20-40 years), it has a greater influence on cardiovascular disease than later-onset obesity. Findings have also shown that there is a relationship between obesity and increased mortality at a young age, with no such relationship at an older age implying that it is continuous obesity over many years that affects health and can lead to death. Thus, although cause and effect have not been clearly established, obesity has a high association with coronary artery heart disease, hypertension and maturity-onset diabetes.

The causes of obesity vary between individuals, but may be due to one, two or more of the following factors, namely, genetic, behavioral, physiological, and environmental. Evidence to determine the influence of heredity on obesity is inconclusive. Studies have provided circumstantial evidence to indicate that only 7% of the children of normal weight parents are obese, whereas it is 40% when one parent is obese and 80% when both parents are obese. In other words, if neither parent is obese, your risk of obesity may be less than 10%. But the impact of family food and food consumption patterns, which are taught by parents is thought to have a great impact and can not be excluded or overlooked, for this might be a reflection of shared eating habits or activity patterns. Thus, genetic predisposition may have been modified by environmental and behavioral factors. The implication of this is that nature tends to exaggerate the problems of the heavy and perpetuate them. Ultimately, however, what is inherited "may result in different weights in different circumstances, since it is a product of both nature and nurture".

There are segments of the population that have access to abundance of food, in the presence of the many laborsaving devices at their disposal. From the moment these individuals rise in the morning until they go to bed at night, they engage in very little or no exerting activities. At the end of the day, their energy is conserved, thereby accumulating the extra energy saved in the form of body fat.

While the issue of obesity is not as pressing in the Nigerian society as those of under-nutrition, health workers need to appreciate that, as Nigerians put in place those facilities that will preserve and extend life, they must equally be concerned with the issues that maintain these lives optimally in their old age. So far, there is no other factor that is capable of influencing the health status of the aged as much as the maintenance of a trim body. The consequences of ignoring this pandemic disease is too grim to imagine, as the citizens of the developed world are beginning to find out that that excess weight has a deleterious effect on health. The current surge of obesity in virtually every society has been brought about through inventions of modern technology and mechanization. Such inventions include automobiles, television, cooking-gas stove, and the pipe-borne (tap) water. These modern conveniences have shifted in favor of a large segment of our sedentary population. Even the once popular spectator-type sports like football, and track-and-field events no longer attract the huge crowd they once attracted. The people would now rather watch these events on their television networks. However, since obesity is an important health concern for which modern medical

profession provides little or no effective cure, its best and most effective treatment is its prevention. Losing weight and keeping off the weight is extremely difficult, especially for individuals who are 25% or more overweight. Therefore, a gain of 2 kg above one's ideal body weight should be a signal to begin curtailing one's energy intake or increasing one's energy expenditure by regular, consistent and sustainable exercise.

6.0 Answer to Exercises

See 3.4 for guide

7.0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 8 – Vitamin Deficiency Diseases in Nigeria

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1-0 Introduction

When nutrient deficiencies were first noted, they were generally associated with vitamin deficiencies. This is partly because vitamin deficiencies underlie numerous diseases, and also because numerous diseases induce vitamin deficiencies. Today, nutritional diseases are commonly associated with the excessive or deficient intake of some 55 different nutrients needed by the human body. It is impractical that the deficiencies or excessive intake of all 55 known nutrients be discussed in just one course, lasting just a few weeks. However, an attempt will be made to deal with only a few of the prominent ones commonly found in Nigeria.

The following representative classical vitamin deficiency diseases, namely, the vitamin A deficiency syndromes (xerophthalmia/keratomalacia) and rickets or osteomalacia will now be discussed together on account of their common occurrence in Nigeria. Before the discovery of the vitamins and the subsequent elucidation of their roles in human nutrition vitamin deficiency diseases were more prevalent in human populations than they are in modern times. Thus, the complexity of their pathogenesis must be kept in mind when details of the disease syndromes are being discussed, since an understanding of the underlying causes will make it

possible for the public health worker to prevent their occurrence. For example, chronic alcoholism, drug abuse or even the medically supervised use of drugs and certain food fadism may lead to deficiency disease states.

2-0 Objectives

At the end of this unit you will be able to:

- present a short history of these two vitamins;
- explain how these vitamins function;
- present their patho-physiology,
- present the cure and preventive measures to be taken.

3-0 Main Content

In this presentation, we shall learn about some of the deadliest nutritional diseases that had plagued man for centuries and have continued to have serious socio-economic impact in our time. In this segment, we shall be discussing keratomalacia/xerophthalmia, which is the nutritional cause of blindness in many nations. This will be followed by a discussion of rickets, which had either being a plague in their history or continues to be so, to a lesser degree, even in the present times.

3.1 Xerophthalmia/Keratomalacia

There is perhaps, no other nutritional disorder that has been studied in greater details than that of vitamin A. Night blindness was a well-recognized disease in ancient Egypt. But the credit for announcing the first vitamin (vitamin A) known to be essential to man goes to two outstanding groups of investigators - Osborne and Mendel at Yale and McCollum and Davis at the University of Wisconsin. The discoveries by these investigators in 1913 mark the beginning of the modern nutritional history of vitamin A. Earlier in 1904, the disease had been observed in children fed fat-free diets. Similar symptoms were observed in Danish children who suffered from a lack of dairy products in their diets. Of the estimated 5 million children who develop xerophthalmia annually, approximately one-quarter of them become blind within one year, and another half of the children die. Xerophthalmia seldom occurs in

isolation as it is often associated with marasmus and kwashiorkor. When the disease does not accompany protein-energy malnutrition, its mortality rate is much reduced.

Under normal circumstances, the receptor cells or cones of the retina require constant replenishment of the small amounts of vitamin A lost in the visual cycle during which a nerve impulse is transmitted to the optical nerve and rhodopsin is regenerated. But when there is a deficiency of vitamin A, it expresses itself in a progressive manner. First, the vitamin A-deficient person experiences a history of night blindness (nyctalopia), which results from a reduced concentration of rhodopsin (low serum vitamin A values) in the rod outer segments of the eye, followed by a sequence of abnormalities of increasing severity in the conjunctiva and cornea, termed xerophthalmia. In xerophthalmia, the protective secretions of the eye is lost with consequent keratinization of the epithelial cells. The eyes become dry; the cornea (the transparent outer covering of the eye) also becomes dry and loses its sensitivity. The corneal involvement seems to arise from proteolytic destruction of collagen and other structural proteins following leukocyte infiltration into the corneal stroma. Secondly, this is followed by dryness (xerosis) of the bulbar conjunctiva. A further advancement of this process is the development of Bitot's spot, a heaping up of desquamated, keratinized epithelial cells. The conjunctival changes, which include a loss of goblet cells and the development of Bitot's spots overlying keratinized epithelia, are likely caused by a reduced concentration of retinol and of glycoproteins in tear fluid. Severe irreversible changes in the cornea, which ultimately perforates with loss of aqueous humor, is called keratomalacia. This irreversible corneal involvement commences as a superficial punctate keratopathy, which ultimately perforates the aqueous humor. It proceeds to varying degrees of ulceration and liquefaction. Protein-energy malnutrition and zinc deficiency may also lower the rhodopsin content of the eye, thus, exacerbating the condition. Viral infection such as measles, also exacerbates the process and subsequent bacterial infection complicates it.

Vitamin A deficiency also produces skin changes of extra-ocular manifestations including perifollicular hyperkeratosis, a heaping up of hyperkeratinized skin epithelium around hair follicles. Thus, vitamin A is necessary for the maintenance of the skin.

In the early days of the history of vitamin A, it was termed the "anti-infective" vitamin, based on the increased number of infections noted in vitamin A-deficient animals and humans. In vitamin A deficiency, both specific and nonspecific protective mechanisms are impaired,

namely the humoral response to bacterial, parasitic and viral infections, cell-mediated immunity, mucosal immunity, natural killer cell activity and phagocytosis.

