SESSION 2. THE BASICS OF NUTRITION

Purpose (slide 2)

The purpose of this session is to provide students with basic knowledge of nutrition. Concepts include the importance of nutrition for health, food sources of nutrients, the role of nutrients in the body, health disorders associated with inadequate nutrition, and nutrition interventions and strategies to combat undernutrition.

Learning objectives (slide 3)

By the end of the session, students will be able to:

- Explain the importance of good nutrition for health.
- Identify food sources of nutrients.
- Describe the role of nutrients in the body.
- Understand the causes and consequences of undernutrition,
- Describe national and regional strategies to combat undernutrition.

Prerequisite knowledge

- Basic science (biology, anatomy, physiology, and chemistry)

Estimated time: 125 minutes

Session guide (slide 4)

Content	Methodology	Activities	Estimated time (minutes)
Good nutrition and related terms and concepts	Participatory lecture	Discuss terms related to food and nutrition.	5
Essential nutrients: Macronutrients and micronutrients	Participatory lecture and group activity	Describe and define essential nutrients. Discuss which local foods contain specific essential nutrients.	15
Energy requirements for adults, adolescents, and children and infants	Participatory lecture and individual activity	Describe energy requirements and discuss requirements for different age groups. Complete Exercise 1 and discuss answers.	20
Protein requirements for adults, adolescents, and children and infants	Participatory lecture	Describe protein requirements for different age groups.	15
The causes of undernutrition and its impact on society	Participatory lecture	Describe undernutrition in Africa. Discuss students' understanding of undernutrition in their communities.	10
Protein energy malnutrition (PEM) and body mass index (BMI)	Participatory lecture and individual exercise	Describe PEM, its diagnosis, and strategies for prevention and control. Complete Exercise 2 and discuss answers.	15
Anemia, iron deficiency disorders (IDD), and vitamin A deficiency (VAD)	Participatory lecture and individual exercise	Causes, manifestations, and diagnosis of anemia, IDD, and VAD and strategies to control and prevent other nutrition-related conditions	15
Case studies	Exercise and group discussion	Ask students to complete Exercises 3–5 and discuss answers.	15
Conclusions			5
Review			5
Total time			120

Required materials

- Flipchart paper and stand
- Marker pens
- Blackboard and chalk or whiteboard and markers
- Erasers
- Overhead project and transparencies or LCD project and laptop

Materials provided

- PowerPoint 2
- **Handout 2.1. Macronutrient and Micronutrient Food Sources, Functions, and Manifestations of Deficiencies**
- **Handout 2.2. Nutrition Calculations**
- **Handout 2.3. Length/Height for Age and Weight for Age**
- **Handout 2.4. Body Mass Index Reference Table**

Preparation

- Review Lecture Notes and PowerPoint 2.
- Review handouts and identify questions to help students master the concepts.
- Collect samples or pictures of local foods.

Suggested reading

Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO). 1998. Human Vitamin and Mineral Requirements. Report of a Joint FAO/WHO Expert Consultation. Rome: FAO.

FAO, WHO, and United Nations University (UNU). 1985. Energy and Protein Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. WHO Technical Report Series No. 724. Geneva: WHO.

Latham, M. C. 1997. Human Nutrition in the Developing World. FAO Food and Nutrition Series No. 29. Rome.

Related terms

Balanced diet – The daily provision of a variety of foods which include all the nutrients in the right amounts and combinations required to meet the body's functional needs

Diet – The customary amount and kind of food and drink a person takes in day to day

Carbohydrates – The main sources of energy in the diet, referred to as energy-giving foods

Energy requirement – The amount of energy needed to maintain health and growth and support an individual level of physical activity

Lipids – Fat-soluble compounds high in energy that can be found in solid or liquid form

Macronutrients – Nutrients (carbohydrates, fats, and proteins) needed by the body in relatively large quantities, measured in grams per day

Malnutrition – A condition caused by inadequate or excess intake of nutrients

Meal – Food served or eaten at a given time during the day (e.g., breakfast, lunch, dinner)

Micronutrients – Nutrients (vitamins and minerals) needed by the body in very small quantities, usually less than 1 gram per day

Minerals – Inorganic compounds which must be obtained outside the body, required for chemical and metabolic functions

Nutrients – Substances or components of food which contain carbohydrates, proteins, fats (lipids), vitamins, minerals, and water

Nutrition – The sum of all processes involved in taking in food and the body's assimilation and use of the food

Nutritional status – The health status of the body in relation to a nutrient or group of nutrients

Overnutrition – A condition caused by excess intake of nutrients

Proteins – Macronutrients essential for body growth and building and repairing tissues and muscles

Undernutrition – A condition caused by inadequate intake of nutrients

Vitamins – Organic compounds that performs specific metabolic functions in the body

Introduction (slide 5)

Nutrition is the sum of all processes involved in the intake, assimilation, and utilization of the proper amounts of nutrients to maintain health, well-being, and productivity. Good nutrition relies on a diverse, adequate diet and is essential for the development and maintenance of the body from infancy to old age. Nutritional status can be both the "cause" and the "outcome" of good or poor health.

The terms "nutrition" and "food" are closely related but not interchangeable. Nutrition is a process of events, while food is a product that is eaten or taken into the body. Food is essential because it contains nutrients that the body needs for the following:

- Developing, growing, maintaining, replacing, and repairing cells and tissues
- Resisting and fighting infection and recovering from illness
- Producing energy, warmth, movement, and work
- Carrying out chemical processes such as digestion

Nutrition basics

Nutrients are the substances in food that the body uses to function properly. Nutrients are divided into macronutrients and micronutrients.

Macronutrients are nutrients needed by the body in relatively large quantities (many grams per day and include carbohydrates, fats, and proteins.

Micronutrients are nutrients needed by the body in very small quantities (usually less than 1 gram per day) and include vitamins and minerals.

The body ingests, assimilates, and utilizes the nutrients in food to meet its needs for macronutrients and micronutrients. The body's physical and chemical process of breaking down food and converting it into a useful form of energy is called **metabolism**. The energy produced by metabolism is essential to maintain the body's functions and daily activities. The ability to metabolize food may vary from person to person and may be affected by illness or disease. Balancing the body's ability to metabolize food with an appropriate quantity of nutrients and food types will help ensure good health.

Each person processes and uses nutrients differently. The body responds either positively or negatively when it absorbs a nutrient or group of nutrients. The response affects the body's condition and health status. The body's response to nutrients and the subsequent outcome is called **nutritional status**. The amount and type of food and drink a person eats is called the **diet**. A nutritious or balanced diet includes a variety of foods and the proper nutrients in the correct amounts and combinations to meet the body's functional needs. A healthy and balanced diet should contain food free of harmful substances and in the optimal amounts and mixtures.

Eating a variety of foods is key to good health, especially for people with special needs, such as infants and young children, pregnant and lactating women, and the elderly. Eating a wide assortment of foods increases the likelihood of getting the necessary nutrients. Except for breastmilk, no single food provides all the nutrients the body needs to function properly.

In summary, good nutrition involves eating a variety of safe and appropriate foods in the correct quantities to meet the body's needs for health and well-being.

The essential nutrient groups (slide 6)

To function properly, the body must maintain a proper balance of the following key nutrients:

- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals
- Water

As mentioned earlier, these nutrients are divided into macronutrients and micronutrients. People must eat the appropriate amount of all these nutrients to be well nourished. Refer **Handout 2.1. Macronutrient and Micronutrient Food Sources, Functions, and Manifestations of Deficiencies** lists the essential nutrients and their sources, functions, and deficiencies.

Macronutrients

Macronutrients are the main sources of energy in the diet. Their contribution to individual diets may vary.

