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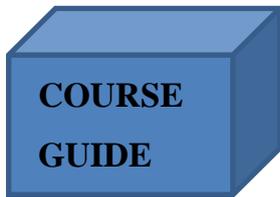
FACULTY OF HEALTH SCIENCES

DEPARTMENT OF PUBLIC HEALTH SCIENCE

COURSE CODE: PHS802



**COURSE TITLE: INTRODUCTION TO PUBLIC
HEALTH NUTRITION**



PHS802: INTRODUCTION TO PUBLIC HEALTH NUTRITION

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PHS802

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Introduction

This course *PHS802: Introduction to Public Health Nutrition* is a two-credit unit course with three modules. Nutrition is the science of food and its nutrients, their functions, interactions and balance in relation to health and diseases. Public Health Nutrition is the branch of human nutrition that deals with nutritional problems that affect large numbers of people which can be solved most effectively through group action. Examples of large numbers of people include communities, displaced people, refugee camps, war and emergency situations, specific populations such as pre-school children (the Under-fives), school children, adolescents, pregnant and lactating mothers and the aged. The major functions of public health nutrition are assessment, policy development and assurance.

This course guide tells you what to expect from reading this course material.

WHAT YOU WILL LEARN IN THIS COURSE

The study of Public Health Nutrition exposes you to science of food and its nutrients and how it relates to health and diseases among communities, displaced people, refugee camps, war and emergency situations, specific populations such as pre-school children (the Under-fives), school children, adolescents, pregnant and lactating mothers and the aged. It exposes you to various nutritional diseases and their relationship to various classes of foods, food nutrients and their solutions. You will learn nutrition through the life cycle, assessment of nutritional status, specific macro and micronutrient disorders and management, community-based nutrition programmes, special nutritional disease and therapy, food and nutrition policies and food security and global issues in nutrition.

COURSE AIM

The aim of this course is to provide a good understanding of public health nutrition in order to apply the knowledge to eradication of nutritional diseases and maintenance of good health among the populace.

COURSE OBJECTIVES

After going through this course, you should be able to:

- i. define and explain the meaning of Public Health Nutrition
- ii. explain the principles of Public Health Nutrition
- iii. discuss the nutrition through the life cycle
- iv. describe the assessment of nutritional status in children
- v. discuss malnutrition and explain the specific macro and micronutrient disorders and their management
- vi. discuss the special nutritional disease and therapy
- vii. explain the food and nutrition policies
- viii. discuss the food safety and global issues in nutrition

WORKING THROUGH THIS COURSE

This course has been carefully written to give you an in-depth knowledge of advanced issues in public health nutrition. The materials have been written in such a way to ensure that adequate explanation and illustrations were made to enhance better understanding of the course. You are therefore advised to spend quality time to study this course and ensure that you attend tutorial sessions where you can ask questions and compare your knowledge with that of your course mates. Happy reading!

THE COURSE MATERIALS

The main components of the course are:

- The Study Guide
- Study Units
- Reference / Further Readings
- Assignments
- Presentation Schedule

STUDY UNITS

This course is made up of three modules broken down into nine (9) units. They are as listed below:

MODULE 1 NUTRIENTS, SOURCES, FUNCTIONS AND THEIR DEFICIENCIES

Unit 1 Macronutrients and their deficiencies

Unit 2 Micronutrients and their deficiencies

Unit 3 Other Nutrients

MODULE 2 NUTRITION THROUGH THE LIFE CYCLE

Unit 1 Nutritional Requirements for Infants

Unit 2 Nutritional Requirements of Pre-school children

Unit 3 Nutritional Requirements of Adolescents

MODULE 3 COMMUNITY-BASED NUTRITION PROGRAMMES

Unit 1 The National Food and Nutrition Policy of Nigeria

Unit 2 Food Safety, Security and Global issues in Nutrition

Unit 3 Nutrition during Special circumstances (disaster, wars, terrorism)

Presentation Schedule

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

ASSESSMENT

There are three aspects to the assessment of this course. The first one is the self-assessment exercises. The second is the Tutor Marked Assignments and the third is the written examination which is the examination to be taken at the end of the course.

Do the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file. The work submitted to your tutor for assessment will count for 30% of your total course work.

At the end of this course, you have to sit for a final or end of course examination of about a three hour duration which will count for 70% of your total course mark.

TUTOR-MARKED ASSIGNMENTS (TMAs)

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given three (3) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of course examination. These answered assignments should be returned to your facilitator.

You're expected to complete the assignments by using the information and material in your readings references and study units.

Reading and researching into you references will give you a wider via point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the

assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting for the examination. The self-assessment activities and TMAs will be useful for this purpose and if you have any comment please do before the examination. The end of course examination covers information from all parts of the course.

COURSE MARKING SCHEME

Table 1: Course marking scheme

Assignment	Marks
Assignments 1 – 3	Three assignments: three marks at 10 % each = 30 % of course marks
End of course examination	70 % of overall course marks
Total	100 % of course materials

Table 2: Course Organisation

Unit	Title of Work	Weeks Activity	Assessment (End of Unit)
	Course Guide	Week	
1	Nutrients, Sources and their functions	Week 1	Assignment 1
2	Nutrition through Life Cycle: Period of growth	Week 2	Assignment 2
3	Nutritional requirements during physiological stress	Week 3	Assignment 3
4	Classification of malnutrition, causes and risk factors	Week 4	Assignment 4
5	Specific macro and micronutrient disorders and management	Week 5	Assignment 5
6	Malnutrition assessment and management	Week 6	Assignment 6
7	Management of malnutrition	Week 7	Assignment 7
8	Community-based Nutrition Programmes	Week 8	Assignment 8
9	Food Security and Global Issues in Nutrition	Week 9	Assignment 9

HOW TO GET THE MOST OUT OF THIS COURSE

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course.

The main body of the units also guides you through the required readings from other sources. This will usually be either from a set book or from other sources.

Self-assessment exercises are provided throughout the unit, to aid personal studies and answers are provided at the end of the unit. Working through these self-tests will help you to achieve the objectives of the unit and also prepare you for tutor marked assignments and examinations. You should attempt each self-test as you encounter them in the units.

THE FOLLOWING ARE PRACTICAL STRATEGIES FOR WORKING THROUGH THIS COURSE

1. Read the Course Guide thoroughly.
2. Organize a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignment relates to the units. Important details, e.g. details of your tutorials and the date of the first day of the semester are available. You need to gather together all these information in one place such as a diary, a wall chart calendar or an organizer. Whatever method you choose, you should decide on and write in your own dates for working on each unit.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course works. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5. Assemble the study materials. Information about what you need for a unit is given in the table of contents at the beginning of each unit. You will almost always need both the study unit you are working on and one of the materials recommended for further readings, on your desk at the same time.
6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit, you will be encouraged to read from your set books.
7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and will help you pass the examination.
8. Review the objectives of each study unit to confirm that you have achieved them. If you are not certain about any of the objectives, review the study material and consult your tutor.

9. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to pace your study so that you can keep yourself on schedule.

10. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also that written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.

11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this course guide).

FACILITATORS/TUTORS AND TUTORIALS

Sixteen (16) hours are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes. As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignment. He will monitor your progress and provide any necessary assistance you need. He or she will mark your TMAs and return to you as soon as possible. You are expected to mail your tutored assignment to your facilitator at least two days before the schedule date.

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if you do not understand any part of the study in the course material. You have difficulty with the self-assessment activities. You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you attend the tutorial classes because this is the only chance to have face to face contact with your facilitator and to ask questions which will be answered instantly. It is also a period where you can say any problem encountered in the course of your study.

FINAL EXAMINATION AND GRADING

The final examination for *PHS802: Introduction to Public Health Nutrition* will be 1½ hours duration. This accounts for 70 % of the total course grade. The examination will consist of questions which reflect the practice, exercises and the Tutor-Marked Assignments (TMAs) you have already attempted in the past. Note that all areas of the course will be assessed. To revise the entire course, you must start from the first unit to the twelfth unit in order to get prepared for the examination. It may be useful to go over your TMAs and probably discuss with your course mates or group if need be. This will make you to be more prepared, since the examination covers information from all aspects of the course.

SUMMARY

Before you are qualified to take this course *PHS802: Introduction to Public Health Nutrition*, you are expected to have taken a basic course in Nutrition because this course will build on your existing knowledge. The course in Module1 will refresh your memory on nutrients and their sources, their functions and metabolism. It will expose you to nutrition through the life cycle which comprises of nutrition during growth and health; nutritional requirements of infants; nutritional requirements of infants 0-12 months; nutritional requirements of young children 1-5 years, nutrition in the 1st 1000 months: Why is it important? and nutritional requirements of adolescents. Module 2 talks about malnutrition and will look at the classes of malnutrition, risk factors and vulnerable groups as well as malnutrition in children, adolescents and pregnant women. It will also discuss the specific macro and micronutrient disorders and management which includes the following: protein energy malnutrition (PEM): marasmus, kwashiorkor; micronutrient deficiencies; Module 3 will finally explain the National Food and Nutrition Policy of Nigeria; food safety, security and global issues in nutrition as well as nutrition during special circumstances such as disaster, wars and terrorism.

I hope you will enjoy the course!

STUDY UNITS

MODULE 1 NUTRIENTS, SOURCES, FUNCTIONS AND THEIR DEFICIENCIES

Unit 1 Macronutrients and their deficiencies

Unit 2 Micronutrients and their deficiencies

Unit 3 Other Nutrients

MODULE 2 NUTRITION THROUGH THE LIFE CYCLE

Unit 1 Nutritional Requirements for Infants

Unit 2 Nutritional Requirements of Pre-school children

Unit 3 Nutritional Requirements of Adolescents

MODULE 3 COMMUNITY-BASED NUTRITION PROGRAMMES

Unit 1 The National Food and Nutrition Policy of Nigeria

Unit 2 Food Safety, Security and Global issues in Nutrition

Unit 3 Nutrition during Special circumstances (disaster, wars, terrorism)

On completion of this course, you will have an advanced knowledge of public health nutrition and you will be able to answer the following questions:

- i. What is Public health nutrition?

- ii. Discuss the nutrients, sources, functions and their deficiencies
- iii. Explain the different nutrition through the life cycle
- iv. Discuss malnutrition, classes, risk factors and at-risk groups
- v. Explain the National Food and Nutrition Policy of Nigeria;
- vi. Food safety, security and global issues in nutrition
- vii. Nutrition during special circumstances such as disaster, wars and terrorism.

The list of questions you are expected to answer is not limited to the above list. You are expected to read wide and apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course!

**MODULE 1 NUTRIENTS, SOURCES, FUNCTIONS AND THEIR
DEFICIENCIES**

Unit 1: Macronutrients and their deficiencies

Unit 2: Micronutrients and their deficiencies

Unit 3: Other Nutrients

**UNIT 1: MACRONUTRIENTS AND THEIR DEFICIENCIES
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1.0 INTRODUCTION

There is no single universally accepted definition of Public Health Nutrition rather; Public health is a combination of science and art of preventing disease, prolonging life and promoting physical health and efficiency through organized community efforts. While science is objective, art is subjective (Stein, 2014). Public Health Nutrition emphasises disease prevention and promotion of well-being. Malnutrition and nutrition-related disease are a global problem. Consumption of adequate quantity and quality of nutritious foods will reduce these nutrition-related diseases and infections. Public Health Nutrition to a large extent should be evidence-based (Stein, 2014). It should be an outcome of evidence gathered through scientific studies and critical appraisal of those evidence. The availability and accessibility of adequate quantity and quality foods and encouraging people to eat them is an aspect of public health nutrition.

Public health nutrition was developed in USA in response to health issues such as malnutrition, epidemics of communicable and non-communicable diseases, infant mortality, access to health care, poor hygiene and sanitation, economic depression, wars and civil rights, poor healthy lifestyles, poverty and migration, elderly care and infant care, care givers and school meals (Nnakwe, 2018)

Public health nutrition involves the problems related to inadequate quantity and quality of the habitual diet; problems related to excessive intake of quantity of the habitual diet and food additives and supplement; food safety problems that affect the health and function of a large percent of the general population; nutrition problems prevented or ameliorated by identification of risk factors and early detection by screening when

feasible, in contrast to only specific nutrient treatment; environmental and life style risk factors and global warming, as well as natural disasters (flooding, droughts, civil strife, etc.) (.....). Public health nutrition relates to problems of inadequate quantity and quality of food intake. If these problems prolongs, it results to nutrient deficiencies. In this Unit, we will discuss in details these nutrients, their sources and fuctions.

2.0 OBJECTIVES

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

- i. Explain in details the types of nutrients
- ii. Describe the nutrients that are called macronutrients.
- iii. List and discuss classes of macronutrients
- iv. List the functions of macronutrients
- v. Discuss the metabolism of macronutrients

3.0 MAIN CONTENT

3.1 TYPES OF NUTRIENTS

Nutrients are essential chemical substances in foods needed by an individual for healthy living which either the body cannot make or makes them in quantities too small to support good health. There are six basic nutrients which include the following:

- i. Carbohydrates
- ii. Proteins
- iii. Lipids (Fats and oil)
- iv. Vitamins and minerals
- v. Water
- vi. Fiber

These nutrients are essential for growth and development. If the body cannot synthesize them or the amount in the body is not adequate, they must be provided from the various foods consumed by individual.

Nutrients are divided into two broad classes: macronutrients and micronutrients. In this Unit, we will be discussing macronutrients while micronutrients will be discussed in the next Unit.

3.2 MACRONUTRIENTS

Macronutrients are nutrients that provide energy/calories required in the body for normal growth, metabolism and other body functions. They are needed in the body in large quantities. Their unit measurements are in grammes. The major types of nutrients that make up the macronutrient group are water, carbohydrates, proteins, fats and oils and fiber. Macronutrients except water are also called energy-providing nutrients. The unit of energy measurement is in calories (cal.). Energy is essential for body growth, repair and development of new body tissues, conduct nerve impulses and regulate life processes.

3.2.1 Carbohydrates

Carbohydrates are the energy building foods. They are the main sources of energy or calories. Carbohydrates provide three quarter of the energy required in the body. Carbohydrates exist in three forms: sugar, starch and fiber. Sources of carbohydrates includes table sugar, rice, yam, sweet potatoes, arrowroot, breadfruit, edible aroids, sago, cassava and its products such as *garri*, *fufu*, *amala* and *ogi*; cereal grains such as whole grains, wheat flour, corn/maize, millet and their products such as bread, biscuits and pasta.

1. Chemical composition of carbohydrates

A carbohydrate is a chemical substance which consists of carbon (C), hydrogen (H) and oxygen (O). The basic unit of carbohydrate is a monosaccharaide with the formular $C_6H_{12}O_6$. The most common monosaccharaide is glucose and is used to store and release energy. The brain functions with the use of glucose. When glucose is in excess in the body, it is stored in the liver as glycogen. Carbohydrate is stored as starch in plants and glycogen in animals. So glycogen is found in liver and muscles. The nutrient value of carbohydrates is four (4) calories per gram.

2. Classification of carbohydrates

Carbohydrates are classified into three groups based on their sugar units and these include: monosaccharides, disaccharides and polysaccharides sugars. Monosaccharides ($C_6H_{12}O_6$) are the simple sugars. Examples are glucose, fructose, galactose, arabinose, and ribose. Glucose is the form of sugar used by the body system. Fructose is the sugar derived from fruits and honey. The simple sugars are absorbed in the small intestine.

Disaccharides ($C_{12}H_{22}O_{11}$) are formed by the combination of two molecules of monosaccharides. Examples are sucrose (from table sugar), maltose (derived from the combination of two glucose molecules) and lactose (derived from the combination of two molecules of glucose and galactose). Good sources of sucrose are all plants, sugar cane and beet. Lactose is milk sugar. Good sources of lactose include milk and milk products. Maltose is malt sugar. It is found in all sprouted and malted products, beer and malt drinks.

Polysaccharides are complex sugars containing many monosaccharide units. They are complex sugars with high molecular weights and are formed by a combination of more than two molecules of monosaccharides ($C_6H_{12}O_6$)_n where n is more than two. In terms of sweetness, monosaccharides are the sweetest, followed by disaccharides and then polysaccharides. Examples of polysaccharides are starch, glycogen, dextrin and cellulose. Glycogen easily degrades back to glucose and so only small amount is found in its sources. Dextrin is the product of first chemical digestion of starch. Cellulose is the chemical name for dietary fibre but is not digestible. Good sources of polysaccharides are cereal grains, seeds, roots and tubers such as cassava and potatoes; fresh oysters, liver and dietary fibre.

Carbohydrates in the form of complex sugars are metabolized in the body into simple sugars such as glucose, fructose and maltose. Complex sugars from fruits are metabolized as simple sugars and are known as fructose sugars; table sugars and sugars from foods are metabolized as glucose, sugar from malt are metabolized as maltose. Examples of complex sugars are all forms of edible carbohydrate foods listed as

carbohydrates sources above. Examples of simple sugars are glucose, fructose and maltose. Simple sugars go into the blood stream without further digestion.

Knowledge of these classes of carbohydrates is very important for patients with special needs such as diabetes (i.e people that have challenges controlling their blood sugar levels). Monosaccharides and disaccharides are called simple sugars or simple carbohydrates. These are types of sugars that can be easily utilized by the body without further action. Diabetic patients are advised to avoid these types of carbohydrates. Examples are table sugar, honey, sweet fruits and sugar cane. Polysaccharides are known as complex carbohydrates. They undergo digestion which breaks them down into simple sugars before the body can use them. They can be eaten by diabetic patients without restriction.

Polysaccharides can also be sub-grouped into digestible and indigestible sugars as shown in Table 1.