Vitamin A is not a limiting nutrient in healthy individuals who eat an adequate mixed diet. Good dietary sources of preformed vitamin A are liver and other internal organs, whole eggs, dairy products and whole small fish. By far the richest sources of preformed vitamin A are the liver oils of marine fish and of marine mammals. On the other hand, the good sources of provitamin A (precursors) are carrots, dark green leafy vegetables, yams, spinach, tomatoes, yellow maize, papayas, ripe mangoes and oranges. The richest sources of carotenoids are red palm oil and carrot oil. Nutritionally, palm oil is preferable to most other vegetable oils found in the Nigerian market.

Self Assessment Exercise 1:

Summarize the history of Xerophthalmia in 3 lines.

3-3 Rickets/Osteomalacia

Francis Glisson was the first to describe the clinical manifestation of the bone disorder which later came to be known as rickets. Children had been afflicted with rickets for centuries before the relationship of the deforming disease to vitamin D or sunshine was understood. It was a prevalent disease in England and other industrialized nations of the Northern Hemisphere during the Industrial revolution. This was a time when there was slum crowding in the cities and the smoke poured into the air to block the sun. In 1890, Palm observed that the disease was rare where sunshine was abundant, and in 1919 Mellanby demonstrated that rickets was a nutritional disease. In 1922, McCollum and coworkers discovered that cod liver oil contained an antirachitic factor that he named vitamin D.

By current definitions, vitamin D can be viewed as both a vitamin and a hormone. Thus, vitamin D supplementation is unnecessary for those who are able to meet their requirement through the sunlight activation of 7-dehydrocholesterol in the skin. The resultant active metabolite, 1,25-dihydroxycholecalciferol, produced exclusively in the kidney and functions in the intestines and bones, thus serves as a hormone. The most current nomenclature of the active forms of the vitamin, namely vitamin D_2 and D_3 are respectively referred to as ergocalciferol or ercalciol and cholecalciferol or calciol.

It has been demonstrated that vitamin D brings about normal bone and endochondral calcification, preventing rickets in the young and osteomalacia in the adult. Thus, the biochemical and physiological consequences of inadequate vitamin D intake results in rickets in growing children and osteomalacia in adults. The ultimate effect of vitamin D is that the vitamin D hormone alters the intestinal epithelial cells to permit Ca to enter the cell to be transferred across and to be expelled in the serosal medium by a Na-dependent process. Rickets occurs when newly synthesized organic matrix, osteoid, fails to mineralize, resulting in soft bones. It shows a stricking failure of endochondrial calcification, which results in the widening of the epiphyseal plate and the buildup of osteoid tissue, seen as bone deformities, especially the bowing of the leg. In some instances, knock knees result instead of bowed legs. Since the vitamin is essential for Ca absorption, it may also function in the prevention of osteoporosis later in life. The usual background of such a person is a series of pregnancies and periods of lactation, combined with a low intake of vitamin D intake and little exposure to sunlight. The proof of the disease is that the defective absorption of calcium in the disease is promptly corrected by vitamin D therapy. Usually, there is an extensive demineralization of the skeleton.

Few foods, other than liver, supply much vitamin D. Nature seemed to have relied on the sun’s irradiation of the skin to form vitamin D3, which is the form more often found in fatty fishes, eggs and liver. Ordinarily, a daily vitamin D requirement of 200 to 400 international units (I.U.) can be satisfied without vitamin supplementation. However, since rickets can occur in breast-fed infants or those who are fed unfortified milk, it is recommended that a daily supplement of 400 IU be administered.

4.0 Conclusion

The micro-nutrient deficiencies discussed in this segment are all easily preventable if proper nutrition education is emphasized. Fortunately, the foods which provide these nutrients are all easily obtainable in practically all the endemic the communities. What needs to be emphasized and vigorously promoted is the adoption of culturally acceptable delivery of their food sources. The iodization programs of the World Health Organization, which incorporate several of these nutrients in deliverable source, such as vitamin A-enriched salts have gone a long way to eliminate or stem their high prevalence world wide. In terms of vitamin D, nature has endowed us in the African sub-region, with abundant sunshine that exposes us to the UV light that irradiates the preformed vitamin D to its active form. People should be educated on the advantages of being exposed to early sunshine, as a way of obtaining all the vitamin D required.

5-0 Summary

Of the estimated 5 million children who develop xerophthalmia annually, approximately one-quarter of them become blind within one year, and another half of the children die. Although the cause of this disease is well known, its prevalence continues to attest to the socio-cultural factors perpetrating it. Furthermore, since this disease does not only affects the eye, but also the skin, as well as the body's ability to withstand infections, special educational programs need to be mounted to overcome the disease or prevent its escalation, world-wide. Fortuitously, many of the good sources of provitamin A (precursors) are the readily available sources, such as carrots, dark green leafy vegetables, yams, spinach, tomatoes, yellow maize, papayas, ripe mangoes and oranges, and its richest sources of carotenoids are red palm oil and carrot oil. It is difficult to understand why this disease should be so prevalent in places where these foods abound.

6.0 Answer to Exercises

See 3.2 for guide.

7.0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

2. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 9 Mineral Deficiency Diseases in Nigeria

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1-0 Introduction

Nearly half of the world's population lives in areas where there is significant iodine deficiency. Its worst consequences are found in the developing fetus and child, leading to death, complications of pregnancy and irreversible mental retardation. The knowledge of endemic goiter, now known to result from iodine deficiency, goes back many centuries. Although the association of endemic goiter with endemic cretinism had been recognized since the 17^{th} century, its relation to the thyroid gland was not known until the 19^{th} century. It was in the early 1920s that salt iodization was introduced.

Although early Egyptians used rust (iron oxide) to treat baldness, it was not until 1932 that its role in human nutrition became established. Although iron constitutes only about 4 grams in the entire body of a well-nourished adult, its significance in the physical well-being of an individual can not be over-emphasized. Iron is one of the most important elements in human nutrition, as it is of fundamental importance to life. However, its role in nutrition is almost exclusively confined to its role in oxygen transport and cellular respiration.

2-0 Objectives

At the end of this unit you will be able to:

- describe the physiological role and consequences of iodine deficiency in human populations;
- describe the physiological role and limitations of dietary sources of iron.
- explain the vagaries and prospects for the supplementation of these two minerals in human populations.

3-0 Main Content

3.1 Goiter

Although the Chinese had used seaweed as a remedy for goiter for centuries, iodine was not used for the treatment of goiter until 1816. Similarly, even though Courtois had discovered the element in 1811, during the course of making gunpowder, it was not until 1895 that Baumann discovered it in the thyroid gland in 1895. A landmark event in the history of this mineral was demonstrated in 1917 by Marine and Kimball when they showed that endemic goiter could be prevented by administration of small amounts of iodine to children at risk. They later demonstrated that goiter resulted from iodine deficiency. Subsequently, mass prophylaxis of goiter with iodized salt was first introduced in Switzerland and in Michigan. When goiter is due to the lack of iodine, it is termed simple, endemic or euthyroid goiter. This disease is more common in women than in men and is often noticed at the onset of puberty, during pregnancy, or at the menopause. In the developing countries of the world, more than one billion persons are said to be at risk of iodine deficiency disorders. In these places, some 220 million people suffer from goiter, and more than 5 million are suffering from mental retardation as gross cretins, and 15 to 25 million suffer from lesser mental defects.