Carbohydrates (slide 7)

Carbohydrates are called energy-giving foods because they make up a large percentage of the energy in people's diets. In developing countries the basic foods that people eat regularly (staple foods) are usually high in carbohydrates. In fact, carbohydrates account for up to 80 percent of the total energy in diets in developing countries, compared with 45–50 percent in industrialized countries (Lantham 1997). Staple foods often contain other essential nutrients such as protein, vitamins, and minerals, but in smaller amounts. Staple foods are usually produced locally and are readily available, accessible, and affordable.

Rich sources of carbohydrates include cereals (rice, millet, sorghum, wheat, and barley), root crops (cassava, sweet potatoes, yams, and potatoes), and starchy fruits (green bananas and plantains). These foods contain what are known as complex carbohydrates. Complex carbohydrates usually provide more fiber, vitamins, and minerals than simple carbohydrates (FAO 1998). Simple carbohydrates provide energy but are often called "empty calories" because they lack the extra vitamins and minerals found in complex carbohydrates. Simple carbohydrates are quickly digested and absorbed because they lack fiber. They include sugar, honey, and baked goods such as doughnuts and cake.

Carbohydrates cannot meet all the body's energy needs because they do not provide all the essential nutrients. People should eat other kinds of food in combination with staple foods for a nutritious and well-balanced diet.

Lipids (slide 8)

Lipids are found in fats and oils and are a concentrated source of high energy that is slowly absorbed by the body. Lipids provide essential fatty acids that the body does not produce itself and has to get from food. In developing countries lipids represent only 8 percent of the total energy in people's diets, compared with as much as 36 percent in high-income countries (Latham 1997).

Foods that contain lipids generally have a satisfying taste, ensuring that people include them in their diets. These foods include butter, margarine, and lard, which are solid at room temperature, and corn oil, olive oil, cotton oil, linseed oil, and soybean oil, which are liquid at room temperature.

Lipids are categorized as visible and invisible fats. Visible fats are easily recognized and include butter, margarine, vegetable oils, bacon fat, and lard. Their lipid content can be measured accurately. Invisible fats are not seen or measured as easily and are found in milk, nuts, avocados, cheese, egg yolks, and baked goods such as cake.

The body digests and absorbs liquids more slowly than carbohydrates and proteins. Lipids leave people feeling satisfied longer and provide nearly twice as much energy as other macronutrients. Because they are energy dense, lipids are important for people who need to gain weight. Because dietary lipids also help the body transport and absorb fat-soluble vitamins, they may be a good source of vitamins A, D, E, and K. However, eating too many lipids may lead to heart disease, obesity, and related complications. People should therefore eat lipids sparingly.

Proteins (slide 9)

Known as body-building foods, proteins form the main structural components of cells and, apart from water, make up the bulk of tissues and organs. The body needs additional protein from the diet to grow, develop, maintain, and repair tissues and muscles. Proteins are necessary for the following:

- Growth and development
- Maintenance and repair of tissues and replacement of worn-out or damaged tissues
- Production of metabolic and digestive enzymes
- Make up of certain hormones and all cells and tissues

There are two main types of protein: plant protein, which includes legumes (e.g., beans, lentils, soybeans, and chickpeas), groundnuts, and other nuts and 2) animal protein, which includes meat, poultry, fish, insects, milk, cheese, and eggs.

Proteins are made of amino acids, some of which are absolutely essential for humans. Not all proteins have the same quality and nutritional importance. Proteins in some foods do not contain the full range of essential amino acids that the body needs. Foods such as milk and eggs contain high-quality, easily digested proteins with the essential amino acids. Foods such as maize and wheat contain protein with fewer essential amino acids and are less easily digested.

Animal protein is often of high quality and as a result contains more of the amino acids, vitamins, and minerals needed for the body's proper functioning. When people do not eat enough protein, their bodies use protein from their muscle mass, leading to muscle wasting over time.

Micronutrients

Micronutrients are needed in very small amounts but play an important role in the proper functioning of the body. Micronutrients include vitamins and minerals that the body needs to produce various hormones and enzymes to develop and maintain systems including the immune and reproductive systems.

Vitamins (slide 10)

Vitamins are organic compounds that perform specific metabolic functions in the body. The body does not synthesize most vitamins and must get them from food. Unlike carbohydrates, lipids, and proteins, vitamins do not produce energy. However, they are necessary for many of the metabolic processes that produce energy. People who do not eat the proper amounts of vitamins can get vitamin deficiencies that cause illness and disease.

Vitamins are classified into two categories based on the substances they dissolve in. **Fat-soluble vitamins** can be stored by the body when they are not used. These vitamins are essential for good health but not needed every day. Fat-soluble vitamins include A, D, E, and K. These vitamins are necessary for the development and maintenance of certain body tissues, including those in the eyes (vitamin A), bones (vitamin D), and muscles; for the coagulation of blood (vitamin K); for synthesizing certain enzymes, and for absorbing other essential nutrients such as calcium (vitamin D) (Latham 1997).

Water-soluble vitamins pass directly into the bloodstream. The body has limited ability to store these vitamins and must get them daily from food. Water-soluble vitamins include C (ascorbic acid), B_1 (thiamine), B_2 (riboflavin), B_3 (niacin), B_6 (pyroxidine), B_{12} (cobalamin), pantothenic acid, and folic acid.

These vitamins are often classified by their functions. **Energy-releasing vitamins** that enable the body to use macronutrients include B_1 (thiamine), B_2 (riboflavin), B_3 (niacin or nicotinic acid), biotin, and pantothenic acid. **Hematopoietic (red blood cell-synthesizing) vitamins** that help the body make new red blood cells include folacin (folic acid) and B_{12} (cobalamin). **Co-enzyme vitamins** that help the body break down amino acids, produce enzymes, and synthesize new proteins include B_6 (pyroxidine), which helps metabolize protein, and others. **Skin- and bone-building vitamins** that help form collagen, an important component of skin, bone, and connective tissues include C (ascorbic acid).

Minerals (slide 11)

Minerals are inorganic compounds that are not produced by the body but are necessary for health and well-being. Minerals are referred to as essential trace elements because they are needed in very small quantities. While they are chemically different from

vitamins, minerals serve similar purposes. They influence many of the body's biochemical reactions and are used to form cells and tissues.

Important minerals for health include iron, zinc, calcium, and iodine. Iron is an essential component of blood and helps transfer oxygen to various tissues. Zinc is important to enhance and strengthen the immune system, help wounds heal, and facilitate digestion and is an important component of the skeletal system. Calcium is a key component of bone and is needed for a strong skeleton. Other minerals involved in various body reactions are chromium, copper, fluoride, magnesium, manganese, molybdenum, nickel, phosphorus, and selenium.

Water (slide 12)

Water is considered an essential nutrient because it is necessary for body functions including digestion and absorption and certain metabolic processes. Water is also a primary component of the body, representing over 60 percent of a person's weight. Water regularly leaves the body through sweating, excretion, and breathing and therefore must be replaced. Adults should drink at least 2 liters or about 8 cups of water a day. The water should be safe, clean, and boiled if necessary. Tea, soup, milk, juice, and fruit also contain water and can help meet the body's needs. The caffeine in tea and coffee, however, can dehydrate the body and should be drunk in moderation. Tea and coffee also contain substances that bind essential nutrients such as iron, making these nutrients unavailable for the body to use.

To maintain a well-balanced diet, people should eat a variety of foods that contain all the nutrients mentioned above in the right daily amounts and combinations to meet the body's functional needs.