Table 1: Sub-groups of polysaccharides

Polysaccharides sub-groups	Examples	Sources
Digestible	Starch	Grain products, roots and tubers
	Dextrin	Dextrin can be produced by starch breakdown during cooking. It can also be produced artificially from rice, potatoes, corn, wheat, arrowroot and sago or tapioca starch enzymes, heat, acids and alkalis.
	Glycogen	Liver, fresh oysters
Indigestible	Cellulose	Fruits and vegetables (such as broccoli, cabbage, kale, brussel sprouts, collard greens, kale and cauliflower) and whole grains.
	Hemicellulose	Cereals, seeds and nuts
	Pectin	Fruits such as guava and apple.
	Agar-agar	Gel product from seaweed

3. Functions of carbohydrates

- i. They are the major sources of energy for the brain, nervous system and the red blood cells using glucose sugars.
- ii. They spare proteins so that they can be used for their own important functions of growth, repair and maintenance of cell tissues.
- iii. Carbohydrates have anti-ketogenic effects. Adequate supply of carbohydrates in the body minimizes the use of fats in large amounts which could result in the formation and accumulation of ketones. The presence of ketones can lead to a disorder called ketosis or acidosis, a condition encountered in uncontrolled diabetes.
- iv. They provide faecal bulk which enables faecal elimination. This is done by the cellulose.
- v. They encourage the favourable growth of intestinal bacteria by the lactose.
- vi. Carbohydrates are also important for fat oxidation.
- vii. They can be converted into proteins (FAO, 2020).

3.2.2 Proteins

The word protein comes from a Greek word which means '*Primary or holding first place*'. Proteins provide amino acids and are the major components of cell structure especially the cell membrane. Proteins build, repair and maintain tissues and cells. It functions as parts of various enzymes (as coenzymes), hormones and antibodies. Proteins are responsible for gene regulation, formation of cellular structures and oxygen blood transportation in the body. In cases of lack of energy in the body, of all the macronutrients, proteins are the last to be used. In extreme cases of starvation, muscles containing protein are converted to energy thus resulting in what is called "muscle wasting".

Food sources of proteins are meat, fish, poultry and its products, milk and milk products, insects, legumes, seeds and nuts. The nutrient value of proteins in foods is 4 gram per calorie. In the absence of energy supply from carbohydrates in the body probably due to shortage, protein supplies the energy.

1. Chemical composition of proteins

Proteins are made up of amino-acids. Each amino-acid contains a carboxyl (COOH) or acidic group and a basic amino group (NH₂). Many amino groups are formed by varying the grouping which is attached to the carbon containing the amino group. For example: glycine (CH₂(NH₂).COOH; alanine (CH₂.CH(NH₂).COOH) and lysine (CH₂.CH₂.CH₂.CH(NH₂).COOH). Like carbohydrates, the nutrient value of protein is also four (4) calories per gram.

Protein in foods are digested and broken down into amino-acids. Many more amino-acids exist in the body but only 20 basic amino-acids are required to form all the different forms of proteins. These include: alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine and valine.

2. Classification of proteins

Proteins are classified into two groups: essential and non-essential amino-acids as shown in Table 2. Essential amino-acids cannot be synthesized in the body and their daily requirement will only be met through dietary intake. There are ten (10) essential amino-acids for infants out of which two are non-essential for adults. There are ten (10) non-essential amino-acids. They can be synthesized by the body and need not be produced from the diet.

Table 2: Classification of amino-acids

Classification of amino-acids		
S/N	Essential amino-acids	Non-essential amino-acids
i.	*Histidine	Alanine
ii.	Isoleucine	Asparagine
iii.	Leucine	Aspartic acid
iv.	Lysine	Cysteine
v.	Methionine	Glutamic acid
vi.	Phenylalanine	Glutamine
vii.	Threonine	Glycine
viii.	Tryptophan	Proline
ix.	Valine	Serine
x.	*Arginine	Tyrosine**

i. Growth and maintenance: Proteins are the major components of muscles, cells, organs and endocrine glands.

ii. Energy supply: For a healthy person, the primary source of energy in the body is carbohydrates and lipids. But when carbohydrates and lipids are not adequate, proteins are used instead. Even though carbohydrates and proteins provide the same amount of energy (4.0 calories/gram), energy supply using carbohydrate is cheaper than using protein because of the enormous metabolism and processes the liver and kidney will do to use protein. Besides, the important functions the protein will do will suffer since no other nutrient will do it.

iii. Glucose supply: There must be fairly constant blood glucose for the red blood cells, brain cells and nervous tissue cells. These cells rely solely on blood glucose for energy. However, when there is insufficient glucose supply from carbohydrate to maintain the blood glucose level, protein becomes the last resort for energy. The liver and kidney then produces glucose from the amino-acids present in the body tissues.

iv. Production of vital body structures: Protein provides structural support to body cells and tissues using structural proteins such as collagen, actin and myosin. They provide a matrix for muscle, connective tissue and bone.

v. Maintaining fluid balance: The blood proteins such as albumin and globulin maintain fluid balance between the blood and the surrounding tissue space.

vi. Contributes to acid-base balance: Proteins act as buffers. They help to maintain acid-base balance and body pH within a narrow range. Proteins situated in cell membranes, pump chemical ions in and out of cells thereby keeping the blood slightly alkaline (pH = 7.35 – 7.45) (Byrd-Bredbenner et al. 2007).

vii. Formation of hormones, enzymes and neurotransmitters: Proteins are the major constituents of the blood, antibodies, hormones, enzymes, synthesis of all body proteins and muscles. Amino acids are used to synthesize hormones such as thyroid hormones and insulin. Amino acids are also involved in the synthesis of metabolic enzymes. They are also used to produce neurotransmitters especially those released by

nerve endings. For example, dopamine synthesized from amino acid tyrosine, norepinephrine from amino acid tyrosine and serotonin from amino acid tryptophan.

viii. Contributes to immune function: Antibody proteins are the major components of immune system. They bind to foreign proteins called antigens that invade the body thus preventing their attack on target cells.

ix. Nutrient transportation: Proteins serve as transporters of other nutrients (oxygen, lipids, vitamin A, iron and copper) from blood stream to cells and across cell membranes to action sites. For examples: the protein haemoglobin transports oxygen from the lungs to the cells; lipoproteins carry large lipid molecules from the small intestine, through the lymph and blood to the body cells; retinol-binding protein transports vitamin A; transferrin carries iron while ferritin is a storage protein for iron and ceruloplasmin transports copper.

3.2.3 Lipids (Fats and Oils)

Fats and oils are also known as lipids. Fats are a more concentrated form of energy storage than carbohydrate. They are stored in the adipose (fatty) tissues of animals. When fats are consumed, they undergo the following processes: emulsification, digestion and absorption. Food sources of fats and oils are all types of cooking oil (e.g palm oil, coconut oil, vegetable oil and groundnut oil); animal fat, tropical nuts, melon seeds, fish oil, butter and margarine.

When carbohydrate is consumed in excess quantity, it is converted and stored as fat in the adipose tissue. The use of fat as energy source is slow and it is done when the availability of carbohydrate is inadequate.

1. Chemical composition

Fat is a complex molecule made up of a mixture of fatty acids and an alcohol called glycerol. Similar to carbohydrates, it contains carbon, hydrogen and oxygen but in a higher proportion than carbohydrate. It contains more carbon, hydrogen and less oxygen. Fats have the highest caloric content and provide the highest energy value when burnt more than any other nutrient. One gram of fat yields 9.0 calories of energy

as opposed to the 4.0 calories per gram produced by carbohydrate. Excess fat is stored in the adipose tissue. This stored fat is converted to energy in cases of low body carbohydrate.

2. Classification of fats

There can be three classes of Lipids as follows: simple lipids, compound lipids and derived lipids. Simple fats are described as the *neutral fats*. They are chemically made up of triglycerides. Triglycerides contain a glycerol and three fatty acids. Neutral fats make up about 99 percent of food and body fats. They are neutral because they do not change and do not contain acidic or basic groups.

Compound lipids are chemically made up of simple lipids containing phosphorus, carbohydrate or protein. They are referred to as phospholipids, glycolipids and lipoproteins. Lipoproteins are the carriers of fats in the blood and as such, are the most important. Phospholipids relate with nervous system.

Derived lipids are the fat-like substances produced from fats and fatty compounds such as glycerol and fatty acids. Glycerol is the water-soluble part of triglycerides or neutral fat and it makes up about 10 percent of the lipid. During the digestion process, glycerol is removed and reserved for the production of glucose when it is needed. Fatty acids are the forms of fat that the cells burn to produce energy. They may be saturated or unsaturated. Examples are palmitic acid, myristic acid, oleic acid, stearic acid, linoleic acid, linolenic acid and arachidonic acid.

Saturated fatty acids do not contain double bonds between their individual carbon atoms like unsaturated fatty acid does. Consequently, unsaturated fatty acids can undergo the process of hydrogenation unlike saturated fatty acids due to the presence of double bonds. Saturated fatty acids are solid at room temperature while unsaturated fatty acids are in liquid form. Animal fats are examples of saturated fats while vegetable fats are mainly unsaturated. Unsaturated fatty acid is nutritionally better than saturated fatty acids because the latter increases the cholesterol level in the blood. The different groups of fatty acids and their health effects are shown in Table 4.

Nutritionally, fatty acids are classified into two: essential and non-essential fatty acids. Essential fatty acids are those that cannot be produced in the body and need to be supplied through the food we eat. Examples are Linoleic acid, Linolenic acid and arachidonic acid. However, non-essential fatty acids can be synthesized by the body. Examples are palmitic acid, oleic acid and butyric acid.

Table 4: Main sources of fatty acids and their health effects

Type	Health effects	Main sources	State at room temperature
Saturated fatty acids	Increases blood cholesterol level	Beef, pork, lamb, milk fat (butter), coconut oil, palm oil, palm kernel oil,	Solid
Mono-unsaturated fatty acids	Decreases blood cholesterol level	Olive oil, canola oil, peanut oil	Liquid
Poly-unsaturated fatty acids (PUFA)	Decreases blood cholesterol level	Sunflower oil, corn oil, safflower oil, fish oil	Liquid
Essential fatty acids	Omega 3 reduces inflammation responses, blood clotting & plasma triglycerides	Cold-water fish (salmon, tuna, sardines, mackerel), walnuts, flaxseed, hemp oil, canola oil, soybean oil	Liquid
	Omega 6 regulates blood pressure and increases blood clotting.		Solid to liquid
Trans fatty acids	Increases blood cholesterol more than saturated fat	Margarine, shortening	Soft to very soft

Source: Byrd-Bredbenner et al. 2007

Fats are also classified as hidden or visible fats. Visible fats include all fats added to foods or used in frying. Examples include pickles, salad dressings, margarine, butter and all cooking oils. Hidden fats include baked products, egg-yolk, whole milk, cream, all sweet meats, cheese, ice-cream, oilseeds and nuts.

3. Functions of Lipids

- i. Lipids supply heat (1 gram of fat = 9 calories). Tissues except those of central nervous system can use fat as energy source in the presence of oxygen.
- ii. Subcutaneous fat acts as insulation and helps to retain body heat.
- iii. Lipids provide padding around the important organs. It holds them in place and helps them to absorb or with stand the shock of physical blows. However, excessive fats around the organs should be minimized as it affects the functions of the organs negatively.
- iv. Lipids transport fat-soluble vitamins: A, D, E and K.
- v. Adequate dietary intake of fats reduces the amount vitamin B₁ needed.
- vi. Fats have satiety value. They slow down the secretion of hydrochloric acid, muscle contractions and the rate of digestion. A fatty diet stays longer in the stomach and prevents the feeling of hunger. This prevention of hunger is referred to as the satiety value of lipids.
- vii. Lipids add flavor to many foods. For example, the taste of skimmed milk is different from that of whole milk.
- viii. Lipids spare proteins. In the absence of adequate carbohydrate for energy, fat will be oxidized for energy instead of protein.
- ix. Cholesterol is needed in the synthesis of sex and adrenal hormones such as steroid hormones. Cholesterol is one of the steroids found in different concentrations in all animal tissues and blood. In addition to the ones consumed, the liver synthesizes it in the body. The body produces 2g of cholesterol daily and the normal blood level is 150 – 300 mg/dl or 100ml of blood. Examples of good food sources of cholesterol are organ meat, egg-yolk, dairy products and shell-fish. Cholesterol is a precursor of bile salts.
- x. Some ‘good fats’ such as poly-unsaturated fatty acids (PUFA) are used to reduce the level of blood cholesterol via heart diseases when there are eaten in higher proportions than the saturated fats.
- xi. Essential fatty acids are useful for the maintenance of the following body functions:
 - a. Delaying of blood clotting time.
 - b. Acting as precursors of an important group of hormone-like compounds such as prostaglandins.
 - c. Regulation of cholesterol metabolism by transporting it between the blood and body tissues.
- x. Fats are used in making steroids and hormones.

- xi. They serve as solvents for fat soluble vitamins and hormones.

Deficiencies, excesses and imbalances of nutrients in our daily diets might result to negative health effects such as diseases and probably death. Safe water and good sanitation is very important.

3.3 MACRONUTRIENT DEFICIENCIES

Macronutrient deficiencies are diseases that are as a result of low consumption of macronutrients. The relationship between macronutrient deficiencies is inter-related. Where one is deficient, the other ones will be used up and it becomes a vicious cycle. Macronutrient deficiencies that arise as a result of low dietary intake of carbohydrates and proteins include the following:

3.3.1 Protein-energy malnutrition (PEM)

Protein-energy malnutrition (PEM) is also called Protein-calorie malnutrition (PCM). PEM occurs mainly in young children as a result of low consumption of carbohydrates and protein. Their dietary intake of macronutrients is lower than their recommended daily intake (RDA) so the children do not get the required energy or calories and proteins for their growth and development. PEM is usually found in children during war periods, isolation camps (idps), and poverty stricken communities.

3.3.2 Forms of Protein-energy malnutrition (PEM)

There are two forms of PEM as follows: Marasmus or Kwashiorkor. Marasmus develops as a result of severe deficiency of energy and protein while kwashiorkor is as a result of severe protein deficiency often accompanied by other diseases, infection and deficiencies. Marasmus develops gradually and culminates in kwashiorkor if not treated on time.

3.3.3 Characteristics of Protein-Energy Malnutrition (PEM)

- i. Presence of edema

- ii. Weight loss
- iii. Muscle and fat loss
- iv. Poor growth
- v. Weakness
- vi. Increased vulnerability to other diseases, infection and deficiencies

Table 5: Characteristics of Marasmus and Kwashiorkor

S/N	Marasmus	Kwashiorkor
1.	Severe weight loss	Edema
2.	Wasting of muscle and body fat (skin and bones appearance)	Mild to moderate weight loss
3.	Severe growth impairment (less than 60 % of normal weight for age)	Maintenance of some muscle and subcutaneous fat
4.	Develops gradually	Growth impairment (60 – 80% of normal weight for age)
5.		Rapid onset
6.		Fatty liver

Source: Byrd-Bredbenner et al. 2007

3.3.4 Diseases associated with excessive consumption of macronutrients

Excessive consumption of macronutrients in the form of sugar, fats and calories could result in the following non-communicable diseases such as:

- i. Obesity
- ii. Diabetes mellitus

One of the causes of obesity is due to excessive accumulation of fats. Diabetes mellitus (DM) has to do with abnormal metabolism of carbohydrates, fats and proteins. DM is characterised by increased sugar levels in the blood and urine. Obesity and diabetes are risk factors of other chronic diseases if not treated on time. These chronic diseases are cardiovascular diseases such as coronary heart diseases, hypertension, stroke, and death.



Figure 1 : Obesity

Source:<https://depositphotos.com/stockphotos/obesity.html?qview=12686568>

4.0 CONCLUSION

Macronutrients are major sources of energy or calories and nutrients for growth and cell development. They are needed in large quantities in the body. However, excess consumption of carbohydrates and lipids could lead to cardiovascular diseases such as high blood pressure, stroke, heart failure, heart attack and premature death.

5.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

- 1). With relevant examples, list the nutrients called macronutrients and explain one of them.
- 2). What is the difference between proteins and lipids?
- 3). Explain the deficiencies associated with consumption of macronutrients.

6.0 SUMMARY

Macronutrients consist of carbohydrates, proteins, lipids and fiber. We looked at their physical and chemical properties as well as their functions. In tabular forms, we also listed their dietary sources and the examples of these macronutrients. We also saw that malnutrition is associated with low dietary intake of macronutrients especially in young children. Coronary heart diseases also result due to excessive consumption of macronutrients. You are encouraged to study these major nutrients and understand them because the knowledge of these nutrients will form the major foundation for this course.

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**MODULE 1 NUTRIENTS, SOURCES, FUNCTIONS AND THEIR
DEFICIENCIES**

UNIT 2 MICRONUTRIENTS AND THEIR DEFICIENCIES

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- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main content
 - 3.1 What are micronutrients?
 - 3.2 Types of micronutrients
 - 3.3 Functions of micronutrients
 - 3.4 Micronutrient deficiencies
- 4.0 Conclusion
- 5.0 Tutor-Marked Assignments (TMAs)
- 6.0 Summary
- 7.0 References/Further Readings

1.0 INTRODUCTION

In this Unit two, we will be discussing micronutrients. Micronutrients are another essential class of nutrients. We are going to be looking at nutrients that make up of micronutrients, their physical and chemical properties, sources and functions.

2.0 OBJECTIVES

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

- i. Understand and explain what micronutrients are
- ii. Describe the nutrients that are called micronutrients
- iii. List and discuss classes of micronutrients
- iv. List and explain the functions of micronutrients
- v. Discuss micronutrient deficiencies in details

3.0 MAIN CONTENT

3.1 VITAMINS AND MINERALS

Vitamins are a group of organic compounds needed in minute quantities for normal function, growth and maintenance of body tissues. Majority of the vitamins are not synthesized in the body and have to be provided through dietary intake. Examples include vitamins A, B, C, D, E and K. Only folic acid and vitamin D are partially synthesized in the body. Minerals are inorganic elements that occur in the form of their salts. They make up about four percent of the body weight. Examples are phosphorus, calcium, potassium, sodium, iodine, iron, copper, sulphur, chlorine, manganese, magnesium and molybdenum.