Most of the iodine found in nature resides in the sea and ocean. Glaciation, snow, or rain, having been washed down from the hilly regions of the world brought it there. Thus, iodine deficiency is likely to occur in all elevated regions subject to glaciation, high rainfall and runoff. Iodine occurs in soil and the sea as iodide. Iodine ions are oxidized by sunlight to elemental iodine, which is volatile. Annually, some 400,000 tons of iodine escape from the

surface of the sea. Happily, some of this is returned to the soil by rainfall, but it does not compensate for the loss. Consequently, primary iodine deficiency persists in the soil indefinitely, and all crops grown in such soils are iodine-deficient. This may explain why goiter is found mainly in the hilly regions of Nigeria. Where food supply comes from crops grown on iodine-deficient land, supplement will have to be provided or the diet diversified to allow for sea foods.

The regulation of the thyroid hormones is a complex process involving several organs, including the thyroid, the pituitary, the brain and the peripheral tissues. Consequently, when goiter is severe, it is often accompanied by cretinism. In recent years, it has become evident that maternal iodine deficiency is an important cause of fetal growth retardation, which particularly affect the development of the brain.

The thyroid gland, which weighs only about 15 to 25 g, contains about 70 to 80% of the total iodine in the body, thus possessing a remarkable concentrating power for iodine. However, the normal intake and requirement for the mineral is about 100 to 150 micrograms. Within the thyroid gland, it exists as inorganic iodine. Its functional forms are the iodine-containing amino acids, monoiodothyronine (MIT), diiodo-thyronine (DIT) and as polypeptides containing thyroxine.The thyroid gland has to trap about 60 micrograms of iodine per day in order to maintain an adequate supply of thyroxine. The active transport mechanism by which this happens is what is called the ”iodine pump,” and is regulated by the thyroid-stimulating hormone.

In communities where improperly processed cassava is consumed, goitrogens such as thiocyanate - a derivative of hydrogen cyanide found in cassava - may compete with iodide, thus rendering the iodine unavailable. Where there is a congenital defect in biosynthesis of MIT and DIT, it might result in a congenital form of goiter and hypothyroidism, which may run in families. However, congenital goiter does not occur in iodine-deficient goiter. Where goiter is due primary to iodine deficiency, the term, iodine deficiency disorder (IDD) has been used to describe the effects of the deficiency. Indeed, iodine deficiency is indicated in any community when the 8-14 year-olds are shown to have goiter.

The Food and Nutrition Board (1989) has recommended that a daily iodine intake of 40 micrograms for children aged 0 to 6 months, 50 micrograms for those between 6 months and

1 year, 70 to 120 micro-grams for 1 to 10 year-olds and 120 to 150 micrograms for 11 year-olds and beyond. The recommended rates during pregnancy and lactation, respectively, are 175 to 200 micrograms. These amounts are usually supplied by increasing the amount of sea foods consumed in the community and by the use of iodized salt and injectable iodized oil. Currently, an International Council for the Control of Iodine Deficiency Disorders (ICCIDD) is being coordinated by the WHO and UNICEF.

3.2 Iron-Deficiency Anemia

Anemia is a decrease in the total red cell mass due to fewer red blood cells or to smaller red blood cells which contain less hemoglobin. There are three forms of nutritional anemia, depending on the nutritional factor(s) involved in their causation. These factors include iron, folic acid and vitamin B_{12}, the deficiencies of which respectively, cause iron deficiency anemia, folic acid deficiency anemia and pernicious anemia. The commonest of them is iron deficiency anemia. This review will be dealing with only the latter since it is, by far, the commonest of them all. Furthermore, iron deficiency is a systemic disorder in which symptoms do not arise from the anemia alone, but may occur in the absence of an anemia.

The infantile form of hypochromic iron-deficiency anemia occurs during infancy all over the world. Unfortunately, anemias, especially, iron-deficiency anemia, constitute an important problem that has received less attention than it deserves, possibly because of its relatively undramatic clinical picture. Indeed, iron deficiency is the most common nutrient deficiency and may well be the most common organic/nutritional disease of man. Hypochromia and microcytosis of the red blood cells characterize severe iron deficiency anemia.

Iron deficiency results from one or a combination of the following inadequate diet, impaired absorption, blood loss or repeated pregnancies. However, iron-poor diet is very rarely the primary cause of iron deficiency in adults. This is because the normal excretory loss of iron is so small that once a person has attained adulthood with normal body iron stores, a subsequent iron-poor diet and poor iron absorption deplete iron reserves and lead to anemia only after many years. Spoon-shaped nails (koilonychia) are characteristic of long-standing iron deficiency. Even mild degrees of iron deficiency are considered to be an important factor in decreased work efficiency.

Iron, as a metal, is one of the most useful in technology and biology as they are involved in numerous oxidation-reduction reactions. Aerobic metabolism is dependent on iron because of its role in the functional groups of most of the enzymes of the Krebs cycle and as an electron carrier in cytochromes. Iron-deficiency anemia is most prevalent during pregnancy. This is because the requirements during pregnancy are frequently so large that they are greater than the amount available from diet alone thus necessitating supplemental therapy, especially in the last trimester. During the last trimester of pregnancy, 3 to 4 mg of iron are transferred to the fetus each day. The fetus has a highly effective acceptor system for assimilating iron. Normally, iron from maternal transferrin is moved to the placental tissue, to the fetal plasma transferrin, from where it is transferred to the placental tissue in a unidirectional pathway that operates against increased maternal requirement for iron, even when there is maternal iron deficiency. In areas where intestinal heminthiasis, especially hookworm disease, exists in a large proportion, iron deficiency anemia is nearly universal. The only way by which significant amounts of iron leave the body after absorption into the bloodstream is through loss of blood due to the admirable blood donations, abnormal hemorrhage from accidents or illness and menstruation. Thus, the development of iron deficiency in an adult man or post menopausal women should be assumed to be due to blood loss until proved otherwise. Indeed, the two most common causes of iron deficiency among adults are increased menstrual bleeding and hemorrhage from the alimentary tract. Many healthy women have virtually no iron reserves. The women who consider their menses normal may lose more than 100 ml and occasionally more than 200 ml per period. IU devices, which increase menstrual bleeding, influence these losses, and by contraceptive pills, which decrease it. Hallberg and coworkers reported that the mean mentrual loss of iron amounts to about 0.5 mg per day. A good indicator of iron store in a healthy person is the concentration of ferritin. A useful rule of thumb is that 1 ml of packed red cells contains 1 mg of iron. Therefore, a chronic loss of even a small volume of blood may significantly increase iron requirements, and for those who donate blood, each 500 ml of donated blood contains 200-250 mg of iron.

A healthy person can only absorb about 5 to 10% of dietary iron, and those who are iron-deficient absorb about 10 to 20%. Since maize is poor in iron, and also contains phytates that chelate iron, further reducing iron availability, iron deficiency anemia is quite common among cereal- (maize)-eating populations. Furthermore, geophagia, which interferes with iron absorption, is common among children and adult women. The ingested clay chelates or precipitates iron as insoluble compounds. Among the poor, clay-eating is more common than

generally realized. This is particularly true when animal protein intake is low. However, women often fail to recognize an abnormal blood flow, even when double pads must be worn because one soaks through, or duration of periods is greater than 5 days, or large clots are passed, or more than 12 pads are needed per period. Also, the admirable and necessary donation of large amounts of blood is a form of hemorrhage.