Nutrient requirements of adults and children: Energy (slides 13 and 14)

Energy requirements are the "amount of food energy needed to balance energy expenditure in order to maintain body size, body composition, and a level of necessary and desirable physical activity consistent with long-term good health (FAO, Who, UNU 2004). Essentially, energy requirements are the general guidelines for attaining and maintaining a health life that reflect the body's dietary and expenditure needs. These requirements vary according to age and gender. Infants, children, adolescents, pregnant and lactating women, other adults, and the elderly all have different energy requirements and should eat a well-balanced diet that takes into account their various needs. Energy requirements are also based on the following factors:

- **Basal metabolism**—the minimal energy expenditure needed to maintain the basic body functions needed for life, such as the functioning of vital organs and the nervous system. The basal metabolic rate (BMR) is used to determine basal metabolism over a standard period of time and can represent from 45 to 70 percent of daily energy needs.
- **Metabolic response to food**—the level of energy needed to digest, absorb, and utilize all food eaten.
- **Physical activity**—all daily activities ranging from work to play to rest. These activities may be occupational, associated with work, or discretionary, associated with household and social tasks.

- **Physiological needs**—Young children have added energy needs to support growth and development. Pregnant and lactating women need additional energy to support the growth of the fetus, the placenta, maternal tissues, and milk production (FAO, WHO, UNU 2004).

Estimating energy requirements for adults (slide 15)

Energy requirements and the dietary intake needed to meet these requirements may change from day to day. These definitions are estimates of the appropriate energy for a particular group of people. Energy requirements are measured in calories and are determined by multiplying the BMR by an activity multiplier. The BMR is one of the most important determinants of energy requirements. It is calculated using age, gender, height, and weight. Table 1 shows the BMR for males and females of various ages and weight.

Table 1. Equations for estimating BMR from body weight

Age (years)	Kcal/day
Males	
18–30	15.1 x weight (kg) + 692
30–60	11.5 x weight (kg) + 873
> 60	11.7 x weight (kg) + 588
Females	
18–30	14.7 x weight (kg) + 496
30–60	8.7 x weight (kg) + 829
> 60	10.5 x weight (kg) + 596

Source: FAO, WHO, and UNU. 1985.

Table 2 shows multiples of BMR used to determine the average daily energy requirements of adults based on their physical activity. Activities are classified as light (e.g., the work of an office clerk), moderate (e.g., the work of a subsistence farmer), and heavy (e.g., the work of a laborer). The equation for determining estimated energy requirements based on activity is **kcal/day = BMR x activity factor**.

Table 2. Activity factors

	Light	Moderate	Heavy
Male	1.55	1.78	2.10
Female	1.56	1.64	1.82

As an example, to determine the estimated daily energy required by a healthy 35-year-old man who weighs 70 kg and does heavy activity, we would multiply 2.10 x BMR, or 2.10 x (11.5 x 79 kg + 873). This would give us 3,534 kcal/day.

Exercise 1. Determine the energy requirement of a 23-year-old woman who weighs 53 kg and does farming and household work (moderate activity).

BMR: _____ x _____ kg + _____ = _____ kcal/day

Total kcal/day: BMR of _____ x activity factor of _____ = _____ kcal/day

Answers to the exercises are found in Appendix 1.

To quickly estimate energy requirements, assume that healthy adults who are not obese need 25–35 kcal per kg of body weight (Ireton-Jones and Turner 1991). This estimate should only be used when BMR equations and activity factors are not readily available.

Handout 2.2. Nutrition Calculations can be used to calculate BMR and find the energy and protein requirements of children and adults.

Estimating energy requirements for pregnant and lactating women

The energy needs of women of reproductive age often increase because of the demands of pregnancy, lactation, and even menstruation.

Pregnancy

During pregnancy women need extra energy and nutrients for the growth of the fetus, the placenta, and associated maternal tissues. A pregnant woman who neglects her energy requirements and proper diet may have a higher risk of giving birth to an unhealthy child. Energy demands gradually increase over pregnancy, with the most energy needed during the third trimester. However, a woman can meet her energy needs throughout the 9 months of pregnancy if she gets the added energy in table 3 every day. The body can store extra energy absorbed early in pregnancy and use it when demand increases. Energy levels differ based on activity levels.

Table 3. Added daily energy requirements of pregnant women

Full activity	285 kcal/day
Reduced activity	200 kcal/day

Source: FAO, WHO, and UNU. 1985.

Lactation

Energy and nutrient requirements increase during lactation for milk production and secretion. Meeting these needs is important for the health of the infant, as many nutrients provided by breastmilk come from the mother's diet. Table 4 shows the additional energy needed by lactating women.

Table 4. Added daily energy requirements of lactating women

First 6 months	500 kcal/day
Second 6 months	500 kcal/day

Source: FAO, WHO, and UNU. 1985.

Estimating energy requirement for children and adolescents 1–18 years old (slide 16)

Energy requirements for adolescents, children, and infants > 1 year old are calculated taking into account BMR, physical activity level, and energy needs for growth. Table 5 shows the average daily energy requirements of this group, assuming moderate activity of the average child.

Table 5. Added daily energy requirements of children 1–18 years old

Age (years)	**Energy requirements (kcal/day)**	
	Girls	**Boys**
1–2	865	948
2–3	1,047	1,129
3–4	1,156	1,252
4–5	1,241	1,360
5–6	1,330	1,467
6–7	1,428	1,573
7–8	1,554	`1,692
8–9	1,698	1,830
9–10	1,854	1,978
10–11	2,006	2,150
11–12	2,149	2,341
12–13	2,276	2,548
13–14	2,379	2,,770
14–15	2,449	2,990
15–16	2,491	3,178
16–17	2,503	3,332
17–18	2,503	3,410

Source: FAO, WHO, and UNU. 2004.

These levels may be higher or lower depending on the physical activity of a particular child. In general children under 10 years old have lower activity levels and energy requirements than adolescents. During adolescence the tissues in the body change composition and grow rapidly. Adolescents need additional energy to maintain health, promote optimal growth and nutrition, and support physical activity.

Infants (slide 17)

The first 12 months of life are a critical time when the infant is developing and tissues are growing. In fact, during the first 3 months of life, the body uses 35 percent of the energy it needs specifically for growth (FAO, WHO, and UNU 2004). Breastmilk alone contains all the energy and nutrients a child needs for the first 6 months of life. Beyond 6 months the child needs additional food supplements to provide the appropriate level of micronutrients and macronutrients, as shown in table 6.

Table 6. Average daily energy requirements of infants

Age (months)	Energy requirements (kcal/day)	
	Girls	Boys
0–1	464	518
1–2	517	570
2–3	550	596
3–4	537	569
4–5	571	608
5–6	599	639
6–7	604	653
7–8	629	680
8–9	652	702
9–10	676	731
10–11	694	752
11–12	712	775

Source: FAO, WHO, and UNU. 2004.

Infants who are undernourished or born with low birth weight may need additional energy for catch-up growth to reach the normal height and weight of children their age.

Protein requirements (slide 18)

Protein is essential for body growth and maintenance, particularly for children and adolescents. Because protein in the body is constantly depleted and cannot be stored, it must be replenished daily. Requirements may differ from person to person based on health status and physiological condition. Protein requirements for adults are the same for both sexes at all ages and body weights, except for pregnant and lactating women.

Pregnancy substantially increases protein requirements for women to support the growth of the fetus, placenta, and additional maternal tissue. There is some evidence that pregnant women utilize protein less efficiently, thereby increasing the need for dietary sources.

Lactation also increases protein needs, because breastmilk must supply protein to the infant for growth.

Table 7 shows the basic minimum protein required by adults to compensate for protein loss and support growth.

Table 7. Safe protein intake requirements for adults

	Safe protein intake (g/kg of body weight)
Average adult	0.75
Pregnant woman	0.75 + 6 g/day
Lactating woman	
6 months	0.75 + 16 g/day
6–12 months	0.75 + 12 g/day
12+ months	0.75 + 11 g/day

Source: FAO, WHO, and UNU. 1985.