Like vitamins, minerals are also needed in minute quantities. They are excreted from the body through the kidney, skin and the bowel so they need to be supplied daily through the diet. Minerals can also be in the body in the form of organic (carbon containing) compounds, inorganic compounds and free ions. Examples of organic compounds are phospholipids, phosphor-proteins, haemoglobin and thyroxine while examples of inorganic compounds are sodium chloride and calcium phosphate.

3.2 CLASSIFICATION OF VITAMINS

Vitamins are classified into two:

- i. **Fat soluble vitamins:** They dissolve in organic solvents. Examples are vitamins A, D, E and K.
- ii. **Water soluble vitamins:** They dissolve in water. Examples are vitamins B-complex and C. Vitamins B-complex includes vitamins B₁ (Thiamine), B₂ (Riboflavin), B₃ (Pantothenic acid), B₆ (Pyridoxine) and B₁₂ (Cyanacobalamin).

3.3 CLASSIFICATION OF MINERALS

Minerals are classified into three:

- i. **Major minerals or macro-minerals:** They are required in large amounts in the body. Their recommended daily allowance (RDA) is approximately 100 mg/day. Examples are phosphorus, calcium, chlorine, sodium and potassium.
- ii. **Minor minerals:** They are required in small amounts in the body. Examples are iron, magnesium and sulphur.
- iii. **Trace elements:** They are needed in few micrograms. Examples are iodine, zinc, fluorine and molybdenum

3.4 Chemical characteristics of vitamins

a. Fat-soluble vitamins

- i. They are not easily destroyed by cooking methods. However ever, vitamin A is unstable and easily destroyed by heat, light, pH, moisture, etc.
- ii. They are not easily eliminated and so are stored in the body. Their excess consumption could lead to toxicity.
- iii. They are destroyed by rancidity.

b. Water-soluble vitamins

- i. Unlike fat-soluble vitamins, they are unstable to heat, light oxidation and radiation.
- ii. They are affected by cooking practices. Since they leach into the water, if the water is decanted, they are wasted.
- iii. Excess intake does not result in toxicity since they are excreted in the urine.

3.5 FUNCTIONS OF MINERALS

- i. They regulate cellular oxidation.
- ii. Minerals act as enzyme activators.
- iii. They are part of hormone and enzyme molecules.
- iv. Minerals help to maintain acid-base balance of body fluids.
- v. They control the water balance in the body through osmotic pressure and by regulation of the permeability of cell membranes.

3.6 SOURCES OF VITAMINS AND MINERALS

The major sources of vitamins and minerals are shown in tables 6 and 7.

Table 6: Good sources of vitamins

Vitamin	Good sources
Vitamin A -Retinol -Precursor -carotene	Green and yellow fruits and vegetables, ripe tomatoes, liver, whole milk, egg-yolk, butter, fortified margarine and fish liver oil
Vitamin B ₁ -Thiamine	Meat especially pork, liver, nuts and peanut butter, grain and enriched cereals, milk and milk products, eggs, brewer's yeast and wheat germ, legumes especially soybeans
Vitamin B ₂ -Riboflavin	Milk and milk products, liver, legumes, eggs, brewer's yeast, green leafy vegetables, enriched and whole grain cereals.
Niacin -Tryptophan precursor	Meat especially liver, poultry, fish, enriched and whole grain cereals, brewer's yeast, nuts and peanuts
Vitamin C	Fresh fruits especially citrus such as oranges, lemon, strawberries, canned fruit juices, tomatoes, raw vegetables especially green cabbage, pepper and potatoes
Vitamin D -Calciferol	Milk, butter (small amounts), egg-yolk, liver, fish oil and organ meat, nuts, legumes
Vitamin E	Green leafy vegetables, vegetable oil, margarine, egg-yolk, milk fat, wheat germ oil
Vitamin K	Green leafy vegetables, liver, cabbage and cauliflower

The major sources of minerals are as shown in Table 7.

Table 7: Good sources of minerals

MINERALS	GOOD SOURCES
Calcium	Green leafy vegetables, milk, cheese, bones
Chlorine	Table salt
Copper	Whole grain cereals, organ meat, shell-fish, nuts and legumes
Fluorine	Tea, sea-foods
Iodine	Iodine fortified table salt, salt water fish, shell fish, seaweed
Iron	Green leafy vegetables, liver, lean meat, fish and poultry, legumes, dry fruits, whole grain cereals
Magnesium	Fresh green vegetables, dairy products, meat nuts, legumes and sea foods
Potassium	Meat, fish, poultry, milk and curds
Phosphorus	Milk, meat, fish, legumes, whole grain cereals and flour
Sodium	Table salt, milk, egg-white, meat, fish, poultry and vegetables such as spinach (Fruits, vegetables, cereals, legumes and drinking water contain small quantities of sodium).
Sulphur	Meat, milk, egg, meat, fish, poultry, cheese and nuts. All proteins containing methionine, cysteine and cysteine are excellent sources of sulphur.
Zinc	Human colostrum, beef, liver, oyster, spices and wheat bran, popcorn, pork, crab, peanuts, peanut butter, cheddar cheese

3.7 MICRONUTRIENT DEFICIENCIES

Micronutrient deficiencies arise as a result of a prolonged low dietary intake of micronutrients such as vitamin A, iodine, folic, zinc and iron. These nutrients have their daily recommended quantities needed by the body every day for normal function of cells, tissues and organs. If these standard quantities are not being consumed in food for a long time, micronutrient deficiencies will arise.

The major challenge is that some of these micronutrients are taken in small quantities and are not produced by the body. So prolonged dietary intake of foods that lack these nutrients will result in micronutrient deficiencies (Uchendu and Atinmo, 2011). Long term strategies that have been taken to eradicate micronutrient deficiencies include food supplementation, micronutrient food fortification, biofortification, dietary diversification and nutrition education (Uchendu and Atinmo, 2011)

3.7.1 Types of Micronutrient deficiencies

Global micronutrient deficiencies that have been declared public health problems are vitamin A deficiency (VAD), iodine deficiency disorders (IDD), Iron deficiency Anemia (IDA), zinc deficiency and folic deficiency. It is important to note that these micronutrient deficiencies coexist and interrelate with one another (Uchendu and Atinmo, 2011). The at-risk groups for micronutrient deficiencies are young children especially the Under-5, pregnant mothers and lactating mothers. Table 8 shows the micronutrient deficiencies and the nutrients involved.

Table 8: Micronutrient deficiencies and the nutrients involved

S/N	Micronutrient deficiencies	Nutrients involved
1.	Vitamin A deficiency	Vitamin A
2.	Iodine deficiency disorders	Iodine
3.	Iron deficiency Anemia	Iron
	Zinc deficiency	Zinc
	Folic deficiency	Folate

4.0 TUTOR- MARKED ASSIGNMENTS (TMAs)

- 1). Explain with relevant examples the nutrients that make up micronutrients.
- 2). Discuss micronutrient deficiencies.
- 3). Describe the at-risk groups of micronutrient deficiencies.

5.0 CONCLUSION

In Module 1 Unit 2, we have learnt about micronutrients which are made up of vitamins and mineral. We also looked at the good sources of these nutrients especially fruits and vegetables. Their physical and chemical properties were explained as well as their functions. Global micronutrient deficiencies and the long-term strategies that have been adopted to eradicate these deficiencies were also considered. I hope you enjoyed it.

6.0 SUMMARY

Module 1, Unit 2 discussed the micronutrients, their sources, functions, physical and chemical properties and deficiencies. Adequate knowledge of nutrients is very important because it will be applied in subsequent modules.

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MODULE 1 NUTRIENTS, THEIR FUNCTIONS AND METABOLISM

UNIT 3: OTHER NUTRIENTS

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1.0 INTRODUCTION

Water and fiber are most often than not, forgotten as nutrients. However, they are so essential that you cannot do without them. In this Unit, we will refresh your memory on these two nutrients.

2.0 OBJECTIVES

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

- i. Discuss the importance of water
- ii. Discuss the importance of fiber

3.0 MAIN CONTENT

3.1 WATER

Water is a chemical compound made of hydrogen and oxygen with the chemical formula H₂O. Water is fundamental to human health as the human body is composed of approximately 75 percent of water. Besides being part of the body tissue, water assists in transporting nutrients to the cells and removal of waste products from the cells. It helps in regulating body temperature and facilitates digestion. Because water is continually being lost from the body through sweat, urine, feaces - stool and breathing, it must be continually replenished.

Water is obtained from drinking water, foods and beverages. For good health, it is recommended that you - individuals drink about 8-10 glasses of clean portable water daily. Water enhances weight loss because it flushes down the by-products of fat breakdown. Water has zero calories. As a zero calorie nutrient, water is an effective appetite suppressant that reduces calorie intake.

Water is fundamental to human health, making up over 70 percent of your body's mass. Besides being part of your body tissue, water transports oxygen and nutrients to and waste products from cells. Water helps to regulate body temperature and facilitates digestion. Because water is continually being lost from your body through sweat, urine, feaces and your breath, it must be continually replenished. You get water from foods, beverages and drinking water. The human body is made up of about 75% water. For good health, we should drink about 8-10 glasses of water daily. The more water we drink the more we save ourselves from some health problems. However, water enhances weight loss. Drinking water helps you lose weight because it flushes down the by-products of fat breakdown. It also reduces hunger. It is an effective appetite suppressant so it makes you eat less.

3.2 FIBER

Fruits and vegetables are good sources of fiber. Fiber helps to empty your bowl and prevent constipation and fat deposit. Fiber is also known as "roughage." It is an indigestible plant matter such as cellulose. Insoluble fiber plays an important role in digestion, helping food move smoothly through the colon (large intestine). Good sources of insoluble are the skin and pulp of many fruits and vegetables, whole grains, popcorn, and seeds. Soluble fiber helps stabilize blood sugar and may reduce Low Density Lipoprotein (LDL) cholesterol levels. Sources of soluble fiber include oatmeal and oat bran, legumes, nuts, and fruits such as apples, oranges, pears, and grapes.

Fibre is not a nutrient. This is because it does not give energy and does not support growth. However, it has health-promoting properties hence it is included in the list of "Balanced Diet". Most animals cannot digest the cellulosic part of plant foods, and in the diets of humans this part of vegetable intake functions as dietary fibre. Dietary fibres are otherwise called non-starch polysaccharides because the bonds between their monosaccharides cannot be broken down by digestive enzymes in the human body. Dietary fibre is divided into soluble and insoluble fibre. Soluble fibre is soluble in water and forms gel. They are easily fermented by bacteria in the colon, and are commonly found in oatmeal and oat bran, barley, legumes, nuts, citrus fruits, apples and pears. They are often associated with protecting against heart disease and diabetes by lowering blood cholesterol and glucose levels. Insoluble fibre does not dissolve in water and are less readily fermented. They are mostly found in whole grains (bran), the skin and pulp of many fruits, vegetables and seeds.

Dietary fibres promote bowel movements and alleviate constipation. They absorb and hold water thereby aiding formation of softer and bulkier stool for easy elimination from the colon. They bind to and remove toxic metals from the body system and help to prevent fat deposits. They also give some sense of satisfaction and prevent overeating through lingering in the stomach and delaying gastric emptying, thereby preventing overweight.

4.0 CONCLUSION

Water and fibre are very important in our daily lives. Humans cannot do without water and fibre. Water can be used in so many ways at home, schools, factories and industries. Please read and refresh your memories on the various uses of water and fiber.

5.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

1. List the functions of water.
2. Explain the importance of fiber
3. Fiber is not a nutrient. Discuss

6.0 SUMMARY

Water and fiber are also nutrients very essential for healthy living. Water is regarded as a universal solvent because it has so many applications. Daily intake of food with low levels of water and fiber will result to dehydration and constipation.

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**MODULE 2 INTRODUCTION TO PUBLIC HEALTH NUTRITION:
NUTRITION THROUGH THE LIFE CYCLE**

Unit 1: Nutritional Requirements for Infants

Unit 2: Micronutrients and their deficiencies

Unit 3: Other Nutrients

UNIT 1 NUTRITIONAL REQUIREMENTS FOR INFANTS

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1.0 INTRODUCTION

Module 2 Unit 1 discusses the nutritional requirements of infants especially those between 0-1 year or 0-23 months. Children from 0-5 years (0-59 months) are called pre-school children. They are also referred to as Under-5 (U-5). In this Unit, we will discuss the infants group (0-23 months). These stages of life are very important because what happens at this stage determines whether a child will be alive or death. It is the foundational stage of the life of a child. Therefore the nutritional requirement of a child at this stage is very important. Nutrition in the early stages of life is a major determinant of the growth, health and development of a child. Everything about a child: brain development, optimal growth (weight and height) and health is largely dependent on the nutritional lifestyle in the early stages of life.

2.0 OBJECTIVES

At the end of this Unit 2, you will be able to:

- i. Describe who neonates and infants are.
- ii. Discuss types of foods to be given to infants
- iii. Define Exclusive Breast Feeding (EBF)
- iv. Discuss the composition of human milk
- v. Explain the nutritional requirements of neonates 0-6 months.

3.0 MAIN CONTENT

3.1. NUTRITIONAL REQUIREMENTS OF NEONATES AND INFANTS 0-12 MONTHS

3.1.1. WHO IS AN INFANT?

Before we discuss who the infants are, I will like us to know who the neonates are. A neonate is an infant in the first 4 weeks or 28 days of delivery. The term neonate is derived from the latin word “neonates” meaning “newborn”. This term applies to premature, full-term, and post mature infants. A neonate is also called a newborn or a

baby. It is a period of rapid changes with occurrence of critical events such as establishment of feeding patterns, beginning of bonding between infant and parents, vulnerability to many infections and notice of many birth or congenital defects (MedlinePlus, 2019a).

An infant is a child in earliest stage of life especially before he/she can walk. An infant is a synonym for a baby in a formal sense. Infants can be grouped as babies between 0 – 12 months old. During this period, the child is at the highest risk of death (WHO, 2019). Therefore, it is very important that adequate feeding and care be provided during this period to improve the infant's survival rate and lay a healthy life foundation for the baby.

3.2 FOODS REQUIRED BY INFANTS 0-12 MONTHS

The best food required by infants at this stage of life is breast milk only. Breast milk contains all the nutrients the baby requires for optimal growth at this period. Breast milk is a natural sterilized food packaged specially for the baby by God. It is the baby's 'take away', ready to eat meal. Breast milk is the best meal a mother can give to her baby. Have you watched a baby sucking breast? The baby sucks intently with his hand scratching his hair and one leg raised up. This is the extent a baby can enjoy breast milk. No mother except there is a medical issue should deny her baby breast milk. Denying a baby breast milk is tantamount to 'punishing' the baby without the mother knowing it.

Babies at this stage are prone to diarrhoea (stooling and vomiting) due to infection which might result in high morbidity and mortality rates. One of the likely sources of this infection might be bottle feeding or spoon feeding. Bottle or spoon feedings might lead to infection if dirty water was used during washing or the feeding bottles, plates and spoons were not properly washed. Sharing of these feeding bottles, plates and spoons and by other members of the family with the baby might also lead to infection of the baby. Part of the reason for this vulnerability of the baby to infection at this stage is due to the low immunity of the baby. The two methods of feeding are discouraged for children 0 – 6 months old except there is a health challenge.

The first breast milk that comes out of the breast of a mother after delivery is called Colostrum. It is a yellowish sticky liquid produced at the end of pregnancy. There is this superstitious believe in many communities in Nigeria that the colostrum is dirty and so should be expressed and thrown away before feeding the baby with breast milk. Many mothers in these communities actually practice it. But this is a myth with no truth in it. World Health Organisation recommends colostrum as the perfect food for the newborn and feeding should be initiated within the first hour after birth (WHO, 2019a).

For a baby to benefit fully from breast milk, the mother of the infant should adopt Exclusive breastfeeding (EBF). Exclusive breastfeeding is recommended up to 6 months of age with continued breastfeeding along with appropriate complementary foods to two years of age or beyond (WHO, 2019a). So from 0 – 6 months only breast milk should be given to an infant, no water or any other liquid. According to the National policy on Infant and Young Child Feeding, exclusive breastfeeding is giving an infant only breast milk in the first six months of life, no other liquids, drinks, semi-solids, and not even water except oral rehydration solution or drops/syrups of vitamins, minerals or medicines as prescribed by a physician (NigeriaHealth Online, 2019). Breast milk from a healthy woman with good nutritional status is a complete food a child from 0 - 6 months.

3.3 EXCLUSIVE BREAST FEEDING (EBF)

World Health Organisation (WHO) recommends exclusive breast feeding (EBF) for infants 0 – 6 months of age. Exclusive breast feeding means a nursing mother feeds the baby with breast milk only, without any additional food or liquid even water, with the exception of oral rehydration therapy, drops, syrups of vitamins, minerals or medicines (WHO, 2014). Breast milk contains enough of all the required nutrients necessary for the baby to thrive from 0-6 months. This fact is at times very difficult for some mothers and grandmothers to believe but it is true. We will discuss the composition of human breast milk in due course to confirm this claim!

During the period of EBF, water cannot be given to the baby even when the weather is hot because the water might be contaminated and so cause the child to have diarrhoea which might be fatal. Many babies have died before their 1st birthday from diarrhoea.

Breast milk contains enough water, more than 80 % especially the 1st feed. If the baby is thirsty, the mother should give breast milk to quench the taste. Again, giving the baby water will make the baby to drink less breast milk or stop breast feeding early thereby predisposing the child to malnutrition. Feeding the baby water instead of breast milk might cause the mother to have less milk in future.

After six months, complementary feeding should be added to the breast milk. The baby should be given all the family meals at six months including water. WHO recommends that EBF should continue until the baby is 24 months old.