Iron is absorbed in two forms: heme and non-heme forms. However, the major source of iron for the greater percentage of the population is nonheme iron, and a means of enhancing its absorption is a necessity for combating iron deficiency anemia. These factors are capable of intiating or perpetuating iron deficiency anemia. Heme iron found in fish, meat and poultry is highly available and not affected by the composition of the diet, whereas the nonheme forms found in cereals and vegetables are less available and are influenced by the dietary composition. Actually, meats improve the absorption of nonheme iron, while dairy products (egg, milk and cheese) do not. On the other hand, vit.C increases the absorption of non-heme iron by reducing the ferric form to the more soluble and better absorbed ferrous form. Furthermore, two foods, bran and tea, interfere with iron absorption owing, respectively, to their fiber and phytate components. Drinking tannin-containing beverages, such as tea with meals that consist largely of vegetable foods causes a decrease in iron absorption. In contrast to the very poor absorption of iron from such foods as wheat germ, spinach, on account of their phytate content, iron absorption is moderately good in carrots, tomatoes, cabbage which contain substantial amounts of malic, citric or ascorbic acids. Exogenous iron is significant in the iron-rich diets of many African peoples. The iron is derived from iron pots used for cooking and for the preparation of fermented beverages. Other studies have shown that iron utensils contribute significantly to the iron content of cooked foods. Thus, the substitution of aluminum, stainless steel or plastic-coated pots and pans has certainly had an adverse effect on dietary iron intake.

Self Assessment Exercises 1

Quickly recap the factors required for nutritional anaemia formation

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_____

Both the intake and uptake of iron can affect iron status. Fortuitously, blood loss through hemorrhage or blood donation increases erythropoiesis and absorption. The absorption depends on mucosal uptake of dietary iron by the intestinal absorptive cells and the transfer of the same into the body. This further depends on ample supply being exposed for sufficient interval of time for the action to take place. Thus, the iron must be in a physiochemical form that permits absorption to the extent of the body's requirement. Thus, the knowledge of the iron content of a diet may be a relatively poor indicator of nutritional adequacy or inadequacy.

Unlike most nutrients, iron excretion is limited, as its control rests on its absorption. Once iron enters the bloodstream, it tends to be used and reused. Indeed, more than 90% of hemoglobin iron is repeatedly recycled through the process of phagocytosis of old erythrocytes, whereby some 19 to 69% reincorporation occurs within 12 days. The remaining iron derived from hemoglobin catabolism enters the storage as ferritin or hemosiderin. Iron is stored chiefly in the liver, spleen and bone marrow. Only about 0.3 to 0.5 mg of iron is excreted daily in the feces, which comes from blood loss into the intestine and desquamated intestinal mucosal cells and from an unabsorbed food iron.

4.0 Conclusion

The two micro-nutrient deficiencies discussed in this segment are all easily preventable if proper nutrition education is emphasized. Fortunately, the foods which provide these nutrients are all easily obtainable in practically all the communities were they are endemic. What needs to be emphasized and vigorously promoted is the adoption of culturally acceptable delivery of their food sources. The iodization programs of the World Health Organization, which incorporate several of these nutrients in deliverable source, such as iodized salts have gone a long way to eliminate or stem their high prevalence world wide. Since a good knowledge of the iron content of a diet may not be a good indicator of nutritional adequacy or inadequacy, continuous nutrition education should be a continuous exercise.

5.0 Summary

The discovery by Marine and Kimball that endemic goiter could be prevented by administration of small amounts of iodine to children at risk marked the beginning of man's conquest of this disease that has plagued mankind for centuries. This disease is more

common in women than in men and is often noticed at the onset of puberty, during pregnancy, or at the menopause. It seems restricted to or is more likely to occur in all elevated regions subject to glaciation, high rainfall and runoff and explains why goiter is found mainly in the hilly regions of Nigeria. Where goiter is due primary to iodine deficiency, the term, iodine deficiency disorder (IDD) has been used to describe the effects of the deficiency. Indeed, goiter is endemic in any community when the 8-14 year-olds are shown to suffer from the disease. Elemental iodine, that is very volatile and easily oxidized by sunlight, should not be exposed as it is currently done in most Nigerian markets. Since iodine deficiency has been shown to be the cause of fetal growth retardation, which particularly affects the development of the brain, care should be taken to ensure that pregnant women have excellent supply of iodine rich foods during pregnancy. In communities where improperly processed cassava is consumed, goitrogens found in cassava and several other foods may compete with iodide, thus rendering the iodine unavailable. In these endemic areas, the recommended dietary allowances may not be met through proper food selection. Consequently, it is recommended that the consumption of sea foods be greatly increased, coupled by the use of iodized salt and injectable iodized oil.

On account of the fact that iron deficiency is a systemic disorder in which its relatively undramatic clinical picture does not arise from the anemia alone, but may occur in the absence of an anemia, the disease has often been ignored or overlooked in most parts of the world. Nevertheless, iron deficiency is the most common nutrient deficiency and may well be the most common organic/nutritional disease of man. However, iron-poor diet is very rarely the primary cause of iron deficiency in adults. Most often, it results from one or a combination of the following: inadequate dietary intake, impaired absorption, blood loss or repeated pregnancies. Iron-deficiency anemia is rare in infants. This is because the fetus has a highly effective acceptor system for assimilating iron. Normally, iron from maternal transferrin is moved to the placental tissue, to the fetal plasma transferrin, from where it is transferred to the placental tissue in a unidirectional pathway that operates against increased maternal requirement for iron, even when there is maternal iron deficiency. However, in areas where intestinal heminthiasis, especially hookworm disease, is endemic, iron deficiency anemia is nearly universal. Nevertheless, the only way by which significant amounts of iron leave the body after absorption into the bloodstream is through loss of blood due to the admirable blood donations, abnormal hemorrhage from accidents or illness and menstruation. Thus, the development of iron deficiency in an adult man or post menopausal women should be assumed to be due to blood loss until proved otherwise. Furthermore, since maize is poor

in iron, and also contains phytates that chelate iron, further reducing iron availability, iron deficiency anemia is quite common among cereal- (maize)-eating populations. In such populations, an increased consumption of meats, coupled with vitamin C supplementation, can improve iron nutriture. Fortuitously, exogenous iron, derived from iron pots used for cooking and for the preparation of fermented beverages, is significant in the iron-rich diets of many African peoples. Thus, the substitution of aluminum, stainless steel or plastic-coated pots and pans may have an adverse effect on dietary iron intake. Unlike most nutrients, iron excretion is limited, as its control rests on its absorption. Once iron enters the bloodstream, it tends to be used and reused. However, since a good knowledge of the iron content of a diet does not necessarily guarantee nutritional adequacy, continuous nutrition education on iron supplementation should be emphasized.

6.0 Answer to Exercises

Iron, folic acid and vitamin B_{12}

7.0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.
2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.
3. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 10 Excessive Intake Vitamins and Minerals

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1.0 Introduction

The belief by many uninformed persons that if "a little is good: a lot is better" has led to the excessive intake of several important nutrients. In this discussion, however, we shall concentrate on just three of such nutrients, namely, vitamin A, vitamin C and iron. What is clear, however, is that there is hardly any nutrient that can not be abused or overused.

2.0 Objectives

At the end of this unit, you will be able to:

- explain the phenomenon of nutrient overdose.
- explain the consequences of overload, and
- educate the student on how this can be avoided.

3.0 Main Content

3.1 Hypervitaminosis A and hypercarotenosis

It is well known that vitamin A is an essential nutrient required for the maintenance healthy epithelial tissue, for growth and for vision. On the other hand, there is no nutritional advantage to be derived from exceeding the recommended level of vitamin A. The intolerable upper limit of preformed vitamin A rises from 600 micrograms per day for infants to 2,800 for adolescents up to 3,000 for adults. The most usual cause of hypervitaminosis A are prolonged consumption of vitamin A-containing supplements, in the belief that "a little is good: a lot is better". Furthermore, the physical form of retinol supplements is a major determinant of toxicity: water-miscible, emulsified and solid preparations of retinol are approximately ten times more toxic than oil-based retinol preparations. Unfortunately, some vitamin preparations do contain as many as 25,000 IU of vitamin A. Although the level at which vitamin A becomes toxic varies from one individual to another, a daily dose of 50,000 I.U. for many months can induce toxic symptoms in adults. When taken over an extended period of time, this could be dangerous, especially during pregnancy, producing teratogenic effects in the fetus.