Estimating protein requirements for infants, children, and adolescents

The first year of life is a period of rapid growth. Infants who are breastfed exclusively for the first 6 months of life have their protein requirements met, but it is important to understand the amount of protein needed in their diet. During the first month of life, infants need 2.5 grams of protein per kilogram of body weight. After 4 months and up to 12 months, they need approximately 1.5 grams per kilogram of body weight (FAO, WHO, and UNU 1985).

Protein needs often fluctuate with child growth and development. The most accurate reflection of the protein requirements of an individual child is based on actual body weight. This calculation involves multiplying the safe level of protein intake per age group by weight in kilograms (table 8). Up to age 12, boys and girls need the same level of protein, but the safe protein intake level differs slightly after that point.

Table 8. Safe protein intake requirements for adults

Age (years)	Safe protein intake (g/kg of body weight)	
	Girls and boys combined	
1–2	1.20	
2–3	1.15	
3–5	1.10	
5–7	1.00	
7–10	1.00	
	Girls	Boys
10–12	1.00	1.00
12–14	0.95	1.00
14–16	0.90	0.95
16–18	0.80	0.90

Source: FAO, WHO, and UNU. 1985.

Illness, intense physical activity, and starvation require special protein intake for adults and children because the body needs additional protein to build, repair, or sustain tissues.

Vitamins and minerals are also required in the daily diet. Table 9 shows the recommended daily allowance (RDA) for several vitamins and minerals important for healthy functioning of adults. When intake is inadequate, both children and adults may need a multivitamin. Intake of vitamins and minerals should not exceed 1 RDA.

Table 9. Daily recommended dietary allowances of selected vitamins and minerals for adults 19–50 years old

	Women per day	Men per day
Vitamin A	700 µg	900 µg
Vitamin C	75 mg	90 mg
Vitamin E	15 mg	15 mg
Vitamin B6	1.3 mg	1.3 mg
Vitamin B12	2.4 µg	1.4 µg
Folate	400 µg	400 µg
Zinc	11 mg	11 mg
Iron	18 mg	8 mg
Selenium	55 µg	55 µg

Source: Institute of Medicine, 2005. Dietary Intakes. Available at http://www.iom.edu.

Undernutrition (slides 19–21)

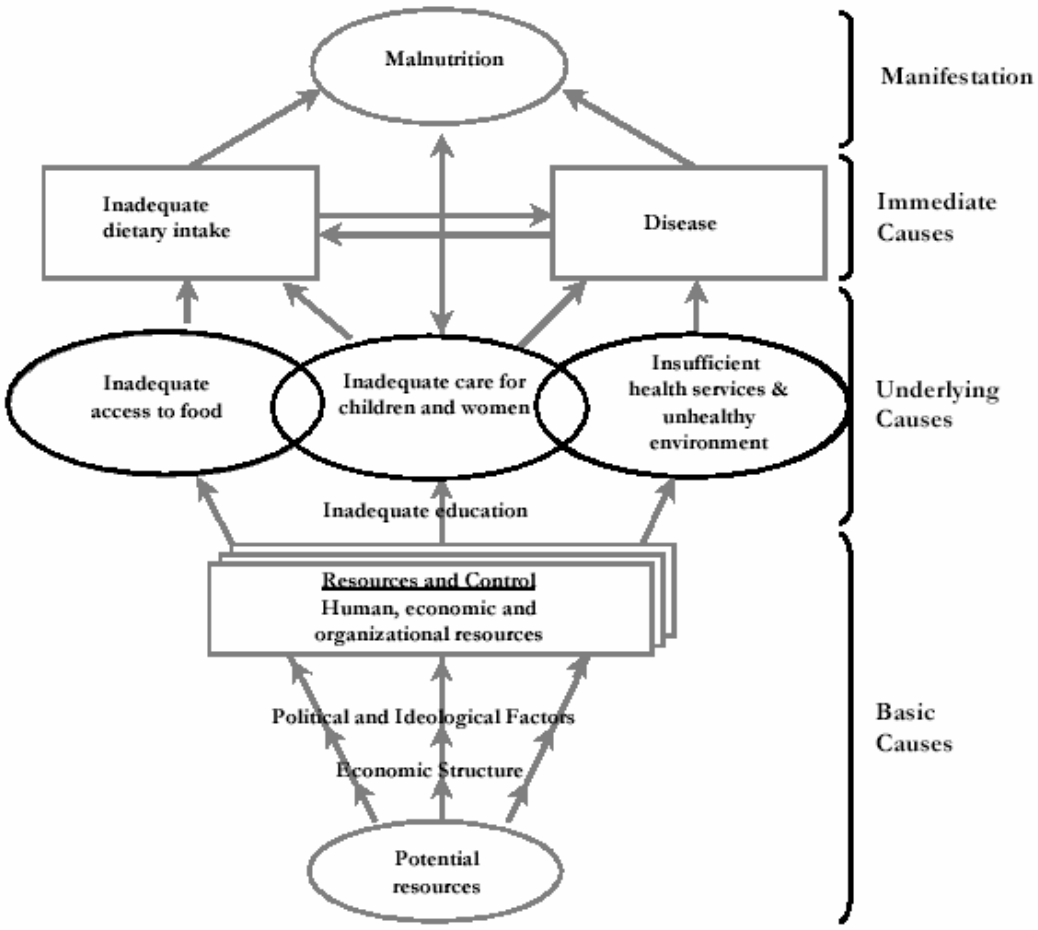
Malnutrition is a condition caused by inadequate or excess intake of nutrients. This session focuses on undernutrition caused by inadequate intake of nutrients. When the body does not receive enough food or receives food that does not provide the appropriate components for healthy living, it becomes weak or overburdened and cannot function properly. Undernutrition is manifested as stunting, underweight, and wasting and/or micronutrient disorders, mainly iron deficiency anemia, iodine deficiency disorders (IDD), and vitamin A deficiency (VAD) (slide 20).

Undernutrition is a serious global problem, causing an estimated 50 percent of all child deaths (WHO 2000). Undernutrition has been widespread in Africa for many years, particularly among young children. Chronic undernutrition is prevalent in sub-Saharan Africa, where alsmot33 percent of all children under 5 are underweight and 38 percent are stunted (low height for age) (UNICEF 2004).

Undernutrition can happened at any point in the life cycle. When it happens early in life, a person can suffer irreversible damage. Nutrition challenges continue throughout the life cycle. Inadequate nutrition usually begins in utero and extends into adolescence and adult life. The cycle of poor nutrition also spans generations. Young children, particularly girls who do not receive adequate nutrition, become stunted women and are more likely to continue the cycle, remaining stunted into adulthood unless the cycle is broken. Pregnancy in the adolescent years increases the risk of low birth weight infants and the difficulty of breaking the cycle. Good nutrition needs support at all stages of the life cycle, including infancy, childhood, adolescence, and adulthood, especially for girls and women. Intensive efforts are needed to prevent and minimize the adverse effects of poor nutrition.

Undernutrition may be improved by improving household access to nutritious foods, improving cultural practices, and improving the individual physiological requirements of food and nutrients. To improve nutritional well-being, coordinated strategies are needed among multiple sectors.

The underlying causes of undernutrition include inadequate access to food and nutrients, improper care of mothers and children, limited access to health services, and unhealthy environments. The UNCEF framework below (slide 21) divides the causes of undernutrition into immediate, underlying, and basic. This framework can guide collection of information on the causes of malnutrition and planning of actions to address undernutrition at the community, district, and national level. Health care staff can use the chart to talk to leaders in various sectors and to communities about the importance of working together to address the multiple causes of undernutrition.



Source: Adapted from UNICEF (1998) *The State of the World's Children 1998.* Oxford University Press, Oxford.