3.3.1 Composition of Human Breast milk

Breast milk provides complete nutrition for an infant and offers immunological and nutritional benefits which cannot be replicated by infant milk formulae (Thompson and Howard, 1998). Husbands, mother-in-laws, grandmothers, health professionals, government and other stakeholders have a responsibility to encourage and support breastfeeding. Breast milk is made up of colostrum and matured milk.

3.3.2 Colostrum

Colostrum is produced at the end of pregnancy. It has a higher protein content than mature milk and much of the protein is present as immunoglobulins especially IgA. Colostrum therefore boosts the child's immunity and helps to protect the child from infections. It has lower fat and energy density contents than mature milk and also very rich in minerals and vitamins such as vitamin A, D and B₁₂ (Thompson and Howard, 1998).

3.3.3 Mature milk

Breastfeeding changes from colostrum to mature milk. This transition is a gradual process stimulated by frequent suckling of breast by the baby. The composition of

mature breast milk is not homogenous but varies between individuals and during a feed. An average composition of breast milk is given in Table 9.

Table 9. Average nutrient composition of human breast milk					
Nutrient	Content	Nutrient	Content	Nutrient	Content
		Micronutrients			
Macronutrients		Vitamins		Minerals	
Energy(kcal)	70.0	A (µg)	60.0	Sodium (mg)	15.0
Protein (g)	1.3	C (mg)	3.8	Potassium (mg)	60.0
Lactose (g)	7.0	D (µg)	0.01	Chloride (mg)	43.0
Fat (g)	4.2	E (mg)	0.35	Calcium (mg)	35.0
Water (%)	88.0	K (µg)	0.21	Phosphorus (mg)	15.0
		Thiamin (µg)	16.0	Magnesium(mg)	3.0
		Riboflavin (µg)	30.0	Iron (µg)	76.0
		Niacin (µg)	620.0	Copper (µg)	39.0
		B ₁₂ (µg)	0.01	Zinc (µg)	295.0
		B ₆ (µg)	6.0	Iodine (µg)	7.0
		Folate, total (µg)	5.0		
		Pantothenic acid (µg)	260.0		
		Biotin (µg)	0.8		
Source: Thompson and Howard, 1998					

Matured breast milk has a lower protein concentration than cow's milk and consequently a lower renal solute load. The casein:whey protein ratio of breast milk is 40:60 and this produces a soft, digestible curd in the stomach (Thompson and Howard, 1998). Breast milk contains higher levels of cysteine which is an amino acid very important for brain development.

Matured milk has two portions during feeding: the foremilk and the hindmilk. The foremilk is the initial breast milk at the start of feeding while the hindmilk is the breast milk that comes out as feed progresses. Fat produces approximately 50.0 % of the total energy of breast milk. The fat content of foremilk and hindmilk varies during a feed. The fat content of breast milk is low at the start (foremilk), and increases as the feed progresses (hindmilk) (Thompson and Howard, 1998). Human milk is rich in essential

fatty acids, and the long chain polyunsaturated fatty acids required for brain and retinal development.

The carbohydrate is present in the form of lactose which enhances calcium absorption. Even though vitamin levels in breast milk are influenced by a mother's dietary status, they are usually sufficient to meet demand. The bioavailability of minerals in the breast milk is very good.

3.4 ADVANTAGES OF EXCLUSIVE BREASTFEEDING

- i.** Breast milk is economical.
- ii.** Breast milk is always available at the right temperature.
- iii.** Human milk contains immunoglobulins and other antimicrobial factors which blocks the entry of potential pathogens across the gut mucosa and reduces the risk of infections.
- iv.** Breastfeeding reduces incidences of gastro-enteritis and respiratory infections if given for 13 weeks (3 months).
- v.** Breast milk contains optimal ratios of long chain polysaturated fatty acids required for brain and retinal development.
- vi.** The absolute concentration and consequently the potential renal solute load of breast milk is low.
- vii.** The bioavailability of minerals in breast milk is excellent.
- viii.** Breastfeeding has been reported to delay the onset and reduce the severity of allergies in children with a family history of atopic disease.
- ix.** Breastfeeding reduces the incidence of necrotizing enterocolitis in pre-term babies.
- x.** Evidence indicates that breastfeeding protects against development of breast cancer in premenopausal women.
- xi.** Breast milk is the ideal food for the survival, health, growth and development of a child.
- xii.** It is an integral part of the reproduction process with important implications for the health of mother and the entire family.

One reported challenge of exclusive breast feeding is that the baby might be refusing family meals after being exclusively breast fed. This will only happen if the mother did not start family meals immediately the baby cloaked six months or was not diligent in making the baby to eat the family meals. The meals should be prepared in such a way the baby will like to eat it. For example, some of the foods can be mashed and made in an attractive and delicious manner, e.g yam, beans, and rice.

3.5 TRENDS OF BREASTFEEDING IN NIGERIA

Approximately 7 million children are born in Nigeria yearly. Out of this number, only 25.0 % are exclusively breastfed from 0-6 months of age (UNICEF, 2016). This is an improvement over 17.0 % it has been stagnated for over a decade. The pressure to give water to babies in addition to breast milk is high in Nigeria. Some mothers and grandmothers, belief that breastmilk is not enough for the baby. They ask the question, “How will a baby not drink water?” But breast milk contains the adequate volume of water the baby needs as seen in Table 9.

The annual World breastfeeding week is every 1st – 7th August of every year. Nigeria launched the Breastfeeding Advocacy Initiative (BAI) and the National Social and Behavioural Change Communication Strategy for Maternal Infant and Young child Nutrition (NBBCCS 4 MIYCN) in 2017. The exclusive breastfeeding has shown a marginal increase from 2.0 % in 1990 to 17.0 % in 2013 and then 25.0 % in 2014.

3.4 FACTORS AFFECTING EXCLUSIVE BREASTFEEDING

Antenatal care was strongly associated with an increased rate of EBF (Agho et al. 2011). A study in Southwest Nigeria among 248 mothers of pre-school children (U-5), found respondents with good knowledge of breastfeeding in urban and rural areas as 84.7 % and 89.5 % respectively. The overall positive attitude to breastfeeding among the urban and rural respondents was reported as 52.4 % and 57.3 % respectively. About 75.8 % of rural and 43.5 % urban respondents initiated breastfeeding immediately after

birth. Most of the rural respondents who had babies aged 0-24 months (46.8 %) were currently breastfeeding their babies as opposed to 25.9 % of urban groups. About 79.8 % rural respondents had practiced EBF compared to 29.0 % of the urban respondents who cited work resumption as one of the reasons for non-compliance. Overall good practice was 16.1 % (urban) and 69.4 % (rural). The study concluded that even though the respondents had good knowledge of EBF, attitude was fair while the practice of EBF was low especially among the urban respondents (Balogun et al. 2017).

From these findings, factors that limited EBF were location (urban and rural), work (working mothers), and attitude. Other factors include painful or engorged breasts, baby rejecting breast and no enjoyment when breast feeding. After 2 weeks, the main reasons for stopping breastfeeding were: the baby is not settling or seems hungry, breast milk not enough baby cries all the time, breast milk not flowing enough for the baby and that breastfeeding takes too long, is too stressful and the mother afraid that her breast will fall.

4.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

- 1). Who is an infant?
- 2). Explain with relevant examples the nutritional requirements of infants.
- 3). Discuss the prevalence of EBF in Nigeria

5.0 CONCLUSION

We have come to the end of this Unit, Module 2 Unit 1. I hope you learnt something! In this Unit we discussed in details the nutrient requirements of infants. We first of all explained who an infant is. I am sure you can now explain the difference between a neonate and an infant. We also discussed exclusive breast feeding and the composition of human breast milk. We explained the advantages and disadvantages of exclusive breast feeding.

6.0 SUMMARY

We now know that the best food for infants (0 – 12 months) is breast milk. The optimal infant and child feeding practices include exclusive breastfeeding for the 1st 6 months of life, age-appropriate and safe complementary feeding, and the prevention of micronutrients deficiencies. Exclusive breast feeding should be practiced by nursing mothers for the 1st six months without water or any other food or drink. From Table 9 we saw that the water content of human breast milk is 88.0 % and this is high enough to satisfy the baby. If the baby cries most of the time, it is not that he/she is thirsty and that breast milk water is not enough. It might be due to other reasons.

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**MODULE 2 INTRODUCTION TO PUBLIC HEALTH NUTRITION:
NUTRITION THROUGH THE LIFE CYCLE**

**UNIT 2 NUTRITIONAL REQUIREMENTS OF PRE-SCHOOL
CHILDREN**

CONTENTS

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1.0 INTRODUCTION

Pre-school children are children from 0 – 5 years. They are also referred to as Under-5 (U-5). We have already treated infants between 0-1 year or 0-23 months in Module 2 Unit 1 above. In this Unit 2, we will look at pre-school children. Pre-school children are young children from 1 – 5 years old. These Under-5 (U-5) children include the infants and young children at 0 –12 months, 1-3 years and 4-5 years.

2.0 OBJECTIVES

At the end of this Module 2 Unit 2, you will be able to:

- i. Describe the nutritional characteristics of pre-school children.
- ii. Growth Monitoring
- iii. Discuss the nutritional requirements of children 1-5 years
- iv. Explain why the nutrition in the 1st 1000 months is very important.

3.0 MAIN CONTENT

3.1 FOOD CONSUMPTION PATTERN OF PRE-SCHOOL CHILDREN

Pre-school age is pre-primary education age equivalent to kindergarten or nursery. It is the age attained before a child starts primary school. Mean compulsory age for starting school in European countries is five years (Eurydice, 2013). According to international standard classification of education (ISCED 01), the minimum age for a child to start primary school is five years (UNESCO, 1997).

Childhood period from 24-35 months is the initial phase of dietary transition from infant to adult-style of eating habits. This process continues from 36-59 months and the term pre-school is used to describe this stage (Howard, 1998). Pre-school period is characterized by a slower growth rate, relative body leanness and increasing developmental skills and independence. These factors affect both nutrient needs and food intake. Consequently, preschool child has a relatively small appetite with periods of increasing food intake in advance of a growth spurt. Pre-school child experiences

increased autonomy and expression of food preferences, combined with a variable appetite.

From the age of 36 months, a child's food preferences and eating habits are influenced greatly by external factors outside the home. Pre-school aged children's food choices are influenced by nursery school, peer preferences, fictional heroes in a story, television advertising and experience of eating away from home (Howard, 1998). Peer influence has been shown to be effective in influencing pre-school children food choices than parental influence (Westenhoefer, 2000). Family meal patterns are affected by family routines, parents' working hours and child's appetite at different times of the day (Howard, 1998).

A snack is a light, casual, or ready-to-eat food eaten in-between meals. A snack should therefore be a nutritious mini-meal. Too many snacks will reduce appetite for meals, often to the detriment of total nutrient intake (Howard, 1998). Best snacks are those chosen from bread and cereals or fruit and vegetables food groups. Examples include bread roll, toast, plain cracker, oatcake, banana, Satsuma, etc. The number of servings of bread, other cereals and potatoes recommended for pre-school children is 4⁺ per day and above (Howard, 1998).

Basic nutritional needs of children are similar to the nutritional needs of other family members except that the amounts differ because of age (Martin, 2007). Children grow in spurts. Pre-school children should be offered a variety of foods from the basic food groups and this includes breads, cereals, rice and pasta, vegetables, fruits, milk, yogurt, cheese, meats, poultry, fish, beans and peas, and eggs (Martin, 2007). Breads and cereals contribute minerals and vitamins (Martin, 2007). Consumption of bread and biscuits by children under five years of age in urban Saoss Paulo, Brazil and rural Northeast Brazil were 96% and 65% respectively (USAID/DSM, 2010).

The diet characteristics of pre-school children (2-5 years) in Nigeria is that at that age, they are no longer breast-fed and they consume family foods which depend on the tribe: eba, fufu for Igbos; amala, fufu and ewedu for Yorubas and tuwo-masara for the Hausas. They consume more of biscuits, jallof rice, fried plantain (dodo), bread,

beverages, cake, pap (ogi), and cereal foods. They like sweet confectionaries. Many of them do not like vegetables. They consume relatively small amounts of food and depend on caregivers to feed them (WHO/FAO, 2006; McLaren and Frigg, 2001). Food frequency survey studies have indicated that irrespective of social economic status (SES), all the children consumed rice daily (Vijayapushpam et al. 2002). The low dietary quality of the diet in terms of both insufficiency and low diversity is typical of the food-consumption patterns in West Africa (Nana et al. 2005). In most developing countries, diets are monotonous and mainly based on cereals and legumes that are poor sources of vitamin A (Dary and Mora, 2002).

Many factors make assessing dietary intake in pre-school aged children difficult: pre-school children eat small amounts of food at frequent intervals; they are not able to complete questionnaires on their own and have a limited cognitive ability to recall, estimate, and otherwise cooperate; they often spend time under the care of several individuals; and their food habits and nutrient intakes may change rapidly.

3.2 ASSESSMENT OF GROWTH AND NUTRITIONAL STATUS OF CHILDREN

Assessment of growth and nutritional status of children can be done through field techniques, anthropometry and using growth charts as primary health care tool.

3.2.1 Growth Monitoring for Pre-school Children

Pre-school age is a period of tremendous growth. Therefore growth monitoring at this stage is very important.

3.2.2 What is Growth?

Growth is the increase in size over a period of time. The growth of a child can be assessed in three ways:

- i. By determining nutritional status of the child and comparing it with another child of the same age
- ii. Use of growth curve and

- iii. growth pattern

3.2.3 Determination of the Nutritional Status of the Child

Nutritional status is the best indicator for measuring a child's health status. Three variables or parameters are used to measure the nutritional status of a child. These include weight, height and mid-upper arm circumference (MUAC). The measurement of weight, height and MUAC is called anthropometric measurements. Anthropometric data have been identified as the most universally accepted methods of assessing body composition and size (Wells and Fewtrell, 2006). Anthropometric data is a globally accepted method of determining Nutritional status. This might be because it is simple and easy to measure, non-invasive and not expensive because the instruments are available. They also have strong correlations with health gains and survival.

i. Weight

This is the most commonly used measure of body size in children. This is because it is easy to weigh a child and provides accurate result. To weigh an infant, lie the young child on a scale, wait until the child lies still and then take weight to the nearest 10 g. The child should be weighed with minimal clothing, undressed or wearing only a vest. Remove the nappy before weighing as this might falsely increase the weight.

Older children are weighed standing up. The weight is recorded to the nearest 100 gramme or 0.1 kg. The child should be weighed wearing only underpants.

Zero the scale before weighing the child and calibrate the scale weekly to maintain accuracy of the weights.

The weight of an infant should be measured and recorded every month for the first year of life, every 2 months for the second year and then every 6 months till the child becomes 5 years old. However it is often measured routinely during immunization visits in the hospitals and Primary Health Care Centres (PHCs).

ii. Height or length

This is a very useful measure of body size, especially in older children. However, it is more difficult to measure height accurately than weight. Height is measured with the child standing. In infants, the length is measured instead of height. This measurement is done while lying down the baby on the weighing scale. A child's length and height are the same.

Measure the height of the child while standing barefooted. Both heels should be kept on the floor with the child's back pressing against a wall. The child should stretch as tall as possible with the arms kept at the side while looking straight ahead. The measuring device should have a fixed tape or ruler on the wall and a sliding head board if possible. If this is not available, move a square block of wood or a book down against the wall until it touches the top of the child's head. Then measure the distance from the floor to the block of wood, to the nearest 1 mm, to get the correct height.

For children under 2 years, the lying length is often measured. If possible, a measuring board should be used. The infant is laid down on the back with legs fully extended while holding the infant's head against the top board and the legs are stretched, keeping the knees flat and pressing the heels of the infant's feet against the bottom board. The distance is measured to the nearest 1 mm between the boards to get the length of the infant. Measuring length with a tape gives an inaccurate result.

Length or height of a child should be measured every 6 months till the child is 5 years old.

iii. Head circumference

This is another useful measure of body size but must be measured correctly. To measure head circumference accurately, use a measuring tape and record to the nearest 1 mm. Measure the largest circumference of the head (occipito-frontal circumference) with the tape across the forehead and then around to the back of the head (occiput).

Head circumference should be routinely measured at birth, 14 weeks and 12 months. There is little increase in head circumference after 36 months. Head circumference is not measured at every clinic visit unless there is a good reason.

iv. Mid-upper arm circumference (MUAC)

This is a quick and simple method that can be used in the home or clinic. However it is more useful as a screen for malnutrition than as a measure of growth.

Mid-upper arm circumference (MUAC) is measured at the midpoint between the tip of the shoulder and the tip of the elbow of the left upper arm with a tape rule or a special measuring tape. The arm is allowed to hang and relax at the side before the measurement is done. The tape should not be pulled too tightly. Measure to the nearest 1 mm. Mid-upper arm circumference should be measured every 3 months to 5 years of age.

Increase in a child's weight and height is a sign of growth. It is there very important to record a child's weight and height and plot the measurements on a growth chart at clinic visits. This is shown in the growth curve in Figure 1 below.

Regular measurement of a child's weight, height or length and head circumference in order to monitor the child's growth is growth monitoring. The determination of nutritional status is then carried out by combining these measured indices as shown below:

- a. Weight-for-height or weight-for-length
- b. Height –for-age
- c. Weight-for-age

Infant and child nutritional status is expressed as a weight-for-age, height-for-age and weight –for-height z scores in relation to the median (50th centile) of a reference population (Penny, 2012).

- v. Weight-for-height** is an index used for assessing wasting. Wasting is an indication of acute malnutrition. Wasting is defined as a low weight for height of a child compared to a child of the same height.

vi. Weight-for-age is an index used in growth monitoring for assessing children who may be underweight. You assess weight-for-age of all children under two years old.