Symptoms often include anorexia, irritability, loss of weight, sparseness of hair. A single dose of a million units of vitamin A can cause severe, acute toxicity. Persons have been known to die from eating large amounts of polar bear liver. Acute manifestations include transient hydrocephalus and vomiting. Chronic hypervitaminosis A has also been observed in infants 3 to 6 months of age. Chronic hypervitaminosis A in children usually results from overzealous parents who are uninformed or believe that high doses will provide beneficial results. A skin disorder, such as acne, for which a remedy is sought, may be a result of excessive dosage of vitamin A. In adults, chronic hypervitaminosis A has been observed in patients receiving large doses (20–30 times RDA) as a treatment for a dermatologic condition. Thus, hypervitaminosis A can be avoided by obtaining vitamin A only from dietary sources or low potency preparations.

The only therapy is to stop the administration of the vitamin or such other drug containing it. If it is necessary to take vitamin A supplements, the vitamin A content of the supplement should approximate the Recommended Dietary Allowance.

Excessive intake of carotenoids can cause hypercarotenosis – yellow or orange discolor-ation of the skin. Some persons do consume unusually large amounts of provitamin A sources, such as the carotenoids but the inefficiency of the conversion of provitamin A to pure vitamin A virtually eliminates the possibility of hypervitaminosis A. The resultant accumulation of the provitamin A pigment causes the yellowing of the skin and the other epithelial layers of the body. Hypercarotenemia has also been documented where there has been prolonged ingestion of large amounts of carrot juice. Where hypercarotenemia has been due to dietary origin, symptoms disappear within a few weeks after withdrawal of the cause.

3.3 Hypervitaminosis C

A book, *Vitamin C and the Common Cold*, by Linus Pauling, a two-time Nobel Prize winning scientist, extolled the virtues of large doses of vitamin C in preventing and treating the common cold. He recommended the astronomical doses of 10,000 to 15,000 milligrams per day, in comparison with the 45 mg per day recommendation of the American National Research Council. Although Pauling's theory has captured public interest, there have been several reasonably well-documented studies that have not substantiated his theory.

It has been suggested that vitamin C plays a role in cholesterol metabolism. Some studies have shown that when large doses of vitamin C was given to hypercholesterolemic subjects, their serum cholesterol levels were decreased. The claim has also been made that doses larger than the RDA could be advantageous in treating respiratory ailments. However, the ingestion of large amounts of vitamin C is not without toxic effects. Reports have indicated that the resultant acid urines may contribute to the formation of renal calculi in those with tendency to gout Furthermore, ascorbic acid is metabolized through the formation of oxalic acid, a substance that also contributes to the production of renal calculi. Thus, chronic intake of vitamin C in excess of the adult tolerable upper limit of 2,000 mg per day can cause diarrhea, kidney stones and excess iron absorption.

While massive doses of vitamin C might reduce the severity of upper respiratory infections in individuals whose tissues are not fully saturated with the vitamin, levels above those necessary for tissue saturation could be harmful, as respiratory infections could increase the amount of vitamin C required for tissue saturation.

Self Assessment Exercises 1

Highlight the differences between Hypervitaminosis A and hypercarotenosis

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3.4 Hemosiderosis

There is no evidence that high iron intake, by itself, can lead to secondary iron overload. But excessive dietary iron intake can be detrimental to health, under certain circumstances. The storage form of iron, ferritin, is normally found in the intestine, liver, spleen and bone marrow. If iron is taken into the body parenterally, in amounts exceeding the capacity of the body to store ferritin, it accumulates in the liver as microscopically visible hemosiderin. Furthermore, in certain parts of Africa, traditional fermented beer from maize has been shown to be contaminated by the iron-containing brewing vessels, causing hemosiderosis. Acute iron poisoning causes vomiting, upper abdominal pain, diarrhea, drowsiness and shock. Death may occur in children who mistake iron tablets for sweets. In chronic iron toxicity (hemochromatosis or iron load) affects many organs and tissues. Eventually, diabetes often results in 80% of such patients. The liver becomes enlarged and cirrhotic, and hepatocellular cancer may develop. Cardiomyopathy may also develop, causing heart failure. Mental aberrations and pituitary failure may cause testicular atrophy and loss of libido. Focal hemosiderosis can damage lungs and kidneys.

Sub-Saharan hemochromatosis appears to have a genetic basis, but it is usually associated with long-term diets high in iron derived from cooking pots or steel barrels used in preparing fermented alcoholic beverages. In such patients, portal cirrhosis and diabetes are common.

However, despite associations of high serum ferritin with heart disease, type-2 diabetes, and colon cancer, adverse health effects of moderately elevated iron stores in the general population should be viewed with caution.

4.0 Conclusions

In general, there seems to be no nutritional advantage to be derived from exceeding the recommended level of vitamin A, vitamin C and iron. On the other hand, the intakes of these

nutrients, which exceed the recommended dietary allowances can be harmful. For vitamin A, extended period of supplementation could be dangerous, especially during pregnancy, producing teratogenic effects in the fetus. Hypervitaminosis A can be avoided by obtaining vitamin A only from dietary sources or low potency preparations. In the case of vitamin C, chronic intake in excess of the adult tolerable upper limit of 2,000 mg per day can cause diarrhea, kidney stones and excess iron absorption. While massive doses of vitamin C might reduce the severity of upper respiratory infections in individuals whose tissues are not fully saturated with the vitamin, levels above those necessary for tissue saturation could be harmful, as respiratory infections could increase the amount of vitamin C required for tissue saturation. In chronic iron toxicity (hemochromatosis or iron load) many organs and tissues are affected, and could result in diabetes, cirrhosis of the liver, hepatocellular cancer, cardiomyopathy, mental aberrations and pituitary failure, which can cause testicular atrophy and loss of libido. Focal hemosiderosis can damage lungs and kidneys.

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5.0 Summary

There are no nutritional advantages to be derived from exceeding the recommended level of intake of the nutrients under consideration. The most usual cause of hypervitaminosis A are prolonged consumption of vitamin A-containing supplements, in the belief that “a little is good: a lot is better”. However, the physical form of retinol supplements is a major determinant of toxicity: water-miscible, emulsified and solid preparations of retinol are approximately ten times more toxic than oil-based retinol preparations. When taken over an extended period of time, this could be dangerous, especially during pregnancy, producing teratogenic effects in the fetus. Chronic hypervitaminosis A in children usually results from overzealous parents who are uninformed or believe that high doses will provide beneficial results. Hypervitaminosis A can be avoided by obtaining vitamin A only from dietary sources or low potency preparations. The only therapy is to stop the administration of the vitamin or such other drug containing it. Excessive intake of carotenoids can cause hypercarotenosis – yellow or orange discoloration of the skin. For people who consume unusually large amounts of provitamin A sources, the inefficiency of the conversion of provitamin A to pure vitamin A virtually eliminates the possibility of hypervitaminosis A. However, the resultant accumulation of the provitamin A pigment causes the yellowing of the skin and the other epithelial layers of the body. Hypercarotenemia has also been documented where there has been prolonged ingestion of large amounts of carrot juice. Where hypercarotenemia has been

due to dietary origin, symptoms disappear within a few weeks after withdrawal of the cause. The recommendation of Nobel Laureate, Linus Pauling, of the astronomical doses of 10,000 to 15,000 milligrams per day for the cure of the common cold, in comparison with the recommended 45 mg per day, may have captured public interest, but has not been substantiated by several reasonably well-documented studies. However, some studies have shown that when large doses of vitamin C was given to hypercholesterolemic subjects, their serum cholesterol levels were decreased. Chronic intake of vitamin C in excess of the adult tolerable upper limit of 2,000 mg per day can cause diarrhea, kidney stones and excess iron absorption. While massive doses of vitamin C might reduce the severity of upper respiratory infections in individuals whose tissues are not fully saturated with the vitamin, levels above those necessary for tissue saturation could be harmful, as respiratory infections could increase the amount of vitamin C required for tissue saturation. There is no evidence that high iron intake, by itself, can lead to secondary iron overload. But excessive dietary iron intake can be detrimental to health, under certain circumstances. Acute iron poisoning causes vomiting, upper abdominal pain, diarrhea, drowsiness and shock. Death may occur in children who mistake iron tablets for sweets. In chronic iron toxicity (hemochromatosis or iron load) affects many organs and tissues, causing diabetes, cirrhosis of the liver, hepatocellular cancer, cardiomyopathy, causing heart failure. It could also cause mental aberrations and pituitary failure, which in turn, may cause testicular atrophy and loss of libido, lung and kidney damages.