Using anthropometry to determine nutritional status (slide 22)

The following anthropometric measurements are used to measure nutritional status:

- Weight for age (chronic and acute malnutrition)
- Height for age (chronic malnutrition)
- Weight for height (acute malnutrition)

These indexes measure the following nutrition conditions:

1. **Underweight** (weight for age). Children in this category experience body changes resulting from both acute and chronic malnutrition.
2. **Stunting** (height for age). An indicator of chronic malnutrition or past growth failure as a result of inadequate intake of nutrients over a long period or because of long-term illness
3. **Wasting** (weight significantly below the weight expected for the child's height). An acute condition resulting from inadequate dietary intake or infection.

Handout 2.3. Length/Height for Age and Weight for Age is a series of growth reference charts for girls and boys from birth to age 20.

Other anthropometric measurements (slide 23)

Mid-upper arm circumference (MUAC) is a measurement of the upper arm to determine severe or mild-to-moderate malnutrition. MUAC is a quick and easy way to screen people for interventions but is not appropriate to determine the effectiveness of an intervention.

Low birth weight (LBW) is a manifestation of undernutrition in newborns and a reflection of intrauterine growth retardation. WHO (1995) defines LBW as weight under 2.5 kg at birth. Causes of LBW include inadequate maternal food intake during pregnancy, cigarette smoking by the mother, short maternal stature, and maternal infection such as malaria.

Body mass index (BMI) is calculated to determine adult nutritional status. BMI compares weight and height and is measured by dividing weight in kilograms by height in meters squared (BMI = weight ÷ height^2). This calculation measures body mass, ranging from thin to obese. BMI is not useful to assess PEM in pregnant or lactating women, whose weight does not reflect their nutritional status. Table 10 shows how BMI is categorized.

Table 10. Body mass index as an indicator of body type

BMI	Interpretation
< 16.0	Thinness grade 3 (severe malnutrition)
16.00–16.99	Thinness grade 2 (moderate malnutrition)
17.00–18.49	Thinness grade 1 (mild malnutrition)
18.50–24.99	Normal nutritional status
25.00–29.99	Overweight grade 1
30.00–39.99	Overweight grade 2 (obesity)
40.00 or above	Overweight grade 3 (severe obesity)

Source: WHO 1995.

Handout 2.4. Body Mass Index Reference Table is a color-coded chart that can be used to identify underweight, normal weight, overweight, and obesity.

Exercise 2. Using BMI as an indicator, determine the body type of a farmer who weights 57 kg and is 1.82 m tall. What is his BMI?

BMI = _____ kg ÷ (_____ x _____) = _____

Body type _____

Now try calculating your own BMI.

Action may be needed if:

- A person loses 6–7 kg unintentionally within 1 month, even if BMI is not calculated.
- Unintended weight loss continues for longer than 2 months, with BMI < 18.5.

Protein energy malnutrition (slide 24)

PEM can be manifested as marasmus, kwashiorkor, or marasmic kwashiorkor.

- **Marasmus** is a severe form of PEM in which a child experiences intensive growth failure. Marasmus occurs when the underweight child deteriorates further, appearing extremely thin and frail with severe muscle wasting. Marasmic children also may have wrinkled skin, drawn-in faces, and a strong appetite or sense of hunger. In addition to the physical signs, a marasmic child has body weight < 6 percent of the median weight for age (Latham 1997).

- **Kwashiorkor** is another severe form of PEM, usually characterized by the build-up of fluids in various body tissues (edema). Like marasmus, kwashiorkor involves growth failure but often no intense wasting. In addition to edema, which is often recognized by a swollen face or limbs, children with kwashiorkor have dry, flaky skin, changes in hair color, consistent diarrhea, loss of appetite, and lethargy. As a result of liver damage, children may have distended bellies and opportunistic infections (OIs). Weight for age of children with kwashiorkor ranges between 60 and 80 percent of the median.

- **Marasmic kwashiorkor** is the most serious form of PEM, combining the severe wasting of marasmus with edema. This form of PEM is characterized by a combination of the clinical features of marasmus and kwashiorkor. Body weight at this stage is < 60 percent of the median weight for age.

Strategies to prevent and control undernutrition (slide 25)

The following actions can help prevent and control undernutrition:

- **Improve household food security.** Lack of consistent access to an adequate supply of a variety of nutritious foods is an underlying cause of undernutrition.

Households must also promote equitable distribution of food, prioritizing vulnerable groups such as children and pregnant and lactating women.

- **Improve maternal nutrition and health care.** Inadequate nourishment and poor health of mothers often result in poor birth outcomes in addition to compromised health and nutrition status of mothers. Improving maternal nutrition and health care is an important strategy to prevent undernutrition in women and LBW in their infants.

- **Promote appropriate child feeding practices.** Exclusive breastfeeding of infants for the first 6 months of life and adding the appropriate amount of nutritious complementary foods after 6 months can reduce the prevalence of undernutrition. Breastfeeding beyond 6 months should be encouraged in most situations. Session 6 provides detailed information on infant and young child feeding in the context of HIV. Efforts should be made to provide a nutritious diet throughout childhood.

- **Provide nutrition rehabilitation.** A well-functioning health facility or community-based system should be in place to identify undernourished children and adults and adequately treat the condition. These programs should provide nutrition assessment and counseling, micronutrient supplementation, and therapeutic feeding, if appropriate. Effective programs require the following:

  - A surveillance system to identify and refer people
  - Procedures and tools to categorize malnutrition (severity and complications)
  - Guidelines for treatment and recovery (particularly for severe acute malnutrition
  - A reliable inventory of appropriate supplies for clients, especially those who are severely malnourished, e.g., micronutrient supplements, F-100 and F-75 therapeutic milks, and ready-to-use therapeutic food (RUTF)
  - Follow-up visits and interventions to prevent relapse

Micronutrient deficiencies

Micronutrient deficiencies include iron deficiency anemia, iodine deficiency, and vitamin A deficiency.

Nutritional anemia (slide 26)

Anemia is a disorder of the blood resulting from low hemoglobin levels in the body. Hemoglobin is an iron-rich protein that plays a critical role in transporting oxygen throughout the body and, when impaired, can keep key organs from functioning properly. In an anemic person, the necessary oxygen is not circulated and used by the body, often leaving the person easily fatigued or weak, with breathing or heart problems and experiencing dizziness or fainting. A person with severe anemia may also have edema.

The people most affected by anemia are premature infants and children under 5. Children are often anemic because they do not consume enough iron, which is needed to form hemoglobin. Women of childbearing age, especially pregnant and lactating women, are especially vulnerable to anemia because of the extra iron demands for the developing fetus.

Anemia is classified as hemorrhagic, hemolytic, hypoplastic/aplastic, and nutritional. Nutritional anemia is the most common, caused by a deficiency of one or more essential nutrients needed to synthesize red blood cells, such as iron, folic acid, and vitamin B_{12}. These deficiencies cause the following types of nutritional anemia:

- Iron deficiency anemia (the most common type)
- Folic acid deficiency anemia
- Vitamin B_{12} deficiency anemia

Detecting anemia

Anemia is diagnosed by measuring the hemoglobin level in the blood. People with hemoglobin levels glow the expected value for their age group are considered anemic. Measuring hemoglobin requires laboratory tests that are rare at community health centers. Nevertheless, it is important to be able to recognize the cutoffs used to diagnose anemia, shown in table 11.

Table 11. Suggested cutoffs for diagnosing anemia using hemoglobin (Hb)

Population group	Hb level (in g/dl) indicating anemia
Children 6 months–5 years old	< 11.0
Children 6–14 years old	< 12.0
Adult males	< 13.0
Adult females (non-pregnant)	< 12.0
Pregnant women	< 11.0

Source: Latham, M. C. 1997. Human Nutrition in the Developing World. FAO Food and Nutrition Series No. 29. Rome: FAO.