Percentage of underweight is defined as percentage of weight-for-age below -2 standard deviation (SD) of the WHO Child Growth Standards median among children under five years of age.

$$\text{Weight-for-age} = \frac{\text{Weight of the child}}{\text{Weight of a reference child of the same age}} \times 100$$

vii. Height-for age is an index used for assessing stunting. Stunting is defined as a low height for age of a child compared to another child of the same age. Percentage of stunting is defined as suboptimal linear growth (below 2 SD of the WHO height-for age Standards) among children under five years of age. Stunting could be as a result of fetal and child malnutrition and frequent infections in early stage. Short stature or stunting is the main indicator for chronic undernutrition (Akseer et al, 2012).

Percentage of overweight is defined as weight-for-height above +2SD of the WHO Child Growth Standards median among children under five years of age.

Table 10: Classes of nutritional status in children		
Index	Cut-off value based on standard deviation (SD)/percentage	Indication
Weight-for-age	Less than -2 and more than -3	Moderate underweight
Weight-for-age	Less than -3	Severe underweight
Height-for-age	Less than -2 and more than -3 (i.e. 70–79.99% of the norm)	Moderate acute malnutrition
Height-for-age	Less than -3 (i.e. less than 70% of the norm) and/or bilateral pitting oedema	Severe acute malnutrition
Source: The Open University, 2020		

3.2.4 Use of Growth Curve

A child’s growth is assessed by measuring the child’s weight and height regularly and repeatedly at few months intervals. The increase in weight and height of the child is an indication that the child is growing. The greater the increase, the faster

the child is growing. If there is no increase, the child is not growing. Calculating the child's nutritional status will indicate if the child is normal, stunted, wasted or underweight. It is therefore very important to monitor a child's nutritional status during immunization visits in hospitals and Public Health Centres and plot the measurements on a growth chart. The chart is [plotted to get a growth Curve indicating a child's growth over the years.

A growth chart is a chart used for deciding whether the size of a child falls within the normal range or whether the child is larger or smaller than normal. The size of a healthy child will increase normally with age. This can on be known if the given age of the child is correct and accurate. So the accurate age of children are very important when plotting a growth chart.

The WHO child growth standards

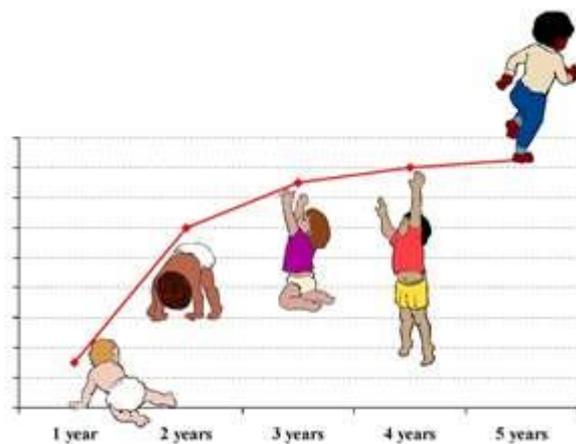


Figure 2: The WHO child growth standards
Source: WHO, 2018

3.3 NUTRITIONAL REQUIREMENTS OF CHILDREN FROM 1-5 YEARS

Children from 1-3 years pol are called toddlers. This age is the age of dietary transition from infant to adult dietary pattern. It is a period of rapid cognitive, social, emotional, and physical development. The nutrient needs of any child must be adequate for growth, body maintenance and repair, energy for daily physical activities and body nutrient

storage. The rate of growth for toddlers is lower than that of infants but their nutrient requirement is higher.

A toddler has a small stomach capacity but often variable capacities (Thompson and Howard, 1998). Consequently, they require a nutrient-dense diet to be able to meet their daily energy and nutrients requirements. Preschool age period (1-5 years) is very important for brain and functional development. Therefore a poor diet will have adverse effect on brain development. Pre-school aged children are one of the at-risk groups for micronutrient deficiencies such as vitamin A deficiency (VAD), Iron deficiency Anemia (IDA), Zinc deficiency and foliate deficiency. Vitamin A deficiency results in night blindness in children. A child is said to have night blindness if that child cannot see very well between 6-7 pm in the evening when other children of his age in that community see during evening period. Micronutrient deficiencies affect childhood growth and education and these effects include stunting, wasting, underweight, anaemia, low intelligent quotient (I.Q), poor academic performance and high school dropout (Uchendu, 2011).

Some authors describe 3-5 years as pre-school. The pre-school stage is characterised by a slowed rate of growth, relative body leanness and increasing developmental skills and independence. These factors affect both nutrient needs and food intake.

It has been reported that from 3-5 years, a child's food preferences and eating habits are also influenced by factors outside the home. These factors include peer group preference, nursery school, television advertisement and eating outside the home experiences. The pre-school diet apart from providing the required nutrients for growth, must also try to resolve these factors thereby inculcating good eating habits.

Pre-school children like sweet things so their food composition is largely made of sugars derived from sugary biscuits, ice-cream, cakes, sweets etc. Too much sugar in the teeth results to tooth decay called dental caries and pre-school children are prone to dental caries due to their dietary lifestyle. Care should therefore be taken in their choice of food.

3.4 NUTRITION IN THE 1ST 1000 MONTHS: WHY IS IT IMPORTANT?

The 1st 1000 days is from the period of conception to two years of life. It is between a woman's pregnancy and her child's 2nd birthday. It is a period of tremendous growth and development. All the organs and tissues are being formed and educated at this time. A child's brain begins to grow and develop in the 1st 1000 days and this is the period the foundation for lifelong health is laid. Maternal pre-natal nutrition and the child's nutrition in the first 2 years of life (1000 days) have been reported as very important factors in a child's neurodevelopment and lifelong mental health (Schwarzenberg et al. 2018). Poor nutrition in the 1st 1000 days of life can irreversible damage to a child's growing brain which might affect the intelligent quotient (I.Q) via the ability to learn, read and write.

Child and adult health chronic diseases like non-communicable diseases such as obesity, hypertension, and diabetes, might be programmed by nutritional status during this period. Carbohydrates provide calories which supply energy necessary for the development of fetus and child but this is not adequate for normal brain development (Schwarzenberg et al. 2018). Even though all nutrients are necessary for brain growth, key nutrients that support neurodevelopment include protein; zinc; iron; choline; folate; iodine; vitamins A, D, B6, and B12; and long-chain polyunsaturated fatty acids (Schwarzenberg et al. 2018).

Failure to provide key nutrients during this critical period of brain development may result in lifelong deficits in brain function despite subsequent nutrient repletion (Schwarzenberg et al. 2018). Almost all stunting takes place within the 1st 1000 days and this accumulated from conception up to 24 months of age (Black et al. 2012). It therefore becomes very important that caregivers have the right nutritional knowledge in order to be able to give adequate diet to mothers, infants and pre-school aged children in the 1st 1000 days.

Table 10 shows the nutrients that affect early brain development and demonstrate a critical or sensitive period.

Table 10. Nutrients that particularly affect early brain development and demonstrate a critical or sensitive period

S/N	Macronutrients	Micronutrients
1	Protein ^a	Zinc ^a
2	Specific fats (eg, LC-PUFAs) ^a	Copper ^a
3	Glucose	Iodine ^a
4		Iron ^a
5		Selenium
6		Vitamins and cofactors
7		B vitamins (B6, B12)
8		Vitamin A
9		Vitamin K
10		Folate ^a
11		Choline ^a

Source: Schwarzenberg et al. (2018).

LC-PUFA, long-chain polyunsaturated fatty acid. Reprinted with permission from Georgieff MK, Brunette KE, Tran PV. Early life nutrition and neural plasticity. *Dev. Psychopathol.* 2015; 27(2):415.

^aNutrients that meet the principles for demonstrating a critical or sensitive period during development.

4.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

1. Describe the uses of a growth curve.
2. Discuss the important of the 1st 1000 days in the life of a child.

5.0 CONCLUSION

In this Module 2 Unit 2, we have been able to discuss in details preschool children and their nutritional requirements.

6.0 SUMMARY

Pre-school children are young children from 0 – 5 years. They are as called the Under-5 (U5). But in this Unit 2, we discussed 1-5 years. We looked at their nutritional requirements and why their 1st 1000 days is very important.

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**MODULE 2 INTRODUCTION TO PUBLIC HEALTH NUTRITION:
NUTRITION THROUGH THE LIFE CYCLE**

UNIT 3 NUTRITIONAL REQUIREMENTS OF ADOLESCENTS

TABLE OF CONTENTS

1.0	Introduction
2.0	Objectives
3.0	Main content
	3.1 Definition of Adolescents
	3.2 Nutritional Requirements of Adolescents
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5.0	Conclusion
6.0	Summary
7.0	References/Further Readings

1.0 INTRODUCTION

I welcome you to Module 2 Unit 3. In this Unit, we will be discussing the nutritional requirements of adolescents. But before we do this, we will try to understand which groups of people are called adolescents. Adolescents are one of the age groups usually neglected.

2.0 OBJECTIVES

At the end of this Module 2 Unit 3, you will be able to:

- i. Define who an adolescent is.
- ii. Discuss the nutritional requirements of adolescents.

3.0 MAIN CONTENT

3.1 DEFINITION OF ADOLESCENTS

Adolescents are young people within the age of 10-24 years old. Young people between the ages of 10 and 24 years make up about two billion of the world's current population (Akseer et al. 2012). Adolescence is the period of development which begins from puberty to early adulthood. It is marked with with physical and sexual maturation, social and economic independence, development of identity, acquisition of skills needed to carry out adult relationships and roles, and the capacity for abstract reasoning (Das et al. 2012). According to the World Health Organization, the period of adolescence is defined as from 10 to 19 years of age; the period defined as "youth" overlaps adolescence and extends to 24 years of age (15-24 years of age); "young people" are defined as all individuals between the ages of 10 and 24 (PAHO, 2011).

Adolescents are divided into three developmental groups:

- i. 10-14 years called young or early adolescents.
- ii. 15-19 years referred to as late or mid- adolescents.
- iii. 20-24 known as older adolescents, emerging adults or young adulthood.

Adolescent period has been characterised by rapid physical growth and development. These characteristics are influenced by several factors such as economic, social and cultural environments. Adolescents is the second fastest growth period following infancy and is accompanied by high energy and nutrient requirements. Again, adolescence is a period of dynamic molecular, cellular, somatic and organizational changes, which are greatly influenced by genetics, nutrition, hormones, and physical factors (Akseer et al. 2012).

3.2 NUTRITIONAL REQUIREMENTS OF ADOLESCENTS

Recent studies have reported that adolescence is a period of potential interest for correcting nutritional inadequacies and in sufficient growth from childhood (Black et al. 2013; PAHO, 2011). Many children in low-income countries enter adolescence underweight, stunted or malnourished (Black et al. 2013). Various cardiometabolic risk factors in adolescents, including obesity, increased body mass index, and high glucose levels, have been related to early onset of chronic conditions in adult hood including premature deaths. Adequate nutrition in adolescence is crucial for both current and future health, as this period is the only window of opportunity for the catch-up nutrition needed to prevent a vicious intergenerational effect of malnourishment (Black et al. Dan et al. 2012, 2013; PAHO, 2011).

Adolescent stage is a critical period for the development of lifestyle and eating behaviours which makes them vulnerable to either underweight, obese or overweight depending on the environment and location where they live. A study associated poor diet diversity and lack of nutrient-dense food, high risk metabolic syndrome, and sedentary lifestyles with adolescent stage (Akseer, 2012). Adolescents have been found to consume a lot of added sugar. The eating pattern of adolescents is influenced peer influences, parental modeling, food availability, food preferences, cost, convenience, personal and cultural beliefs, mass media and body image.

Adolescence age is associated with the burden of iron deficiency and anaemia and iodine deficiency. The former is more prevalent among female adolescents than the males. However, VAD is less of a burden to adolescents compared to iron deficiency and anaemia and iodine deficiency. They also have low physical activities. Adolescents require zinc, calcium and vitamin D to develop. Globally, adolescents were reported to consume less low amounts of fruits and vegetables and very high levels of sodium, sugar and solid fat and added sugar (SoFAS).

The period of adolescence is crucial to the prevention, early detection, and management of metabolic syndrome (MetS) and subsequent adverse conditions, including diabetes

(Akseer, 2012). Adolescents need to eat a lot of fruits and vegetables. They need to eat adequate diet and be physical active. Children and adolescents are required to do at least 60 minutes of moderate to vigorous intensity activity daily (WHO, 2015). Figure 3 shows the nutrition stages through life cycle.

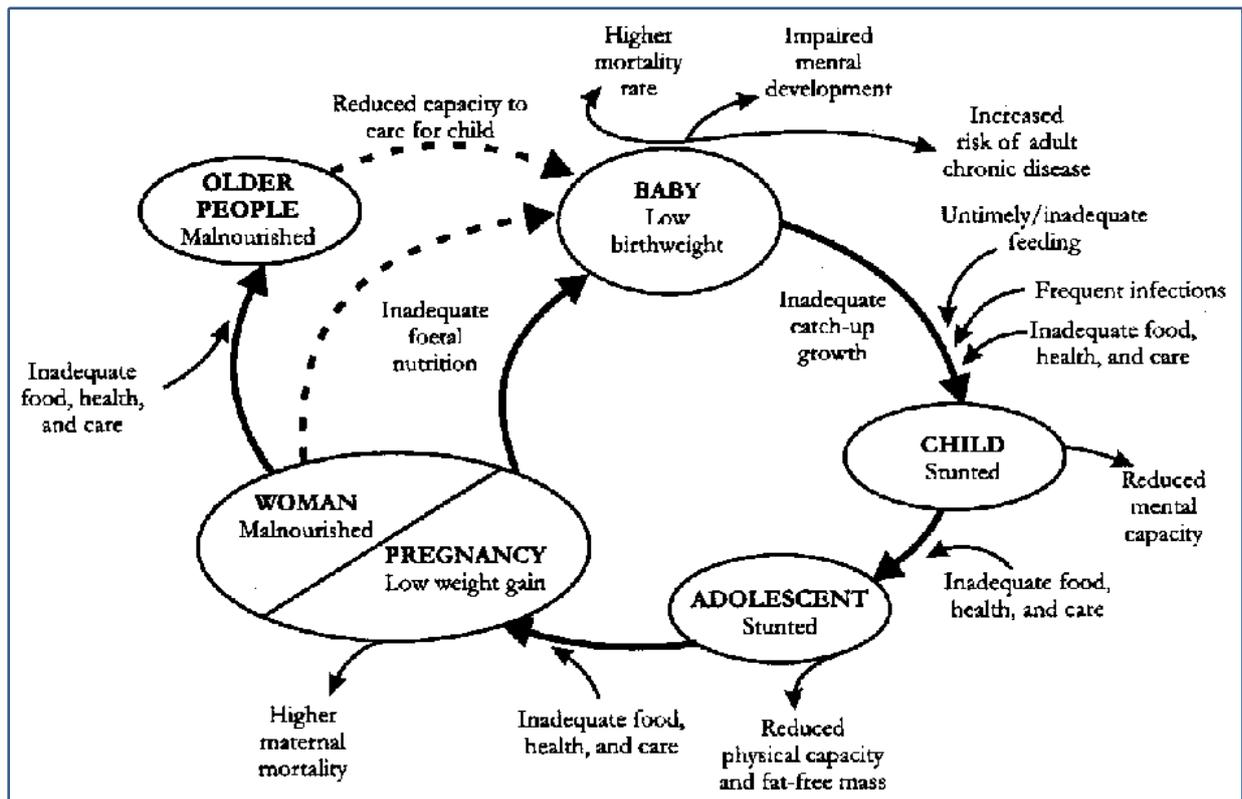


Figure 3: Nutrition throughout the life cycle

Source: Tesfaye, (2002)

4.0 CONCLUSION

Adolescents access to adequate nutrition is very crucial to their development, maturity and future roles as mothers. Adequate diet will reduce chronic diseases in future and pregnancy complications.

5.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

1. Discuss the nutritional challenges of adolescents.
2. Explain with relevant examples the implication of solid fat and added sugar (SoFAS) in adolescent diet.
3. Discuss the nutrition throughout the life cycle.

6.0 SUMMARY

We have successfully looked at adolescents and their nutritional requirements. I am quite sure that you can answer any question on adolescents now. Well done!

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MODULE 3 COMMUNITY-BASED NUTRITION PROGRAMMES

Unit 1 The National Food and Nutrition Policy of Nigeria

Unit 2 Food Safety, Security and Global issues in Nutrition

**Unit 3 Nutrition during Special circumstances (disaster, wars,
terrorism)**

UNIT 1 THE NATIONAL FOOD AND NUTRITION POLICY OF NIGERIA

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main content
 - 3.1 The goals of the national plan of action on food and nutrition in Nigeria (NPAN)
 - 3.2 The objectives of National Food and Nutrition Policy of Nigeria
 - 3.3 Major areas covered by the policy.
- 4.0 Tutor-Marked Assignments (TMAs)
- 5.0 Conclusion
- 6.0 Summary
- 7.0 References/Further Readings

1.0 INTRODUCTION

The National Food and Nutrition Policy is a document that provides the framework for addressing the problems of food and nutrition insecurity in Nigeria, from the individual, household, community and up to the national level (IFPRI, 2020). The National Food and Nutrition Policy of Nigeria (NFNPN) was launched in 2002 and published by National Planning Commission in 2004. This document was adopted same year, 2004 by the National Commission on Food and Nutrition. The type of policy is Comprehensive national nutrition policy, strategy or plan. The overall goal of Nigeria's Food and Nutrition Policy is to improve the nutritional status of all Nigerians, with particular emphasis on the most vulnerable groups such as children, women, and the elderly. The policy is believed to be one of the efforts of the stakeholders that will help to reduce the scourge of malnutrition in Nigeria.

2.0 OBJECTIVES

At the end of this Module 3 Unit 1, you will be able to:

- i. Describe the National Food and Nutrition Policy of Nigeria.
- ii. Discuss the overall and specific objectives.