6.0 Answer to Exercises

See 3.3 for details

7.0 References

1. Alade, I. (2001). Public Health Nutrition, Second Edition, SOA Tosco Ventures Press, Ilorin, Nigeria.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

3. Schneider, HA, Anderson, CE and DB Coursin (1977). Nutritional Support of Medical Practice, Harper & Row Publisherssss, MD, USA.

4. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 7th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 11 Formulation of Weaning and Therapeutic Diets

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1.0 Introduction

A discussion on the foundations of a healthy diet must begin with information regarding food choices. Until recently, the primary focus of human nutrition had been the prevention of nutritional deficiencies as well as achieving the RDA (Recommended Dietary Allowance) for the different nutrients. In recent times, however, the definition of a healthy diet has been expanded to include the optimization of long-term health. The motivative force for this expansion has been the epidemiologic evidence that coronary heart disease (CHD) and cancer are major killers in the world. Thus a consideration of a healthy diet must include macronutrient composition, qualitative aspects of macronutrient such as glycemic index, food constituents such as fiber and carotenoids and the possible benefits of nutrients at intakes higher than those known to prevent deficiencies.

2.0 Objective

At the end of this unit you will be able to:

- describe the purpose of diets as well as the different diets.
- examine the diet therapy.
- describe how weaning diets are formulated.

3.0 Main Content

3.1 Principles of Dietetics

An understanding of nutrition is important since a health worker is often required to help others whose eating habits require improvement. For example, certain patients, under medical care, require diet therapy and the consumption of prescribed foods in specified amounts. Furthermore, patients often have questions and complaints about a group of prescribed foods (diet) which are new to them. This could assume the following dimensions: (a) changing a nutritionally inadequate diet to a nutritionally adequate one and adding a subtracting certain nutrients of foods in specified amounts to or from a diet. Such diets are called therapeutic diets.

Since it is difficult to get patients to eat unfamiliar meals, based on the therapeutic diet, special efforts, which require special skill, should be made by the person serving the food to encourage or motivate the patient to overcome prejudices and eat the food being served., Unless prescribed foods are eaten, any diet is useless and a beautifully designed diet that is not consumed serves no purpose. Often the physician may be surprised that a patient is not sticking to his diet. Thus, having this basic understanding of the special skill of the dietitian is an important interrelationship between the physician and the other health workers, who are looking after the patient. When a patient dislikes a desirable food item, such item could be included in a disguised fashion when combined with other foods. For example, milk could be included in the more acceptable ice-cream or in custard.

Moreover, since most people have better appetites when they are rested, it is advisable to serve the most nutritious meals early in the day, while making the evening meals light.

Adequate nutrition is necessary for building and maintaining good health during and after an illness. Using nutrition to build good health is called diet therapy, which is a means by which the normal diet of a patient is modified or changed in order to meet his current requirements created by disease or injury. Describing an optimal diet is not as simple as it appears. For example, an African soup can be as varied as possible, depending on the type of vegetables used and the mode of preparation (cooking, frying which can destroy certain nutrients, etc.). Also, since excessive body fat, resulting from an imbalance between energy intake and expenditure, is one of the most important nutritional problems of the world, a definition of a healthy diet that fails to address this problem would be incomplete or deficient. Furthermore,

the consumption of the healthiest combination of foods, consumed in slight excess, over an extended period will lead to weight problems. The problem is further compounded by the highly imprecise estimation of the quantities of foods, as serving sizes vary greatly. Therefore, a definition of a healthy diet needs to be linked with the importance of maintaining a healthy weight and the need to make adjustments in intake or physical activity if am imbalance exists.

Obesity, which is a state of having excess body fat, has become the most important nutritional problem in the developed countries and is rapidly becoming a global epidemic and a definition of a healthy diet should address this pandemic problem. However, a fundamental problem of addressing this issue is that even the healthiest combination of foods consumed in slightly excess by only a percentage or two, over an extended period will lead to over-weight.

In general, individuals differ in their response to nutrient intakes. For example, response of serum cholesterol to dietary cholesterol or of blood pressure to sodium intake vary greatly. The elucidation of the human genome and rapid identification of polymorphisms in almost all genes is creating new opportunities to individualized dietary guidance. Thus, the ability to identify individual persons with different requirements allows more detailed studies to ensure that their needs are being met.

3.2 Application of these Principles to Management of Diabetes

The objectives of a diabetic diet therapy include (a) the provision of nutritionally adequate diet; (b) the prevention of excessive postprandial hyperglycemia; (c) the prevention of hypoglycemia in the insulin-dependent patients; (d) the attainment and maintenance of ideal body weight; (e) the control of blood lipids and (f) the prevention or hindrance in development of pathologic changes associated with diabetes. Developing a prescription that is reasonably consistent with the patient’s preferences and situation can greatly increase the likelihood that it will be regularly followed. Even if the prescription is slightly sub-optimal, if well followed, it usually be preferable to a theoretically ideal prescription that is unattractive or unfeasible and will not be followed. Furthermore, since there is a much stronger relation between greater body mass index and insulin resistance, a person who is lean and active can better tolerate a high carbohydrate diet than one who is less active and overweight.

Self Assessment Exercises 1

Highlight the method of achieving the principles of managing diabetes.

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Thus, diabetes is an example of the body's abnormal handling of glucose. What happens is that an inadequate or ineffective insulin levels leave blood glucose high and cells undersupplied with glucose energy. This causes blood vessel and tissue damage. Evidence-supported recommendation is that weight control and exercise, which are effective tools in preventing the predominant Type 2 diabetes and the illnesses that accompany it.. Therefore, a diagnosed case of diabetes must establish patterns of eating, exercise and medication to control blood glucose.

A person who has been diagnosed for diabetes usually show a condition of postprandial hypoglycemia (low blood glucose after meals), with symptoms of fatigue, weakness, irritability, rapid heartbeat, anxiety, sweating, trembling, hunger and headache.

Typically, health facilities usually have standard diets which are nearly normal diets based on the Food Groups available in the particular society. Patients on regular diets require nutrients for health maintenance only, and not for therapy. Although a regular diet includes a great variety of foods, its caloric value is usually lower than for normal diets, since patients on such diets are not normally active and consequently require fewer calories than the ordinary person. These diets are meant for ambulatory patients (those who walk).

The best way of constructing the prescription is to begin with the diet that the patient would follow if he did not have diabetes, but modifying this only to the degree necessary to meet the truly essential requirements imposed by the metabolic disorder. However, of great importance is the need for continuing review and adjustment of the initial prescription. This is necessary because the feasibility, appropriateness and effectiveness of the initial prescription can only be estimated. Subsequent experience will help determine how best to compromise the therapeutic objectives with the patient's preferences and changing patterns of

living. Usually, discrepancies between the diet consumed and the diet prescribed may largely determine failure to make appropriate adjustments to fit changing conditions.

Usually, written instructions should include a list of foods that may be taken in any amount as well as the list of those foods that must be avoided entirely. The best way to achieve this is to teach the patients the concentration of carbohydrate, protein and fat in the common foods available to the patient. This provides a wide range of attractive options than the simpler but less flexible standard hospital menus.