Effects of anemia (slide 27)

The main effects of anemia are listed below.

- Reduced work capacity leading to low productivity
- Reduced mental capacity that negatively affects school performance in children
- Reduced immune competence leading to high incidence of disease
- Poor pregnancy outcomes (low birth weight, spontaneous abortion, premature delivery)
- Maternal death during pregnancy (heavy blood loss during delivery puts mothers at risk)

Strategies to prevent and control anemia (slide 28)

The following interventions can help prevent and control anemia:

- Promote consumption of iron- and vitamin-rich foods.
- Prevent and treat anemia-related diseases such as malaria.
- Prevent and treat parasites such as hookworm to prevent anemia in children.
- Provide iron and folic acid supplementation for at-risk groups such as children, pregnant women, and people with sickle cell disease.
- Fortify food with iron and folic acid.

Iron deficiency disorders (slide 29)

Iodine deficiency disorder (IDD) result from inadequate intake or absorption of the mineral iodine. The body needs only a small amount of iodine, only a teaspoon over an entire lifetime, but the lack of even trace amounts of this mineral can have a negative impact on health. People can usually get iodine by eating a variety of foods, but the level of iodine in certain foods can vary depending on the amount of this mineral in the soil, which edible plants absorb as they grow. The absence of iodine in food because of its limited availability in soil is a major cause of iodine deficiency. Highland and mountainous regions tend to have soil with limited iodine. IDD may also result from eating foods that decrease the rate of iodine absorption, such as cassava, turnips, and certain cabbages and kales.

Manifestations of iodine deficiency (slide 30)

The severity and clinical manifestations of IDD often depend on the age when a person is deficient in iodine. The following conditions are the most common:

- **Goiter.** This is an enlarged thyroid gland, the most obvious sign of iodine deficiency. When a person does not get enough iodine, the thyroid gland cannot produce certain enzymes needed for metabolism and growth and becomes overactive, causing swelling around the neck. Goiter may be distinguishable only on close observation or may be so large that the person cannot move the neck. Goiter may begin to develop in adolescence as a result of iodine deficiency in childhood and can also occur as a result of iron deficiency in adulthood.

- **Hypothyroidism.** This condition occurs when iodine deficiency makes the thyroid less productive, causing dry skin, weight gain, puffiness in the face, slow pulse, and lethargy. Hypothyroidism is most common in adults.

- **Hyperthyroidism (Grave's disease).** This condition results from an overactive thyroid because of iron deficiency or other causes and is characterized by a rapid pulse, considerable weight loss, and nervousness, mainly in adults. Hyperthyroidism can be caused by both iodine deficiency and a sudden increase in iodine by iodine-deficient populations.

- **Cretinism.** This condition in infants and children results from inadequate iodine in the mother during pregnancy. Children with cretinism may have severe mental retardation, physical development problems, spastic movements, abnormal physical features, deafness, and mutism (Latham 1997).

Table 12 shows the recommended daily allowance (RDA) for iodine.

Table 12. Recommended daily allowance (RDA) for iodine for males and females

Age	RDA for iodine (µg/day)	
	Male	Female
0–6 months	110	110
7–12 months	130	130
1–3 years	90	90
4–8 years	90	90
9–13 years	120	120
14 years +	150	150
Pregnant women	N/A	220
Lactating women	N/A	290

Source: Institute of Medicine, 2005. Dietary Intakes. Available at http://www.iom.edu.

Strategies to prevent and control iodine deficiency (slide 31)

When iodine is not sufficient in local vegetables, fruits, and grains, food fortification is an effective strategy to reduce IDD. Iodine can be added to basic food products that people use regularly, such as salt, milk, bread, flour, and sugar, to reach a wide group of people. Foods are fortified with iodine, referred to as iodization, during processing. Because iodization is difficult on a small scale, governments should promote and enforce food fortification at the national level for the greatest effectiveness. Other strategies include providing iodine drops and injections, but these interventions are costly and have limited impact across a broad population (FAO 1996).

Vitamin A deficiency (slide 32)

Vitamin A plays an important role in the body's growth, proper functioning of the immune system, reproduction, maintenance of certain body tissues, and especially vision. Vitamin A deficiency (VAD) commonly leads to eye disorders such as blindness and may make children more susceptible to measles and other infections.

VAD may result from low intake of vitamin A-rich foods; inactivation of the vitamin as a result of food processing, preservation, or preparation practices; limited intake of fat and oil, which help absorb vitamin A; gut conditions that affect absorption, such as worms and chronic diarrhea; and poor breastfeeding practices.

Manifestations of VAD (slide 33)

Vitamin A deficiency has the greatest impact on children under 5 and is the leading cause of blindness in this population (Latham 1997). Eye damage is the most common sign of VAD. A person suffering from VAD may first experience night blindness, then visible evidence of eye damage such as Bitot's spots, xerosis, ulcers, and scarring of the cornea. Eventually, without treatment, the cornea collapses and total blindness ensues.

The most obvious sign of VAD is xerophthalmia (the collective term for eye conditions), but less specific manifestations include increased morbidity and mortality, slowed growth and development, higher risk of anemia, and impaired reproductive health (FAO and WHO 1998).

Strategies to prevent and control VAD (slide 34)

The following interventions can help prevent and control vitamin A deficiency:

- Promote consumption of vitamin A-rich foods (fruits, vegetables, dairy products, liver).
- Provide vitamin A supplements to women and children.
- Provide low-dose vitamin A supplements to all pregnant women and children.
- Provide a single dose of 200,000 IU of vitamin A to mothers within 6–8 weeks after delivery.
- Improve child feeding practices.
- Promote feeding colostrum and increasing/prolonging breastfeeding.
- Improve complementary feeding and access to appropriate complementary foods.
- Treat diseases associated with VAD (measles, respiratory tract infections, diarrhea) early.
- Fortify foods with vitamin A.

Table 13 lists the universal preventive vitamin A dosages for children.

Table 13. Universal preventive vitamin A supplementation of children

Age group	Dosage and timing
< 6 months (non-breastfed only)	50,000 IU orally, once
6–< 12 months	100,000 IU orally, once
12 months +	200,000 IU orally, every 4–6 months

Source: USAID. 2006.

National nutrition policies (slide 35)

Many countries have national policies, strategies, and guidelines on nutrition, which are generally based on international guidelines and country-specific issues and context. They help ensure that nutrition actions and services are technically sound and give consistent messages. The content of nutrition training and services should be consistent with national policies and guidelines.

Case studies (slides 36–38)

The case studies below are exercises to give students a practical understanding of the concepts in this session. Answers are found in Appendix 2.

Exercise 3. Food has been in short supply in your area. A mother brings her 3 year-old daughter to the clinic. She is worried because the child has a poor appetite, skin conditions that won't go away, and excessive diarrhea. Her hair has gotten lighter. You notice swelling around the child's ankles. What might she suffer from? What is the appropriate course of action?

Exercise 4. A 28-year-old pregnant woman attending the antenatal clinic complains of shortness of breath, dizziness, a fast heart rate, and extreme fatigue. When asked about the foods she has been eating, she says she's had little access to meat and fish since her pregnancy. What nutrition deficiency might she be suffering from? What action would you recommend?

Exercise 5. You and another nurse are community health workers making rounds to households to assess the general health of children under five. You notice that most children seem small or thin for their age and decide to assess weight for age and height for age using a hanging scale and height board. In the first household, a 24-month-old boy weighs 13 kg and is 80 cm tall. Using the growth charts in the Appendix, assess this

Conclusions (slide 39)

As discussed, good nutrition is essential for health and well-being. Every day the body needs the appropriate amount of each of the essential nutrients, including carbohydrates, proteins, lipids, vitamins, minerals, and water. These nutrients provide the body with energy and may be obtained through a balanced diet consisting of a variety of foods. Children and pregnant women often have increased energy needs.