3.0 MAIN CONTENT

3.1 THE GOALS AND OBJECTIVES OF NATIONAL FOOD AND NUTRITION POLICY OF NIGERIA (NPAN)

3.1 THE GOALS OF THE NPAN

3.1.1 Overall Goal

The overall goal of Nigeria's Food and Nutrition Policy is to improve the nutritional status of all Nigerians, with particular emphasis on the most vulnerable groups such as children, women, and the elderly.

3.1.2 Specific Goals

The Food and Nutrition Policy aims at promoting the following specific goals:

- i. establishing of a viable system for guiding and coordinating food and nutrition activities undertaken in the various sectors and at various levels of the society, from the community to the national level;
- ii. incorporating of food and nutrition considerations into development plans and allocation of adequate resources towards solving the problems pertaining to food and nutrition at all levels.
- iii. promoting habits and activities that will reduce the level of malnutrition and improve the nutritional status of the population.
- iv. identifying of sectoral roles and assignment of responsibilities for the alleviation of malnutrition.
- v. ensuring that nutrition is recognised and used as an important indicator to monitor and evaluate development policies and programmes; and
- vi. promoting good, indigenous food cultures and dietary habits among Nigerian people for healthy living and development.

3.2 SPECIFIC OBJECTIVES OF NPAN

The specific objectives of NPAN are to:

- i. improve food security at the household and aggregate levels to guarantee that families have access to safe food that is adequate (both in quantity and quality) to meet the nutritional requirements for a healthy and active life.
- ii. enhance care-giving capacity within households with respect to child feeding and child care practices, as well as addressing the care and well-being of mothers.
- iii. improve the provision of human services, such as health care, environmental sanitation, education, and community development.
- iv. improve the capacity within the country to address food and nutrition problems; and
- v. raise understanding of the problems of malnutrition in Nigeria at all levels of society, especially with respect to its causes and possible solutions.

3.2 GOALS OF THE NATIONAL PLAN OF ACTION ON FOOD AND NUTRITION IN NIGERIA (NPAN)

The goals of the National Plan of Action on Food and Nutrition in Nigeria is to initiate new programme focus, integrate and coordinate effectively all food and nutrition programmes of all sectors. Furthermore, it is to advance vigorously a national nutrition agenda that will recognise and respond effectively to regional, zonal, and specific needs in accordance with the National Policy on Food and Nutrition in Nigeria. A detailed individual work plan of each project is expected to be developed based on more detailed time frame and budget.

Subsequently, the following goals will be pursued in the overall national programme:

- i. Improve the economic situation of Nigeria, with particular emphasis on protecting the welfare of the most vulnerable groups in society.
- ii. Increase investment in the social sector, thereby raising the status of women in our society by increasing their access to and control over productive resources.

3.3 MAJOR AREAS COVERED BY THE POLICY

NPAN covers policy topics such as goals and indicators, action areas, nutrition in schools, promotion of healthy diet and prevention of obesity and diet-related non-communicable diseases (NCDs), vitamin and mineral nutrition, acute malnutrition, nutrition and infectious disease, nutrition sensitive actions, Legislation (Policy) and regulations. The composition of these policy areas are as listed below:

1. Goals and indicators

- **Undernutrition:**

- Low birth weight

- Stunting in children 0-5 yrs

- Wasting in children 0-5 years

- Underweight in children 0-5 years

- Underweight in women

- Anaemia

- Iodine deficiency disorders

- Vitamin A deficiency

2. Action areas

- **Maternal, infant and young child nutrition**

- Growth monitoring and promotion

- Breastfeeding promotion/counselling

- Promotion of exclusive breastfeeding for 6 months

- Maternity protection

- Complementary feeding promotion/counselling

- Complementary food provision

3. Nutrition in schools

- School-based health and nutrition programmes

- Nutrition in the school curriculum

- Provision of school meals / School feeding programme

4. Promotion of healthy diet and prevention of obesity and diet-related Non-communicable diseases (NCDs)

Food labelling

Media campaigns on healthy diets and nutrition

Nutrition counselling on healthy diets

Physical activity and healthy lifestyle

5. Vitamin and mineral nutrition

- **Micronutrients**

- Vitamin A

- Micronutrient supplementation

- Food vehicles (i.e. types of fortified foods)

- Wheat flours

- Maize flours

- Refined sugar

- Vegetable oil/Butter/Margarine

6. Acute malnutrition

Food distribution/supplementation for prevention of acute malnutrition

7. Nutrition and infectious disease

HIV/AIDS and nutrition

8. Nutrition sensitive actions

- i. Food related**

- Food safety

- Food security and agriculture

- Household food security

- Home, school or community gardens

- ii. Social protection related**

- Conditional cash transfer programmes

- Vulnerable groups

iii. Legislation (Policy) and regulations

Food fortification regulations

The stakeholders who came together to write NPAN include the representatives of the following Federal Ministries: Health; (Food and Drug Services department and Nutrition division); Women Affairs & Youth Development; Industry; Finance; Education; Information & National Orientation; Science & Technology; Agriculture & Rural Development. Others are Federal agencies such as National Agency for Food and Drug Administration & Control (NAFDAC); and National Primary Health Care Development Agency (NPHCDA); University of Agriculture, Abeokuta; University of Ibadan and professional body of Nutritionist (Nutrition Society of Nigeria).

The United Nations Children's Fund (UNICEF), United States Agency for International Development (USAID), POLICY Project, Basic Support for Institutionalising Child Survival (BASICS II), Helen Keller International (HKI), Johns Hopkins University/Health Communication Project (JHU/HCP), International Institute of Tropical Agriculture (IITA), Food and Agriculture Organization and Dr Rae Galloway of the Human Development Network of World Bank, Washington provided their support.

The staff of Food and Nutrition Unit, Department of Agriculture and Industry, National Planning Commission also provided the administrative and technical support.

4.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

1. List the specific objectives of NPANs.
2. Download and study this policy from the website below:

<https://extranet.who.int/nutrition/gina/en/node/7943>

5.0 CONCLUSION

We have been able to discuss the goals and specific objectives of the national plan of action on food and nutrition in Nigeria (NPAN).

6.0 SUMMARY

The provision and availability of NPAN has given legal backing to issues around the nutrition of the vulnerable groups. Nutrition support can now be obtained from Federal and State Governments as a result of the presence of this policy.

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MODULE 3 COMMUNITY-BASED NUTRITION PROGRAMMES

UNIT 2 FOOD SAFETY, SECURITY AND GLOBAL ISSUES IN NUTRITION

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main content
 - 3.1 Food Safety, from farm to plate, making food safe
 - 3.2 The role of stakeholders in ensuring food safety from farm to plate
 - 3.3 Definitions of food security
 - 3.4 Definition of food insecurity
 - 3.5 Classifications of food security
 - 3.6 Components of food security
 - 3.7 Methods of measuring food security
 - 3.8 Factors that influence food security
 - 3.9 Consequences of food insecurity
- 4.0 Conclusion
- 5.0 Tutor-Marked Assignments (TMAs)
- 6.0 Summary
- 7.0 References/Further Readings

1.0 INTRODUCTION

Food safety is the process of making food safe from the farm to cooked food until it is consumed. This will be done through proper handling, processing and storage to prevent malnutrition and food borne diseases. Food can transmit diseases from one person to the other and also serve as growth medium for bacteria thereby causing food poisoning

(Owusu, 2013). Food nutrients are lost during food processing and storage thereby making the food unsafe and unhealthy for human consumption. Sub-Saharan Africa experienced the highest disease burden for enteric foodborne disease followed by South-East Asia. More than 40% people suffering from enteric diseases caused by contaminated food were pre-school children (0-5 years) (EIN, 2015a). The role of each food safety agent will be discussed in ensuring the safety of food until it reaches the dining table in the homes.

According to the United Nations' Committee on World Food Security, food security means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life (IFPRI, 2020). Globally, many countries are experiencing food insecurity especially in Sub-Sahara African (SSA) and Asian countries. Food insecurity translates to hunger and famine.

2.0 OBJECTIVES

At the end of this Module 3 Unit 2, you will be able to:

- i. define food safety
- ii. define food security.
- iii. explain the roles of food safety agents.
- iv. discuss the components of food security.
- iii. explain factors that can influence food security.

3.0 MAIN CONTENT

3.1 FOOD SAFETY, FROM FARM TO PLATE, MAKING FOOD SAFE

The theme “Food safety: making food safe from farm to plate” makes everyone an agent of food safety. It involves all persons in the chain: the farmer, food transporter who transports food produce from farm to market locations, the government, the market food-stuff seller, the food vendor who sells cooked food on the streets, buckers, hoteliers, restaurants and fast food outlets, airplane caterers, the cook in kitchen who is

either a mother, full housewife or a professional cook, the buyer/final consumer, caregivers and the household (Uchendu, 2015).

There are two major reasons why food should be made safe for consumption. The aim of producing and eating food is for the food to supply nutrients to the body which will nourish the body and make the consumer healthy. Appropriate food safety standards will ensure that food retains and protects the nutrients from destruction or degradation so that they can serve the purpose of nourishing the body. These nutrients include carbohydrate, protein, fats and oils, vitamins and minerals including water. Destruction of the nutrients in the process of food handling, processing and storage before it gets to the spoon or dining table, will result in providing foods with low or zero nutrients especially the vitamins and minerals (Uchendu, 2015).

Prolonged consumption of foods with low nutrients will make the consumer malnourished. Malnutrition is a global public health problem especially in Sub-Saharan Africa and in Asian countries. Two major examples of malnutrition are protein energy malnutrition (PEM) and vitamin and mineral deficiencies also called micronutrient deficiencies or hidden hunger. Micronutrient deficiencies or hidden hunger include vitamin A deficiency (VAD), iron deficiency (IDA), iodine deficiency disorder (IDD), zinc deficiency, and folate deficiency. Hidden hunger is more prevalent in pre-school children, pregnant and lactating mothers. Nigeria is one of the Sub-Saharan African countries experiencing high levels of malnutrition in children, pregnant and lactating mothers (Uchendu and Atinmo, 2011). Causes include consumption of unsafe foods with low vitamins and minerals. Good sources of vitamins and minerals include green and yellow leafy vegetables and fruits. Foods should be handled safely to retain their nutrients until they are consumed to eradicate malnutrition.

Making food safe also protects the food from microbial infestation. Flies, cockroaches, lizards, ants, wall geckos and rats are transporters of harmful microorganisms. Exposing food to dust, selling or cooking food in dirty environments, drinking or cooking food with dirty water makes the food unsafe or unhygienic. Poorly handled foods are usually contaminated with harmful microorganisms which results in food poisoning or food borne diseases. Examples of unsafe food include uncooked foods of animal origin

(such as meat, chicken, fish), fruits and vegetables contaminated with faeces, and raw shellfish containing marine biotoxins. Food borne diseases are caused by bacteria, viruses, parasites or chemical substances. More than 200 diseases ranging from diarrhoea to cancers are consequences of poor food safety. Foodborne and waterborne diarrhoeal diseases kill an estimated 2 million people annually, including many children (WHO, 2015). The Centers for Disease Control and Prevention (CDC) estimates that each year in the United States, one in six Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases (NIH, 2014).

Bacterial food-borne diseases caused by species of Salmonella, Clostridium, Campylobacter and Escherichia contribute to the morbidity and mortality rates in Nigeria and are of major health concerns (Omojokun, 2013). Recently there was an incidence of lead poisoning in Zamfara state of Nigeria which killed many children due to toxic metals in food consumed. Texas grocery chain pulled all their cream from store shelves as a precautionary measure after a recall of some of the ice cream maker's products that were connected to three deaths in Kansas (EIN, 2015c). Another flour Miller made a voluntary recall for its bleached, all-purpose flour because of possible Salmonella contamination in Arizona, New Mexico, Texas and Utah (EIN, 2015d). All packages of soybean sprouts distributed to retail stores in Virginia and Maryland have been recalled after government agencies analysis revealed the presence of Listeria monocytogenes in the products (EIN, 2015e).

Around 300 people sought treatment for food poisoning after complaining of vomiting, diarrhoea, and body pain at hospitals mostly women, after eating free meals served during a temple festival in a temple near Nedumangad in India (EIN, 2015f). There have been 142 confirmed cases of salmonella in the Townsville and a growing number of campylobacter (gastroenteritis) food poisonings which have killed 146 people (Riley, 2015).

Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, pre-school children, the elderly and the sick. Foodborne diseases impede

socioeconomic development by straining health care systems, and harming national borders from where it is produced to where it is consumed (WHO, 2015). Unsafe food also poses major economic risks, especially in a globalized world. In 2011, Germany experienced E. coli outbreak which caused \$1.3 billion losses for farmers and industries and \$236 million in emergency aid payments to 22 European Union Member States (EIN, 2015a).

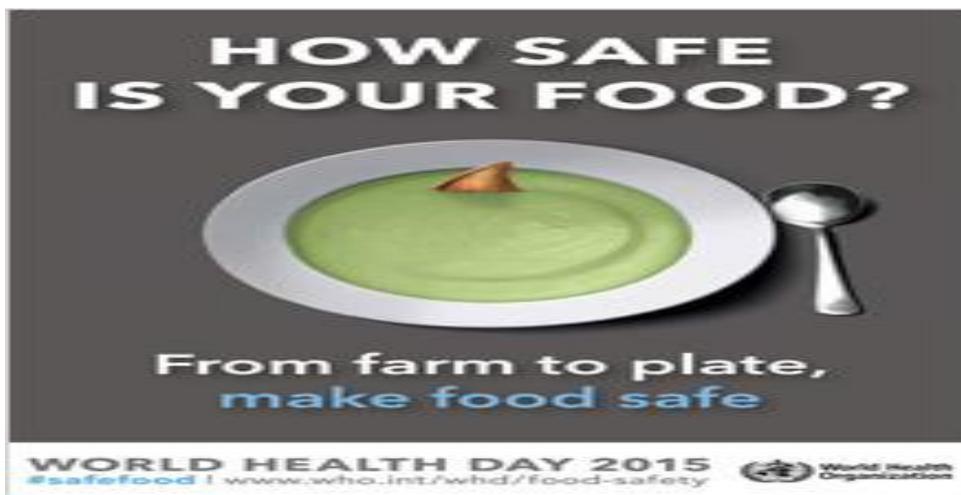


Figure 4: How safe is your food?
Source: WHO, 2015

3.2 THE ROLE OF STAKEHOLDERS IN ENSURING FOOD SAFETY FROM FARM TO PLATE

Good collaboration between governments, food producers and consumers will help to ensure food safety to prevent any contaminated food products entering the food chain. Food chain is the series of processes by which food is grown, produced, transported, stored, sold, cooked and eventually consumed. Stakeholders in the food chain are to make conscientious efforts to make food safe until it is consumed. Their roles are discussed as follows:

i. The farmer

Farmers should harvest ripe and mature food produces with minimal bruises and dents. Bruises and dents on farm produces hasten their decay by microorganisms. Farm

produce, such as vegetables, are often supplied to retailers full of sand and dust, especially during rainy season because they are allowed to creep on the ground in the farm. Creeping farm produces should be lifted off the ground in the farm by supporting the weak steps with sticks and woods. Consumers should be conscious of these sand laden vegetables and wash them well before use. Other unsafe common practices by farmers include the use of pesticides for fishing, inappropriate application of pesticides to stored products such as beans and grains to prevent insect infestation, inappropriate application of chemicals to fruits such as bananas to ripen them or to vegetables such as carrots and cabbages to control insect infestation (Omojokun, 2013).

Persistent residues of the chemicals from pesticides and fertilizers contaminate foods and disperse in the environment and find their way into the food chain. High use of artificial fertilizers and pesticides while growing food grains results in food-borne diseases (EIN, 2015). Animal farmers should be wary of treating animals for human consumption with drugs. A consent decree of permanent injunction was sued against Michael P. Ferry Inc., a dairy operation located in Westport, Massachusetts, U.S, for violating numerous federal food laws including the discovery of “illegal levels of drug residues in animals he sold for slaughter (Duel, 2015).

ii. Food transporters

Food transporters convey farm produces from the farm to market locations. They should be taught how to handle and pack the food properly to avoid bruises, dents and spoilage. Overloading the truck or vehicle encourages food damage and microbial growth.

iii. The government

Government should provide good roads and preservation facilities to transport farm produces from rural to urban areas. Adulterated, contaminated, spoilt, expired, sub-standard/fake and improperly labeled food products should not be found on shelves or markets for consumers to buy. Government food agencies should encourage food producers and vendors to adhere to Hazard Analysis Critical Control Point (HACCP)

and Codex Alimentarius guidelines that ensure food quality and safety. Farmers should be educated on how to apply good agricultural practices (GAP).

Even if the food is free of bacteria, viruses, parasites and chemicals, other contaminants, additives and adulterants make food unsafe. The lack of surveillance by the government on food adulteration is contributing to the food poisoning among people. Common food products adulterated included milk. Some milk suppliers add salt to slow down the decomposition process of milk. Similarly cane sugar is often added to milk. Consumption of such milk leads to multiple health hazards especially in diabetic and blood pressure patients. Kidney patients and blood pressure patients suffer serious consequences due to the salt content of such adulterated milk (EIN, 2015b). Foods which contain high levels of unhealthy fats and chemical substances found in artificial colors or food additives are also not healthy for the heart.

Government should guide against improper use of food additives such as artificial sweeteners, preservatives and food colours which are causative agents for gastrointestinal disorders, carcinogenesis and death. Use of packaging materials with toxic degradable components should be discouraged. Government will address the issue of food safety through public enlightenment campaigns, nutrition education on proper handling of food, provision of improved food infrastructure, and training of food safety stakeholders along the food chain.

iv. The market food-stuff seller

Fresh food stuffs should be sold to consumers. Food quantities that can easily be sold within few days depending on the perishability of the food item should be purchased because of lack of storage system. No spoiled food should be sold to consumers in any form. Adulterating food ingredients using fillers to increase volume and make more gain pre-disposes consumers to food poisoning. In Nigeria, food stuffs such as, meat, fish, fruits and vegetables, beans, rice, melon seeds (*egusi*), *garri* (processed cassava) are displayed and sold uncovered (Fig. 5) thereby exposing them to dust, sand, flies and splashes of dirty water. These food ingredients are likely to be contaminated with microorganisms and if not destroyed by the length and temperature of cooking, could

lead to food borne diseases. Some of the symptoms of food borne diseases include diarrhoea, dysentery, vomiting, abdominal pain and debilitating infections such as meningitis. Food poisoning could be life threatening. Similar unhygienic food handling practices have been reported in Ghana (Frempong, 2015). Food ingredients should be hygienically packaged in transparent cellophane nylons. Government agencies responsible for food safety should implement and monitor compliance.