4-0 Conclusions

Since it is difficult to get patients to eat unfamiliar meals, based on the therapeutic diet, special efforts, which require special skill, should be made by the person serving the food to encourage or motivate the patient to overcome prejudices and eat the food being served., Unless prescribed foods are eaten, any diet is useless and a beautifully designed diet that is not consumed serves no purpose. Adequate nutrition is necessary for building and maintaining good health during and after an illness. Using nutrition to build good health is called diet therapy. The elucidation of the human genome and rapid identification of polymorphisms in almost all genes is creating new opportunities to individualized dietary guidance. Thus, the ability to identify individual persons with different requirements allows more detailed studies to ensure that their needs are being met. Furthermore, individuals differ in their response to nutrient intakes. For example, response of serum cholesterol to dietary cholesterol or of blood pressure to sodium intake vary greatly.

5.0 Summary

Describing an optimal diet is not a simple matter. For example, an African soup can be as varied as possible, depending on the type of vegetables used and the mode of preparation (cooking, frying which can destroy certain nutrients, etc.). Furthermore, the consumption of the healthiest combination of foods, consumed in slight excess, over an extended period could lead to weight problems.

Written instructions should include a list of foods that may be taken in any amount as well as the list of those foods that must be avoided entirely. The best way to achieve this is to teach the patients the concentration of carbohydrate, protein and fat in the common foods available to the patient. The best way of constructing the prescription is to begin with the diet that the

patient would follow if he did not have diabetes, but modifying this only to the degree necessary to meet the truly essential requirements imposed by the metabolic disorder. Developing a prescription that is reasonably consistent with the patient's preferences and situation can greatly increase the likelihood that it will be regularly followed. Even if the prescription is slightly sub-optimal, if well followed, it usually be preferable to a theoretically ideal prescription that is unattractive or unfeasible and will not be followed.

6.0 Answer to Exercises

Teach the patients the concentration of

- Carbohydrate
- Protein
- Fat in the common foods available to the patient.

7.0 References

1. Fleck, H. (1976). Introduction to Nutrition, 3rd Edition, Macmillan Publishing Co., Inc., New York, USA.

2. Shils, ME and VR Young (1988). Modern Nutrition in Health and Disease, 7th Edition, Lea & Febiger, Philadelphia, USA.

3. Sizer, FS and EN Whitney (2003). Nutrition Concepts and Controversies, 9th Edition, Thomson Learning, Inc., CA, USA.

4. Shils, ME, M Shike, CA Ross, B Caballero and RJ Cousins (2006). Modern Nutrition in Health and Disease, 10th Edition, Williams and Wilkins, Philadelphia, USA.

Unit 12 The World Food Situation

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1.0 Introduction

Man spends approximately one-third of his lifetime thinking about, procuring or actually eating, food. Approximately one-third of a lifetime is spent as a result of a struggle for food. Yet the food need of most of mankind is not being met. It becomes quite understandable why wars are conceived, executed and won or lost at the level of the stomach. Between 1960 and the recent past, world food supply kept pace with population growth. This was due mainly to new agricultural technologies, better seed varieties and irrigation (green revolution). At the same time, in many developing countries, contraceptive use has been rising substantially and fertility has fallen rapidly. But between 1985 and 1995, however, food production lagged behind population growth in 64 of the 105 countries studied. The picture shows that Africa, as a whole, now produces nearly 30% less food per person than in 1967. Between 1970 and 1983, total food production in the developing countries of the world increased by 47%; and in the 70s, annual food production gains in these countries averaged 3.3% as compared with the population growth rate of 2½%. But ideally, a 2½% increase in population annually requires a 4% annual increase in food production to sustain it. In Africa however, in the 70s, food production output increased by only 26%, which came to an annual increase of only 1.3% and a population increase of 3.3% (perhaps 3½% in Nigeria). Between 1990 and 1996, food

production increased by about 3% annually, but the number of malnourished children world-wide has reached an all-time high of 800 million, thanks to Rhuandas, Burundis and Liberias. In the meantime, food tonnages imported by the developing countries for human consumption have increased by 150% annually since 1970; African food importations have continued to increase by more than 180% annually. Despite worldwide qualitative and quantitative improvements in food available for human consumption, the underlying causes of hunger, starvation and famine have not disappeared. World food security proposals usually underestimate the complexity of nation-level food problems, as these proposals get confounded by a world population that has increased from three billion in 1960 to more than six billion in 2005! Since 1900, man has been able to increase grain production 5 times as much as the preceding 10, 000 years when agriculture began! While there is dispersed starvation in rural areas, urban food shortages can be particularly dangerous. The ability to meet the challenges of providing the food needs of a nation or a community is referred to as Food Security. It is a state of affairs where all people, at all times, have access to safe and nutritious food to maintain a healthy and active life. By this definition, one person in every three (2 billion people) lack food security, worldwide. Unmanaged urbanization leads to social discontent, pollution and health problems, inefficiency and graft in government, rural stagnation and greater possibility of famine in times of transportation failures, social unrest or blockades associated with revolution or war. Furthermore, trying to meet the rising demand for food is leading mankind to overuse the world's finite resources. For example, most developing countries are already cultivating virtually all arable land. And in many of these places, fertile soils are being exploited faster than they can regenerate. These trends have increased the difficulty of meeting the world's food needs.

2.0 Objectives

At the end of this unit you will be able:

- to appreciate the grim picture of the world food situation
- to actualize the Food and Agricultural Organization's world food program.

3.0 Main Content

3.1 Population Growth and Food Needs

In his book, *Essay on the Principles of Population*, Thomas Malthus theorized, way back in 1795, that since populations of plants and animals including humans, tend to increase geometrically (2, 6, 18, 54), whereas food supply increases only arithmetically (2, 6, 10, 14), there would come a time when man would face imminent starvation. Recent declining fertility trends have raised the hope that the world's population can stabilize, perhaps within the next 100 years. And the sooner the world reaches a replacement-level fertility of about 2 children per couple; the sooner world attention could be shifted away from the need to increased food production towards improving the quality of life for all. In the meantime, world population is growing by over 80 million people a year - one billion people every 12 to 13 years. This is astronomical when one realizes that it was not until 1800 that the world's population reached one billion. It took another 100 years before it reached 2 billion. In the past 50 years, more people have been added to the world's population than during the previous 4 million years. Furthermore, it has been projected that by 2025, the world would contain over 8 billion people, of whom some 6.8 billion would be living in the developing countries. Right now, the America farmer can feed some 96 people, whereas his Nigerian counterpart can hardly feed himself alone. Thank God for giving mankind the wisdom to do something about these alarming trends. For example, it has been estimated that the world contains 400 million fewer people today than it would have had if family planning had not been put in place. World population is thus growing by 1.5% per year today, compared with 2% per year in the 1960s. But in the Sub-Saharan Africa, population is still growing at 2-3½% per year, a rate at which populations world-wide double in 20 to 35 years.

As living standards rise in any community, their demand for meat and dairy products regularly increase, rather than living practically entirely on grains such as rice, maize and wheat. In order to meet these demands, more grains must be produced. When used to fed livestock, grains provide humans less than half as much food energy as when consumed by the people directly. Today, nearly 40% of the world's grains goes to feed livestock, making it more difficult to feed the world's poor who can hardly afford meat at all.

Although the world's population has doubled since World War II, food production has tripled. Concurrently, the daily caloric intake per person has increased from about 1,925 kcal in 1961 to 2,540 in 1992 in the developing countries. This increase in food production has

been due mainly to the Green Revolution - adopting crop rotation, production and use of petro-chemical fertilizers and pesticides, expanded irrigation and the introduction of genetically superior, disease-resistant crops.