Maintaining a proper diet is an important component in preventing overnutrition or undernutrition. A person who does not receive a sufficient amount of the essential nutrients or receives an excess of food may be at risk of developing nutrition-related illnesses such as protein energy malnutrition, obesity, and various vitamin deficiency-related illnesses. Strategies to prevent nutrition-related illnesses include promoting an adequate diet using locally available foods, fortifying commonly used food products, providing vitamin and mineral supplementations, and improving food security.

References

Food and Agriculture Organization of the United Nations (FAO). 1998. Carbohydrates in Human Nutrition. FAO Food and Nutrition Paper 66. Report of Joint FAO/WHO Expert Consultation. Rome.

_____.1996. Food Fortification: Technology and Quality Control. FAO Food and Nutrition Paper 60. Rome.

FAO and World Health Organization (WHO). 1998. Human Vitamin and Mineral Requirements. Report of a Joint FAO/WHO Expert Consultation. Rome: FAO.

FAO, WHO, and United Nations University (UNU). 1985. Energy and Protein Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. WHO Technical Report Series No. 724. Geneva.

_____. 2004. Human Energy Requirements. Report of Joint FAO/WHO/UNU Joint Expert Consultation Rome, 17–24 October 2001. FAO Food and Nutrition Technical Paper Series No.1. Rome.

Ireton-Jones, C. S., and W. W. Turner. 1991. Actual or Ideal Body Weight: Which Should Be Used to Predict Energy Expenditure? *Journal of the American Dietetic Association* 91 (2):193–5.

Latham, M. C. 1997. Human Nutrition in the Developing World. FAO Food and Nutrition Series No.29. Rome: FAO.

United Nations Children's Fund (UNICEF). 2004. State of the World's Children 2005. Geneva.

Rice, A. L, L. Sacco, A. Hyder, and R. E. Black. 2000. Malnutrition is an Underlying Cause of Childhood Deaths Associated with Infectious Diseases in Developing Countries. *Bulletin of the World Health Organization* 78:1207–1221.

U.S. Agency for International Development (USAID). 2006. PVO Child Survival and Health Grant Program Technical Reference Materials: Nutrition. Washington, DC.

World Health Organization (WHO). 1995. Physical Status: The Use and Interpretation of Anthropometry. WHO Technical Report Series No. 854. Geneva.

Handout 2.1. Macronutrient and Micronutrient Food Sources, Functions, and Manifestations of Deficiencies

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
Macronutrients			
Carbohydrates	Cereals: Maize, millet, wheat, and barley Tubers: Sorghum, cassava, potatoes, sweet potatoes, yams Bread, rice, green bananas, plantains, and fruits	Energy production Source of fiber essential for digestion and prevention of some diseases	Protein-energy malnutrition (marasmus, kwashiorkor) Constipation from inadequate fiber intake
Protein	Animal protein: Beef, game, pork, lamb, goat, fish, poultry, edible insects, milk and milk products, eggs Plant protein: Beans, lentils, dried peas, soybeans, chickpeas, groundnuts, peanuts, other nuts	Building and repairing cells Fighting infection Component of enzymes and hormones Producing energy	Protein-energy malnutrition (marasmus, kwashiorkor) Poor wound healing Impaired immune function Easily plucked hair
Fats	Animal fats: Meat, poultry (with skin), lard Vegetable oils: Margarine, butter, whole milk, cream, avocados, groundnuts, and other nuts	Provide energy and fatty acids Help digestion Source of fat-soluble vitamins A, D, E, and K	Marasmus (wasting) Dry and scaly skin Poor wound healing
Micronutrients (vitamins)			
Vitamin A	Liver, eggs, butter, breastmilk, full-cream milk (when fortified), cheese Pigmented vegetables: Carrots, pumpkin, yellow maize, yellow sweet potatoes Pigmented fruits: Paw paws, mangos, etc. Green leafy vegetables cassava leaves, sweet potato leaves, turnips, red palm oil	Vision Maintenance of epithelial tissue Mucous secretion Growth of bones and teeth Reproduction Immunity	Eye problems (blindness, Bitot's spots) Dry and scaly skin and dry hair Vulnerability to infection Male sterility

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
Vitamin D	Produced by the action of the sun on the skin Wheat germ, fish, liver, egg yolks, organ meats, cheese, milk (breastmilk; milk may need to be fortified with vitamin D), butter, margarine, mayonnaise	Facilitates calcium and phosphorus absorption, utilization, and maintenance (hence formation of bones and teeth)	Rickets (children) Osteomalacia (adults)
Vitamin E	Vegetable oils Whole grain cereals	Antioxidant Reproductive functions Contribution to hemoglobin synthesis	Leg cramps Muscle weakness Nerve problems Hearing problems
Vitamin K	Synthesized by plants (vitamin K_1, or phylloquinone) Synthesized by bacteria in the intestines (vitamin K_2, of menaquinone)	Blood coagulation (helps synthesize prothrombin, necessary for blood clotting)	Long time to stop bleeding
Vitamin B_1 (thiamine)	Whole grain cereals such as roasted and cooked maize, pulses Green vegetables such as green peas and fruits, meat, milk, fish, oil seed, yeast	Energy production Appetite promotion Support of the central nervous system	Beriberi (enlargement of nerves, weight loss due to loss of appetite, edema, disturbances in heart function) Lack of energy Lesions in nervous tissues
Vitamin B_6 (riboflavin)	Animal products: Milk, meat, liver, fish, eggs, cheese Vegetable products: Green leafy vegetables Cereal grains and pulses, yeast	Use in metabolism of carbohydrates, fats, and proteins to release energy Helps synthesize corticosteroids and produce red blood cells	Cracked mouth corners and lips Sore and burning lips, mouth, and tongue Rough skin
Vitamin B_3 (niacin)	Meat (especially liver, pork), poultry Groundnuts, beans, peas, other pulses Cereal grains (not readily available in maize and sorghum, but maize can be treated with alkalis such as limewater to make the niacin more available)	Energy production Healthy skin Carbohydrate, fat, and protein metabolism	Pellagra (darkening of the skin exposed to the sun, scaly skin, diarrhea) Dementia (memory loss) Red and sore tongue I some cases

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
	Yeast Any protein-rich food helps form niacin.		
Vitamin B_6 (pyroxidine)	Animal sources: Meat, liver, pork, fish, milk Vegetable and fruit sources: Spinach, turnips, broccoli, bananas, oranges, watermelon Yeast	Protein and fat metabolism Conversion of glycogen in the liver and muscle tissue to glucose (hence energy production and maintenance of blood glucose level) involved in reactions necessary to form hemoglobin	Dermatitis Microcrytic anemia Glossitis (inflammation of the tongue) Chelosis (dry scaling of the lips and mouth corners) Convulsions Medical conditions and drugs such as Chloramphenicol and Isoniazid affect B_6 metabolism and can lead to deficiency
Vitamin B_{12} (cobalamin)	Meat, fish, poultry, cheese, eggs, milk, liver NB. Cobalamin is synthesized by bacteria in plants (e.g., in the nodules of some legumes) and animals.	Involved in synthesis of red and white blood cells Maintenance of nerves and digestive tissues Carbohydrate metabolism	Macrocytic anemia Stomatitis (sores on mouth corners) Glossitis Nerve problems Unsteady gait Delusions Decreased white blood cell count
Vitamin C (ascorbic acid)	Fruits: Citrus fruits (oranges, grapefruit, lemons, tangerines, limes), berries, paw paws, mangos, melons, guavas, tomatoes, bananas Green vegetables : Spinach, cabbage, broccoli, green peppers Cauliflowers, potatoes (with skin), plantains, young maize, sprouted cereals and pulses Animal foods: Liver, milk NB. Substantial vitamin C can be lost during food processing, preservation, and preparation.	Helps the body use calcium and other nutrients to build bones and the walls of blood vessels Helps form collagen, which is important for connective tissues Increases absorption of iron from foods Increases resistance to infection Antioxidant Protein metabolism	Scurvy (bleeding gums, dry skin, dry mouth, impaired wound healing) Gingivitis (bleeding, sore, and inflamed gums) Stomatitis (sores on the corners of the mouth) Anemia