Figure 5. Food ingredients sold in the market.

v. **Food vendors**

Food vendors include those who sell cooked food on the streets, *buckers*, restaurants and fast food outlets. They should do their businesses in a very clean environment by maintaining good personal hygiene, food hygiene, carrying out sanitation through proper and regular disposal of waste, no foul odour, keeping utensils clean to discourage flies, cockroaches, birds and rodent infestation. Flies, rodents and birds contaminate

food by depositing their excreta on the food. Quality food stuffs (not spoilt meat, pepper, tomatoes etc.) and clean water should be used to cook food. Food should not be served with improperly washed plates and cutleries. Washed plates should not be wiped with towels after washing before dishing out food. Water used in washing and rinsing plates, cutleries and utensils should be changed regularly. Nothing cleans better than water. Food vendors should de-worm themselves regularly at least every three months. Food seasoning, bouillon cubes, and sweeteners that contain mono-sodium glutamate should not be used in cooking food. These seasonings make food very tasty even when enough ingredients were not used but they pre-dispose consumers to food poisoning and long exposure can result to cancer. Some of the symptoms of food poisoning are abdominal pain, diarrhoea, vomiting, mild fever, weakness, nausea, and headache.

Grains and cereal foods should be sorted very well before cooking to remove stones, broken bottles, sticks, insect fras and other extraneous materials which could be swallowed along with the cooked food. Some food canteens soak boiled eggs in bucket of water for easy peeling of the shells and sold to customers from there. These eggs are at risk of contamination from 'germs' in the water and could result in outbreak of salmonellosis. Cooked eggs should not be soaked in water before eating.

Food vendors also leave soups, stews, sauces and other cooked foods open as they sell them. In some food canteens, vegetables are cut, soaked in water with salt and hot water for a long time, drained and used to make vegetable soup. This practice destroys the nutrients such as vitamins and minerals in the vegetables. Also, addition of potash to *ewedu* soup to make it draw and improve its green colour destroys the vitamins and minerals in the *ewedu* leaves. Salad ingredients should be washed very well before slicing. Most food vendors are guilty of these poor food hygiene practices. Using salt to wash meat and vegetables denatures the protein and degrades the vitamins and minerals. Raw meat should be cooked very well to make it edible and digestible. Some fast food outlets do not cook their chicken very well.

Other poor food hygiene practices which make food unsafe include: selling food such as bread and spaghetti with bare hands to consumers and sneezing or coughing without covering the mouth with hand or clean handkerchief while cooking. Hands should be

washed thoroughly immediately after any of these acts to avoid food contamination. Hair should be covered while cooking to prevent hair falling inside the food. Finger nails should be cut short and clean. Wearing of long dangling earrings and rings should be avoided while cooking. Do not comb or brush hair while cooking.

vi. Meat butchers

Meat butchers should maintain clean abattoirs. Meat should not be exposed to flies and dust. Spoilt meat should not be sold to consumers. Abattoirs should be encouraged to slaughter the right quantity of meat they will sell off in a day.

vii. Bread bakers

Bread enhancers such as potassium bromate should not be used to bake bread because it is cancerous.

viii. Fruit vendors

Fruit vendors cut the fruits such as pineapple, water melon, paw-paw without washing them. Even the knives and trays are only wiped with foams or towels on a daily basis. This practice attracts flies all over the fruits thereby making them unwholesome. They could be sources of food borne diseases. Fruits, knives and trays should be washed before the business of the day. Sliced fruits should be put in transparent buckets with cover for customers to buy.

ix. Airplane Caterers

Some airplane operators serve foods with high sugar content on-board the aircraft. Foods served should be low in sugars and salt especially for long distance travels because they involve sedentary activities. Regular users of this mode of transport are at risk of diabetes, hypertension and other cardiovascular diseases.

x. The food buyer or 'customer'

The farm produce purchaser should endeavour to buy quality fresh farm produce. They should not pack cheap spoilt broken tomatoes, pepper, *tatasi*, *agbalumo* or *udala*, garden egg (*Aghara*) that the stalk has removed and the head is open. These are agents of microorganisms such as mould, yeast and bacteria. Your strength, vigour, health and

even the span of life depend on what you eat (Hamblin, 2014). According to Lindlahr in 1923, 90% of diseases known to man are at least influenced by cheap food stuff (Hamblin, 2014). No food ingredient should be cut in the market before washing. Many buyers cut food ingredients such as vegetables, okra, fish and meat in the market before washing. This is a common practice among food stuff buyers in Nigerian markets (Uchendu, 2018). Food ingredients should be taken home and washed thoroughly with enough water (at least three times) before cutting to remove *germs*, worms, insect larva and other microorganisms that cause food borne diseases. Improper washing of vegetables and fruits are easy sources of worm infestation especially tape worm which is stubborn to treat. Washing sliced vegetables quickly leaches away the nutrients, especially water soluble micronutrients in water thereby leading to nutrient insecurity via hidden hunger.

xi. The cook

The cook in the kitchen could be a mother, a full housewife or a professional cook. He/She should cook the food using appropriate methods that will not destroy the nutrients in the food. All food ingredients should be washed thoroughly before use. Vegetables should not be over cooked (at least 1-2 minutes) to retain the nutrients which are heat labile. Over cooking of vegetables destroys the nutrients and makes the food unsafe. Habitual consumption of over cooked vegetables results in malnutrition especially in pre-school children, pregnant and lactating mothers.

xii. Care-givers

Care-givers should give their dependants safe food appropriate for their age and health conditions. For the elderly, soft foods and liquid foods that requires less chewing are more appropriate. The food given to the sick should be tailored towards the type of ailment noting the do's and the don'ts. For new born babies, exclusive breast feeding from 0 - 6 months is the safest food for the child. Care-givers should teach children or their wards to wash their hands before eating food and wash their hands immediately after visiting the toilet. Food that has dropped on the ground or floor should not be

picked and eaten. Fruits should be washed very well before eating, paying attention to the cleavages.

xiii. Households

Households should endeavour to drink safe and portable water. Well water and bore-hole water can be boiled very well, left to cool and filtered to kill the microorganisms in the water. Unsafe water is the source of typhoid fever that is common in Nigeria. The typhoid fever bacteria are deposited in water or food by a human carrier and are then spread to other people in the area. Foods should not be stored more than one week in the freezer before use. Families should try to eat as much fresh food as possible. Foods when stored in freezers for a long time, deteriorates and loose tastes e.g. frozen foods.

3.3 DEFINITIONS OF FOOD SECURITY

Food security has been redefined in about 200 ways (Maxwell and Smith, 1992). So whenever the concept is introduced in the title of a study or its objectives, it is necessary to look closely to establish the explicit or implied definition (Maxwell, 1996). Food security as a concept originated only in the mid-1970s, in the discussions of international food problems at a time of global food crisis. Food security is broad and deals with the production, distribution and consumption of food. The initial focus of attention was primarily on food supply problems - of assuring the availability and to some degree the price stability of basic foodstuffs at the international and national level (FAO, 2020).

Let us look at some of these definitions of food security.

In 1974 World Food Summit, food security was defined to base on the global volume and stability of food supplies as follows:

“availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices” (United Nations, 1975).

In 1983, Food Agricultural Organisation (FAO) expanded the food security concept to include securing access by vulnerable people to available supplies, implying that attention should be balanced between the demand and supply side of the food security equation. So food security was defined as:

“ensuring that all people at all times have both physical and economic access to the basic food that they need” (FAO, 1983).

In 1986, the World Bank defined food security base on the temporal dynamics of food insecurity. This definition introduced the widely accepted distinction between chronic food insecurity, associated with problems of continuing or structural poverty and low incomes, and transitory food insecurity, which involved periods of intensified pressure arising from natural disasters, economic collapse or conflict. The definition of food security was further elaborated as:

“access of all people at all times to enough food for an active, healthy life”.

Progressively, by the mid-1990s food security was recognized as a significant concern, spanning a spectrum from the individual to the global level. However, access now involved sufficient food, indicating continuing concern with protein-energy malnutrition. But the definition was broadened to incorporate food safety and also nutritional balance, reflecting concerns about food composition and minor nutrient requirements for an active and healthy life. Food preferences, socially or culturally determined, now became a consideration (FAO, 2020).

The 1996 World Food Summit adopted a more complex definition:

Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The World Food Summit’s 1996 definition is the generally accepted definition of food security.

This definition was again refined in The State of Food Insecurity in 2001 as follows:

Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

A working definition of food security was given as follows:

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern (FAO, 2020).

This definition implies that food insecurity exists among people who do not have adequate physical, social or economic access to food. Please note that the food security, famine and hunger does not mean the same thing. Food security refers to the availability of food whereas famine and hunger are consequences of the non-availability of food which is food insecurity. The Life Sciences Research Office (LSRO) defined food security as access to enough food for an active, healthy life and this includes the availability of nutritionally adequate and safe foods and an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies) (National Research Council, 2006).

The evolution of food and nutrition security

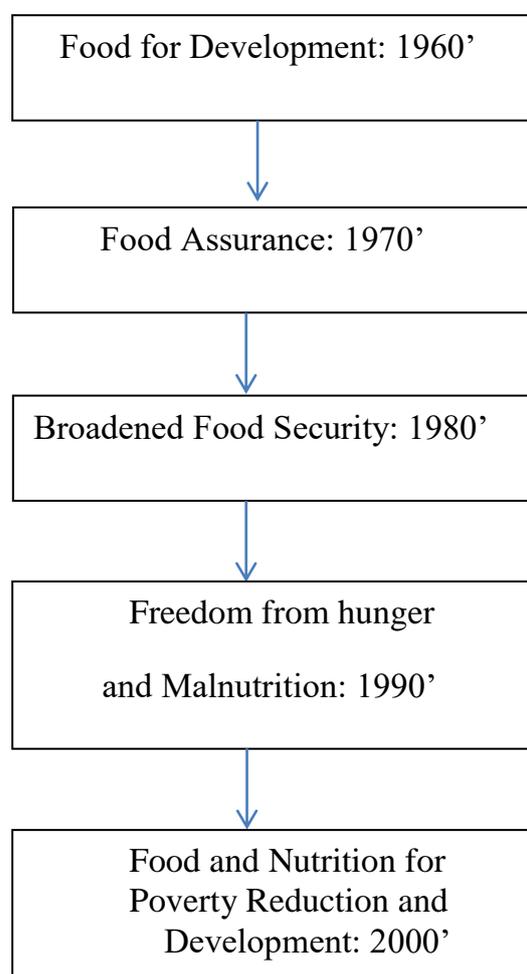


Figure 6: The Concept of Food and Nutrition Security
Source: Weingärtner, 2000.

3.4 DEFINITION OF FOOD INSECURITY

Food insecurity exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain (National Research Council, 2006). According to the Food Agricultural organization (FAO), food insecurity is defined as “A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life”

(Napoli et al. 2010/2011). One of the objectives of the 1996 World Food Summit was to fight against food insecurity and this is stated as follows: “This Plan of Action envisages an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015, and a mid-term review to ascertain whether it is possible to achieve this target by 2010”. This objective was tackled using the Millennium Development Goals (MDGs) which aimed at halving the number of the hungry and undernourished persons in the world by 2015. Whether this goal was achieved is left to be researched.

Consequences of food insecurity leads to a chain reaction: from food insecurity to poor dietary intake to malnutrition via chronic diseases (Fig.7).

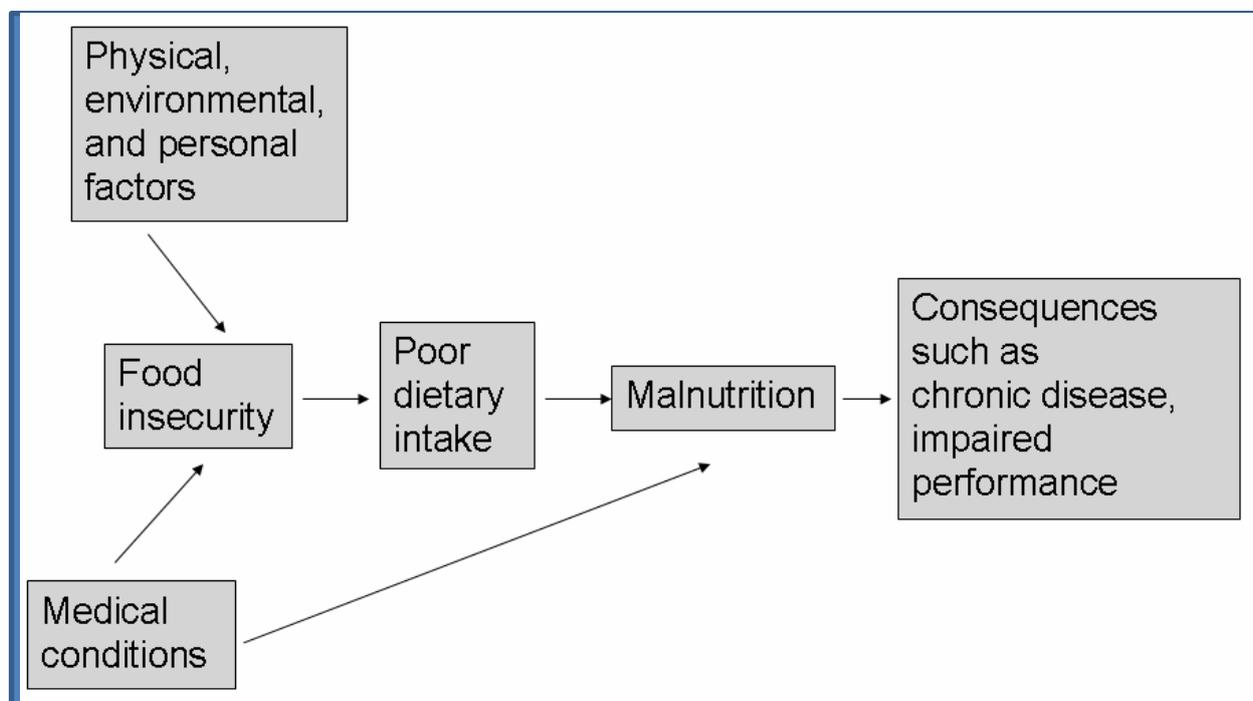


Figure 7: Food Insecurity Core concepts related to nutritional state

Source: National Research Council, (2006)

3.5 CLASSIFICATIONS OF FOOD SECURITY

Food security has been classified into three levels as follows:

- i. Food security at individual level
- ii. Food security at household level
- iii. Food security at national and global level

Food security at individual level, implies that the individual has nutritionally adequate quality and quantity of food to eat. Food security at household level means that all the members of the household have enough food to eat in adequate quantity and quality. Food security at national and global level looks at the number of the population in a country, region or the entire world that have adequate quantity and quality of food to eat.

3.6 COMPONENTS OF FOOD SECURITY

The four pillars or components of food security are:

- i. availability
- ii. accessibility
- iii. utilization and
- iv. stability

These four pillars were derived from the 1996 World Food Summit's definition of food security. According to The World Food Programme availability is "the amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid" (WFP, 2009). However, the term is used for food available at a regional or national level and not at the household level

3.7 METHODS OF MEASURING FOOD SECURITY

Food security can be measured using five (5) methods:

- i. House hold income and expenditure surveys
- ii. The food and Agricultural Organisation (FAO) method of estimating calories available per capita at the national level.
- iii. Individual's dietary intake
- iv. Experience-based food security measurement scales
- v. Anthropometry

i. Household income and expenditure surveys

Household income and expenditure surveys method is an interview method. Respondents are interviewed in their households. Respondents provide information on the amount of money that they spend on food and other necessities. Different time reference periods have been used including the week(s) or month(s) preceding the survey. To use the household income and expenditure survey method, the following data are needed:

- a. quantity of food bought (or expenditures) and costs associated with different foods consumed within and outside the house.
- b. foods received by any household member as either a gift or as payment for work, goods or services.
- c. foods grown for consumption by household members. This method estimates calories consumed on average per household member per day, making it essential to have access to culturally appropriate and valid food composition tables.

ii. The FAO method

FAO method estimates calories per capita at the country level using Food Balance Sheets

and energy intake variance data derived from household income and expenditure surveys.

The following information is needed by countries to be able to apply the FAO method:

- a. total calories available in year of interest

- b. number of people living in country in year of interest
- c. coefficient of variation of caloric intake to generate the energy intake distribution curve
- d. cut-off point to estimate the proportion of the population falling under the minimum per capita average caloric requirement.

Advantages of the FAO method

The FAO method has the following advantages:

- i. almost all countries generate the data needed and estimate their daily per capita caloric availability
- ii. estimates are frequently updated thus allowing the national, regional, and global food insecurity trends across time to be examined and compared
- iii. the method is inexpensive.

Disadvantages of the FAO method

The FAO method has the following disadvantages:

- i. dietary quality is not taken into account
- ii. the national average per capita caloric intake does not allow for understanding the intra country caloric distribution as a function of household characteristics.
- iii. method assumes that caloric consumption above minimum caloric threshold indicates food security, when in fact obesity has become a problem among the poor with excessive caloric consumption being associated with mild to moderate levels of food insecurity.
- iv. high degree of measurement error in numerator (balance sheets provide data on the amount of calories available but not necessarily consumed) and denominator (i.e., number of inhabitants living in the country in the year of origin). Overall, the origin of data used by countries is sometimes difficult to understand and of questionable validity, and there is little standardization and

- v. establishing an average per capita caloric requirement cut-off point has several conceptual weaknesses as in reality it is a function of physical activity levels, gender and age, among other factors.

iii. Individual's dietary intake

An individual's dietary intake can be measured using different methods such as :

- a. 24-hour dietary recall
- b. food frequency questionnaires
- c. food records kept by individuals or by an observer.