Unfortunately however, this trend has again, changed for the worse. For example, from about 1990, global grain production has risen only slightly, with the per capita supplies falling, despite slower rates of population growth. This recent trend has been attributed to rapid population growth, higher population densities in traditionally agricultural areas, fragmentation of small farmsteads, poor land management and inappropriate agricultural and economic policies. With this trend, world food production have to double to provide food security for the 8 billion people projected for 2025.

Food security can be improved if food from countries with surplus were better distributed to, and within countries with food deficits. Unfortunately, international trade system works against the ability of poor countries to meet their food needs with imports. Developed countries protect their agricultural sectors with various economic incentives and trade barriers, including price supports (wheat and corn) and tariffs to shield domestic growers from cheaper imports. A crucial question is: how come these farmers in other lands are able to produce their crops cheaper that the local growers? Why are local growers not adopting these more efficient methods? On the other hand, poor food-deficient countries who export raw commodities are hardest hit when prices of export commodities decline on the world market or when prices of vital imported supplies rise.

In order to meet the FAO recommended food security standards, a nation must have the minimum food cushion of 60 days. The FAO, the World Bank and the International Food Policy Research Institute, however expect that the current prices of food will decline.

3.2 Steps to Food Security

Because the problem of malnutrition has multi-factorial causation, its solution must also be multi-faceted. Unfortunately, conventional solutions in the form of specific programs are usually inadequate to tackle the problems; and their effects, which do not reach the root of the causes, are usually transitory. Therefore, the pessimistic but realistic view is that a permanent elimination of malnutrition can not be accomplished without first overcoming poverty and

mal-distribution of national wealth which make health care available to all citizens. In the meantime, it has been suggested that it is more profitable to return from those ambitious, usually very expensive, national programs to those aimed at the most at-risk groups in each society, such as the mothers and their children. Food security requires a coordinated approach to increased food production, improved food storage and distribution, reducing poverty, coupled with a more prudent management of resources and strict family planning. Furthermore, health care and education must be provided in order to improve people's well-being which will, in turn, promote productivity and sustainable resource use. Along with better food distribution, achieving food security requires addressing the needs of small-scale farmers and raising agricultural productivity as they preserve soil and water resources. One may add that it is not in the overall best interest of the rich that the poor remain poor for too long. Government ought to realize that if one can not change the world, one can at least attempt to alleviate the daily pains of living. Therefore, in order to avoid catastrophe, the following changes should be brought about fast and in the immediate future in order to arrest the deteriorating nutritional status of the people and thus fight or prevent malnutrition:

1. Since the immediate major cause of hunger and malnutrition is poverty, success in controlling them must depend on how effectively we are able to tackle the problems of want.
2. Government must institute Food and Nutrition Policies which will promote adequate food production and intake as well as improve the stability of food supplies through better food production, storage and distribution (adequate transportation) methods which will increase the supply of the right kinds of food to the consumer where and when needed and at affordable prices.
3. Government must take drastic measures to reduce the gap between the ever-growing population and the dwindling resources by instituting family planning which allows for optimal spacing of children by choice rather than by chance and thus decrease/ stabilize population growth.
4. Pregnant and lactating mothers must be encouraged to institute breast-feeding, growth monitoring activities and the use of inexpensive local weaning foods and thus bring about a general improvement in family diets by nutrition education.
5. Infections and diarrheal diseases must be controlled through immunization, proper maintenance of a healthy environment, and by the provision of adequate, and safe water supply at the easy reach of all citizens wherever they may live, as a means of improving their overall health.

6. Early diagnosis and treatment of mild cases of malnutrition must be instituted through Growth Monitoring activities, periodic survey of the population-at-risk, hospitalization of severe cases and an effective referral and follow-up care.

Therefore, government must make up its mind on what it wants to do about reducing poverty and hunger by creating a politico-economic system which will enable all or most citizens who want to work to have access to meaningful work and by reviewing its minimum wage policy for workers, commensurate with the ever-rising cost of living, thereby facilitating adequate food intake. This is within the reach of most countries of the world in which, it costs as much to train and arm one soldier as it is to provide education for 100 children on how to love a productive life, and as much to procure a modern jet-fighter as it is to equip 50,000 village pharmacies with common drugs. It is within the reach of most countries of a world in which nearly a trillion dollars is spent on arms per year, at the rate of more than $2.5 billion per day.

Self Assessment Exercises 1:

List 4 steps to food security----------

The present trend in Government Policy of family self-reliance in food production by a starving people is as unrealistic as was the advice given by the British Government to the starving Irish in the 1840s - to base their development on individual self reliance. A starving people are simply too weak and therefore incapable of helping themselves. Therefore, government should evolve a policy of providing an enabling environment which can increase the supply of the right kinds of foods where they are best produced and transported to where they are needed and when they are needed.

In order to accomplish this, government and health workers should certify a policy which provides government-sponsored incentives to mothers who comply. For example, maternity leave should be extended for working mothers from the present three months to one year for the first two children. This is far superior to the current mode of the Breast-Feeding Initiative.

4.0 Conclusion

The carrying capacity of a nation refers to the number of people that the earth can support on a sustained basis - indefinitely at a constant standard of living without destroying the natural resource base. The English economist, Thomas Malthus, had argued back in 1798 that since productive land and potable water are finite resources, population growth would inevitably outstrip food and water supply at a point when mass starvation and anarchy would follow. His prediction was informed by the devastating famines of 1316 and 1317, followed by the Black Plague of 1346 which had killed, by the end of the century, one-third of the entire population of Europe. It has not happened. Praise God. He is on His throne, in control.

Today however, scientists are warning that our planet may be increasingly at risk in the future as the soil gets degraded and water supplies are drastically reduced; as nature's cycles and biological resources are altered, and as some plant and animal species get extinct. They advise however, that we must slow down population growth as well as use resources more efficiently.

5.0 Summary

Recent declining fertility trends have raised the hope that the world's population can stabilize, perhaps within the next 100 years. In the meantime, world population is growing by over 80 million people a year - one billion people every 12 to 13 years. In the past 50 years, more people have been added to the world's population than during the previous 4 million years. In the meantime, it has been projected that by 2025, the world would contain over 8 billion people, of whom some 6.8 billion would be living in the developing countries. In the Sub-Saharan Africa, population is still growing at 2-3½% per year, a rate at which populations world-wide double in 20 to 35 years. Although the world's population has doubled since World War II, food production has tripled due mainly to the Green Revolution.

From about 1990, however, a worsening scenario has emerged, giving rise to a lowering of per capita food supplies, due mainly to rapid population growth, higher population densities in traditionally agricultural areas, fragmentation of small farmsteads, poor land management and inappropriate agricultural and economic policies. With this trend, World Food Production has to double to provide food security for the 8 billion people projected for 2025.

In order to stem these worsening trends, nations must overcome poverty and mal-distribution of national wealth which make health care available to all citizens. Nations must return from those ambitious, usually very expensive, national programs to those aimed at the most at-risk groups in each society, such as the pregnant and lactating mothers and their children must be encouraged to institute breast-feeding, growth monitoring activities and the use of inexpensive local weaning foods, instituting appropriate national Food and Nutrition Policies, by reducing the gap between the ever-growing population and the dwindling resources through family planning, controlling infections and diarrheal diseases through immunization, proper maintenance of a healthy environment, and by the provision of adequate, and safe water supply and early diagnosis and treatment of mild cases of malnutrition, through growth monitoring activities, periodic survey of the population-at-risk, and an effective referral and follow-up care.

6.0 Answers to Exercise

See 3.2 for guide

7.0 References

1. Ames, GCW and PA Wojtkowski (1986). Projections of Food Supply, Demand, and Human Nutrition for Five African Countries. The Georgia Agricultural Experiment Stations, College of Agriculture, The University of Georgia.