All dietary intake methods need to make use of a reference time frame. The 24-hour dietary recall and food frequency questionnaire rely on the memory of participants while food records rely on the recording of foods, as they are consumed, by the study participant, a proxy or an observer (Pérez-Escamilla and Segall-Corrêa, 2008). Portion size estimations can rely on assisted memory (e.g. using food models) or foods can actually be weighted before and right after consumption. These portion size estimations are needed to estimate food group counts as well as nutrient intakes, the latter provided that culturally appropriate and valid food composition data bases are available. Lastly, to interpret the nutrient intake findings it is important to have cut-off points for determining the proportion of the sample or population at risk of deficiencies for different nutrients (Pérez-Escamilla and Segall-Corrêa, 2008).

Advantages of Individual's dietary intake

- a. It measures food consumption directly and not only food availability
- b. it addresses both dietary quality (macro and micronutrients) and caloric intakes at the individual level
- c. it allows for mapping from the local to the national level, and the determinants and consequences of food insecurity at the individual level can be examined; this is important for understanding, for example, intra-household food consumption patterns and how it is influenced by gender

- d. different dietary intake methods can be used to understand recent (e.g., 24-hour recall) vs. longer term dietary intake patterns (e.g. food frequency questionnaires).

Disadvantages of Individual's dietary intake

- a. the 24-hour recall and the food frequency questionnaire rely heavily upon the memory of respondents and this might lead to measurement error. This is because respondents are asked to recall what they ate the day before, method of preparation of different meals (e.g. boiling, frying, roasting), spices and other ingredients used and to provide the recipes followed with mixed dishes and the quantity of food consumed. In all these, a high measurement error might be encountered especially if untrained interviewers are used. In addition, 24-hour recalls need to be applied in different occasions to the same individuals to be able to have a reasonable estimate of their usual food and nutrient intakes. Single 24-hour recalls cannot meet this need as the intra-subject day-to-day variability in food (and nutrient) intake is very high. In sum, the first major disadvantage of the 24-hour recall and other dietary intake methods is a very high level of measurement error (Pérez-Escamilla and Segall-Corrêa, 2008).
- b. Is expensive especially if is a national survey. Each 24-hour recall takes at least 20 to 30 minutes to apply (depending on the amount of food consumed by the respondent).
- c. a high level of training and skill is required to convert food intake into nutrient intakes.

iv. Anthropometry Method

Anthropometry is defined as the measurement of size, weight, body proportions and ultimately the composition of the human body (Pérez-Escamilla and Segall-Corrêa, 2008). Anthropometric indicators measure the impact of both food insecurity and health status on the nutritional status of individuals. The anthropometric indicators most

commonly used in national surveys are based on weight and height (or length) of infants, young children, youth and adults. The interpretation of the adequacy of the anthropometric indicators is based on well-established cut-off points.

Advantages Anthropometry Method

- i. Weight and height measurements are highly standardized and are highly reproducible across individuals doing the anthropometry and across settings.
- ii. It is inexpensive and this makes popular for national surveys.
- iii. The cut-off points used to interpret anthropometric measures are relatively stronger on their evidence based compared to the cut-off points for establishing the adequacy of nutrient intakes.
- iv. It also allows for mapping nutritional security from the local to the national level and for understanding trends, determinants and consequences of malnutrition at the individual level.

Disadvantages of Anthropometry Method

- i. the indicators used are an indirect approximation to food insecurity, as they measure nutritional status which is the result of the interaction between food (in)security and health status.
- ii. the interpretation of the relationship between food insecurity and obesity is complex, as there is growing evidence that whereas severe food insecurity leads to wasting, mild to moderate food insecurity may lead to obesity (Pérez-Escamilla and Segall-Corrêa, 2008).

v. Food insecurity experience-based measurement scales

All the methods discussed above are derived or indirect measurements of the food insecurity. Household food insecurity has also been measured using scales based on the perception or experience reported by the affected individuals.

3.8 FACTORS THAT INFLUENCE FOOD SECURITY

It has been warned that over the coming decades, a changing climate, growing global population, rising food prices, and environmental stressors will have significant yet uncertain impacts on food security (IFPRI, 2020). Factors that can cause food insecurity includes: non-availability of food, lack of access to food, improper utilization of food, perishability of food items and instability of food nutrients of over time, war, corruption and natural disaster such outbreak of diseases, pandemics. It has been reported that corrupt practices negatively influenced food security and life expectancy in developing countries (Uchendu and Abolarin, 2015). Another recent study also showed that war-torn countries of SSA region had a low global food index (GHI) (18.2%) and global food security index (GFSI) (30.8%) justifying the high number of population (5.0 million) that were malnourished (Uchendu, 2018). The instability of food nutrients over time have been linked to food insecurity in terms of micronutrient deficiencies also known as hidden hunger especially among pre-school children (Uchendu and Atinmo, 2012; Uchendu and Oyewole, 2016; Uchendu and Atinmo, 2019). Poverty is another factor that can lead to food insecurity. The Nigerian living standards survey (NLSS) which is the official survey that is the basis for measuring poverty and living standards shows that 40.1 % Nigerians (52.1 % rural and 18.0% urban) is poor (Nigerian bureau of statistics, 2019). This might imply that about 40 % of Nigerians are experiencing food insecurity. Outbreak of diseases, pandemics such as COVID-19 can result to food insecurity. COVID-19 or Corona Virus disease 2019 started in late 2019 from Wuhan in China. This infection is very contagious passing from human to human through droplets from the mouth, coughing and sneezing. This infection has spread all through the World. As at May 12, 2020, 4641 are infected in Nigeria. Since the infection spreads by movement of human beings, travellers, everybody is asked to stay at home all over the world as one of the means of contending with the infection. During this period many people have exhausted all the have- money and food. Some have lost their jobs. Some daily labourers who depend on daily labour to eat, are starving. Even though, there are

palliatives here and there, it is not sufficient and cannot reach everybody in Nigeria. So food insecurity will be high at this pandemic period.

Livelihood strategies, economic and social resources, functional limitations and context as well as management strategies are other determinants of food insecurity (Fig.4) (National Research Council, (2006)).

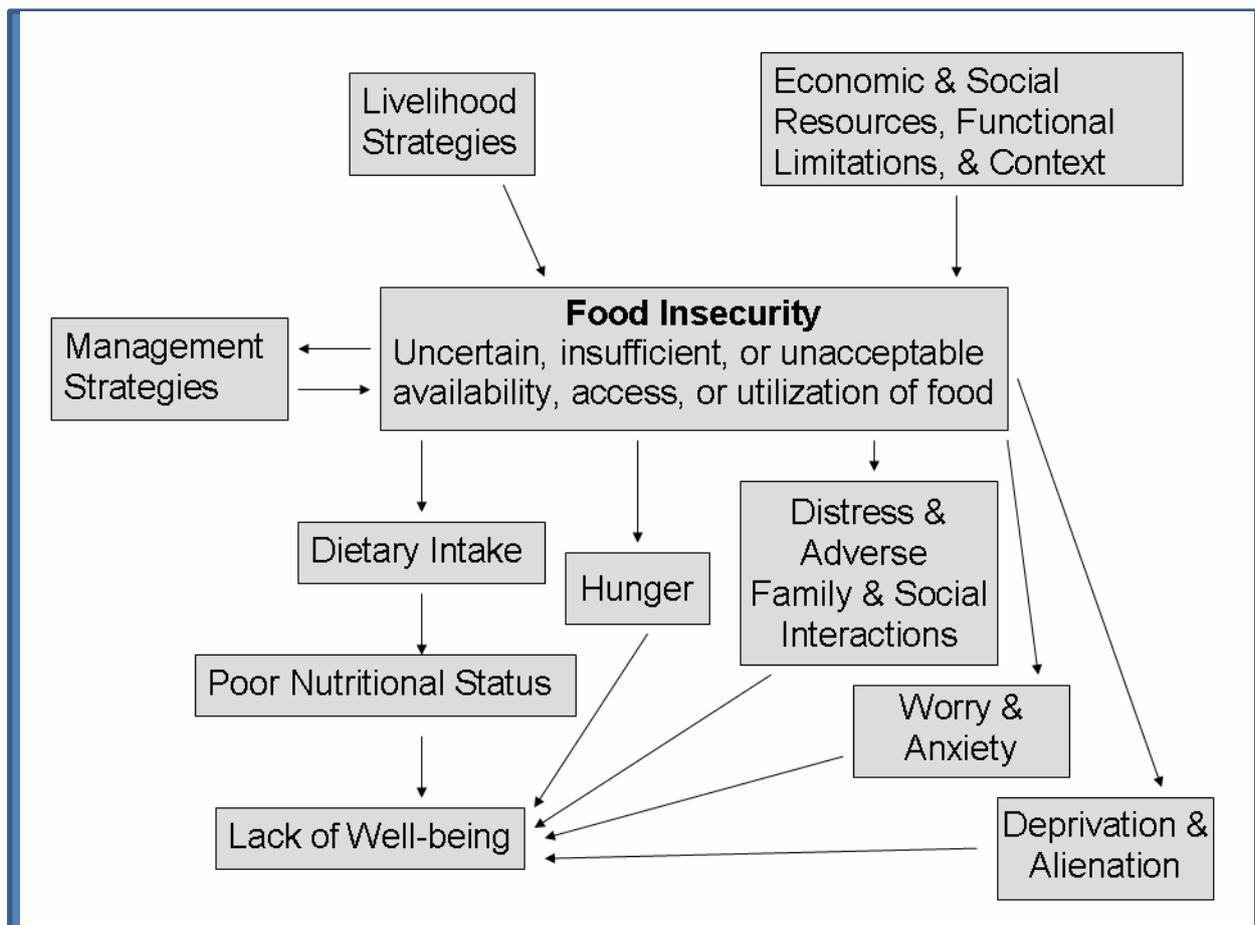


Figure 8: Food insecurity, and its determinants and consequences
 Source: National Research Council, (2006: adapted from Habicht et al., 2004)

Food insecurity can be experienced when the following occurs:

- i. uncertainty about future food availability and access
- ii. insufficiency in the amount and kind of food required for a healthy lifestyle
- iii. the need to use socially unacceptable ways to acquire food (see Figure 4).

- iv. Lack of economic resources
- v. food insecurity can also be experienced when food is available and accessible but cannot be used because of physical or other constraints, such as limited physical functioning by elderly people or those with disabilities (Lee and Frongillo, 2001a, 2001b).

3.9 CONSEQUENCES OF FOOD INSECURITY

- i. High prevalence of inadequate intake of essential nutrients.
- ii. Prevalence of malnutrition especially overweight in women and some adolescent girls.
- iii. Depressive symptoms in adolescents.
- iv. Academic and social developmental delays in children via lower intelligent quotient.
- v. It has been reported that household food insecurity is associated with poor physical and mental health of low-income black and white women (Siefert, Heflin, Corcoran, and Williams, 2004).
- vi. Food insecurity is also associated with more behavioral problems (Olson, 1999; Shook Slack and Yoo, 2004)
- vii. Poorer school performance (Olson, 1999; Alaimo et al., 2001b; Dunifon and Kowaleski-Jones,2003)
- viii. Adverse health outcomes in children (Alaimo, Olson, Frongillo, and Briefel, 2001c; Cook et al., 2004; Weinreb et al., 2005)
- ix. In USA, an Early Child Longitudinal Study-Kindergarten Class revealed that reporting at least one indicator of food insecurity was significantly associated with impaired learning in mathematics from fall to spring of the kindergarten year (Winicki and Jemison, 2003) and with impaired learning in reading from kindergarten to third grade (Jyoti, Frongillo, and Jones, 2005).

Food insecurity is measured as a household-level concept that refers to uncertain, insufficient, or unacceptable availability, access, or utilization of food (National

Research Council, 2006). There is a strong rationale for measuring food insecurity at the household level because it is possible for an individual to be food secure in a food-insecure household, just as it is possible for individuals to not be poor in a poor household, depending on the intra-household allocation of resources (National Research Council, 2006). It means that we can measure and report the number of people who are in food-insecure households (with all of them not necessarily food insecure). When a household contains one or more food-insecure persons, the household is considered food insecure (National Research Council, 2006).

4.0 CONCLUSION

Food safety is an importance aspect of public health. Living a healthy life style by maintaining food safety should be encouraged among the citizenry to eradicate food borne diseases and malnutrition in Nigeria. Government and non-governmental organizations should work together to encourage the masses to maintain a healthy lifestyle. Policies involving nutrition education and monitoring will help to address poor food safety practices. A healthy nation is a wealthy nation. I am sure you now have a better understand of the term food security. Food security can be at individual, household and national/regional/global levels.

5.0 TUTOR-MARKED ASSIGNMENTS (TMAS)

1. Explain with relevant examples the implication of food safety among the food agents.
2. Define food security.
3. List the components of food security.
4. Discuss the factors that influence food security.

6.0 SUMMARY

Food security is the opposite of food insecurity. Consequences of food insecurity include hunger, starvation and malnutrition. This type of malnutrition is called hidden hunger. Hunger is a severe level of food insecurity. A measure of hunger is at the individual level.

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MODULE 3 COMMUNITY-BASED NUTRITION PROGRAMMES

UNIT 3 NUTRITION DURING DISASTER

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1.0 INTRODUCTION

Disaster is a special circumstance. It could be natural or man-made. Natural disaster includes tsunami, flood, earthquake, wind (cyclone), drought, famine, locust invasion

and volcano eruption. Man-made disaster includes conflicts, crises, war, terrorism, infectious diseases and fire outbreak. Examples of terrorism in Nigeria include Boko haram, kidnapping and insurgency. In times of disaster, so many things go wrong. Another aspect of terrorism is food terrorism. Food terrorism is defined as an act or threat of deliberate contamination of food for human consumption with chemicals, biological or radio-nuclear agents for the purpose of causing injury or death to civilian populations and /or disrupting social, economic or political stability (WHO, 2002). The chemical agents are man-made or natural toxins, and the biological agents are infectious or non-infectious pathogenic microorganisms and these include viruses, bacteria and parasites. Radio-nuclear agents are defined in this context as radioactive chemicals capable of causing injury when present at unacceptable levels (WHO, 2002).

2.0 OBJECTIVES

At the end of this Module 3 Unit 3, you will be able to:

- i. Define disaster.
- ii. Enumerate the disadvantages of disaster
- iii. Vulnerable groups in times of disaster
- iv. Discuss nutrition requirements and management during disaster

3.0 MAIN CONTENT

3.1 DEFINITION OF DISASTER

The United Nations International Strategy for Disaster Reduction defines disaster as a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (Mahar et al. 2020). Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences.

3.2 DISADVANTAGES OF DISASTER

Disaster has so many disadvantages and these include:

1. People are displaced from their homes.
2. Disasters lead to illness and death.
3. Disaster leads to abuse and unwanted pregnancies.
4. Disaster leads to hunger, famine and malnutrition.
5. Disaster leads to homeless and joblessness via poverty.
6. Disaster leads to increase in crime.

3.3 VULNERABLE GROUPS IN TIMES OF DISASTER

The main vulnerable groups in times of disaster include children, women, the elderly and the sick. The elderly and the sick ones have low or compromised immunity. The vulnerable groups might not withstand the stress, psychological trauma, hunger and starvation associated with disaster. Food security is an important factor in poverty reduction.

3.4 NUTRITION REQUIREMENT DURING SPECIAL CIRCUMSTANCES (DISASTER, WARS, TERRORISM)

During disaster, people are displaced from their homes so they can no longer farm, work or do their normal businesses. Consequently, disaster is normally associated with lack of food, scarcity of food and water, hunger and starvation. There lack and scarcity of all the local foods such as yam, rice, garri, fufu, tuwo-masara, beans, meat, fishes, salt, oil, sugar, fruits and vegetables. These foods provide body nutrients such as carbohydrates, proteins, fats and oils, vitamins and minerals. But when the people experiencing disaster, cannot have access to these essential nutrients, it results in malnutrition such as wasting, stunting, underweight, morbidity (sickness) and mortality (death) especially among children, pregnant and lactating mothers.

So food and nutrient requirements are very essential during disaster. The Government and humanitarian agencies have very important roles to play for internally displaced persons or refugees and migrants. People experiencing war in their communities and countries at times try to escape to other communities and neighboring countries as refugees and migrants. During disaster the basic nutrient requirement is foods that provide energy, protein, vitamins and minerals for strength, maintenance of body cells and growth. Persons experiencing disaster need to eat three normal meals a day. They need adequate diet to be healthy. Children born during war might experience severe malnutrition in form of Kwashiorkor. So they need a lot of energy, protein, vitamins and minerals such as rice, beans, milk, eggs, meat and fish. Even though it is might be difficult, efforts should be made to provide these essentials foods to them by the Government, humanitarian organizations/agencies, Non-governmental Organizations (NGOs) and good spirited individuals.

4.0 CONCLUSION

Disaster results in food scarcity, hunger and starvation and these are risk factors of malnutrition. Vulnerable groups during disaster include children, pregnant women and lactating mothers.

5.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

1. Explain with relevant examples what you understand by disaster.
2. Enumerate the disadvantages of disaster.
3. Discuss the nutrient requirement during disaster.

6.0 SUMMARY

Nutrient requirement during disaster includes foods that provide nutrients such as energy, protein, vitamins and minerals. Foods that can provide these nutrients include

rice, beans, milk, eggs, meat, fish, fruits and vegetables. These nutrients have been treated in details in Module 1. Endeavour to study and know them very well.

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