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
Folic acid	Animal foods: Liver, eggs, poultry, meat Green leafy vegetables: Spinach, kale, legumes Oranges, whole grain cereals, nuts	Involved in synthesis of red blood cells Maintenance of the nervous system Metabolism of amino acids	Macrocytic anemia Glossitis Stomatitis Diarrhea Neural tube defects
Micronutrients (minerals)			
Iron	Red meat, liver, fish, poultry, shellfish Eggs, legumes, vegetables, fruits NB. Phytates in cereals and vegetables and tannins in tea and coffee decrease iron absorption. Iron in food boiled in water is leached and lost if the water is discarded.	Oxygen transportation Needed by enzymes Absorption of vitamin C Energy production	Macrocytic anemia Fatigue Pallor Glossitis Irritability Dizziness Decreased mental alertness
Iodine	Seafood,, seaweed, iodized salt NB. Iodine content depends on the soil, animal feed, etc.	Development and proper functioning of the brain and nervous system Important for normal growth and development, protein synthesis, energy metabolism, and reproduction	Goiter (swelling on the neck) Hypothyroidism Cretinism Impaired brain function Dwarfism (gross stunting)
Zinc	Animal sources; Meat, liver, fish, poultry, eggs, milk, yoghurt, seafood including shellfish and oysters Plant sources: Cabbage, carrots, spinach, beets, green peas, legumes, whole grain cereals, peanuts, barley	Protects the immune system Needed for digestion Enzyme formation Wound healing Vitamin A metabolism Normal development of male organs Antioxidant Component of insulin	Slow growth Loss of smell and taste Loss of appetite Diarrhea Poor wound healing Skin problems
Calcium	Milk, yoghurt, cheese, green leafy vegetables such as broccoli, legumes, peas, fish with bones that are eaten	Strong bones and teeth Normal functioning of the heart Helps in blood clotting Helps maintain normal blood pressure	Delayed blood clotting Weak, breakable bones (osteoporosis) Osteomalcia Teeth problems Low resistance to infection Stunting

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
Copper	Nuts, shellfish, liver, kidneys, raisins, legumes NB. Copper content of foods is reduced by milling, grinding, and cooking in water and is affected by environmental factors such as type of fertilizer	Copper-containing enzymes play a role in energy metabolism and fatty acid metabolism. Influences iron absorption and mobilization	Mental deterioration Hypothermia Hair depigmentation Microcrytic anemia (indistinguishable from iron deficiency anemia) affecting infants and people with severe protein energy malnutrition
Selenium	Brown rice, nuts, whole grains Mushrooms, UNBOILED asparagus, onions, garlic, egg yolks, milk, meat, seafood	Prevents oxidation and breakdown of fat and other body cells Antioxidant Helps in treatment of children with kwashiorkor	Weakness Pancreatitis (blockage of the pancreatic ducts) Impaired growth Impaired hearing Faster HIV disease progression and reduced survival Impaired immune system
Magnesium	Legumes, avocados, green leafy vegetables (okra, broccoli), cucumber skin, nuts, seeds, whole grain cereals Seafood, dairy products, meat, poultry	Muscle and nerve function Synthesis of proteins and fats Strong bones and teeth	Muscle spasms Cramps Tremors Seizures Coma NB. Excessive loss of magnesium resulting from diarrhea and severe PEM leads to weakness, mental changes, and occasionally convulsions.
Fluoride	Fish and seaweed Bone meal, meat, and dairy products Grains, vegetables, and nuts	Protection of bone and dental tissues Protection against tooth decay (caries) Wound healing	Dental caries
Phosphorus	Milk and milk products Legumes	All energy-producing reactions Calcium metabolism	Weakness Cardiac failure Glucose intolerance Decreased red blood cell function

Nutrient	Food sources	Function	Deficiency, signs, and symptoms
Sodium	Table salt, canned soups	Primary regulator of fluid in the body Maintenance of blood pressure	Dehydration
Potassium	Bananas, avocados, oranges, mangoes, papayas Legumes, spinach, cabbage, carrots, tomatoes, potatoes, yams Milk, meat, chicken, pork, fish	Nervous system functioning Muscle contraction Maintenance of blood pressure	Muscle weakness Tetany Cardiac problems Hypotension (low blood pressure)

Handout 2.2 Nutrition Calculations

Basal metabolic rate (BMR) and activity factors

Equations for estimating BMR from body weight

Age (years)	kcal/day
Males	
18–30	15.1 x weight (kg) + 692
30–60	11.5 x weight (kg) + 873
> 60	11.7 x weight (kg) + 588
Females	
18–30	14.7 x weight (kg) + 496
30–60	8.7 x weight (kg) + 829
> 60	10.5 x weight (kg) + 596

Activity

	Light	Moderate	Heavy
Male	1.55	1.78	2.10
Female	1.56	1.64	1.82

Energy requirements of children > 12 months old

Average daily energy requirements for children 1−18 years old

Age (years)	Energy requirement (kcal/day)	
	Girls	Boys
1–2	865	948
2–3	1,047	1,129
3–4	1,156	1,252
4–5	1,241	1,360
5–6	1,330	1,467
6–7	1,428	1,573
7–8	1,554	1,692
8–9	1,698	1,830
9–10	1,854	1,978
10–11	2,006	2,150
11–12	2,149	2,341
12–13	2,276	2,548
13–14	2,379	2,770
14–15	2,449	2,990
15–16	2,491	3,178
16–17	2,503	3,322
17–18	2,503	3,410

Additional energy requirements for pregnant and lactating women

Additional daily energy requirements for pregnant women

Full activity	285 kcal/day
Reduced activity	200 kcal/day

Additional daily energy requirements for lactating women

First 6 months	500 kcal/day
Second 6 months	500 kcal/day

Additional energy requirements for infants

Average daily energy requirements for infants

Age (months)	Energy requirement (kcal/day)	
	Girls	Boys
0–1	464	518
1–2	517	570
2–3	550	596
3–4	537	569
4–5	571	608
5–6	599	639
6–7	604	653
7–8	629	680
8–9	652	702
9–10	676	731
10–11	694	752
11–12	712	775

Average daily energy requirements for children 1–18 years old

Age (years)	Energy requirement (kcal/day)	
	Girls	Boys
1–2	865	948
2–3	1,047	1129
3–4	1,156	1,252
4–5	1,241	1,360
5–6	1,330	1,467
6–7	1,428	1,573
7–8	1,554	1,692
8–9	1,698	1,830
9–10	1,854	1,978
10–11	2,006	2,150
11–12	2,149	2,341
12–13	2,276	2,548
13–14	2,379	2,770
14–15	2,449	2,990
15–16	2,491	3,178
16–17	2,503	3,322
17–18	2,503	3,410

Protein requirements for adults and children

Safe adult protein intake requirements

	Safe protein intake level (g/kg)
Average adult	**0.75**
Pregnant woman	**0.75 + 6 grams/day**
Lactating woman:	
At 6 months	0.75 + 16 grams/day
At 6−12 months	0.75 + 12 grams/day
At 12 + months	0.75 + 11 grams/day

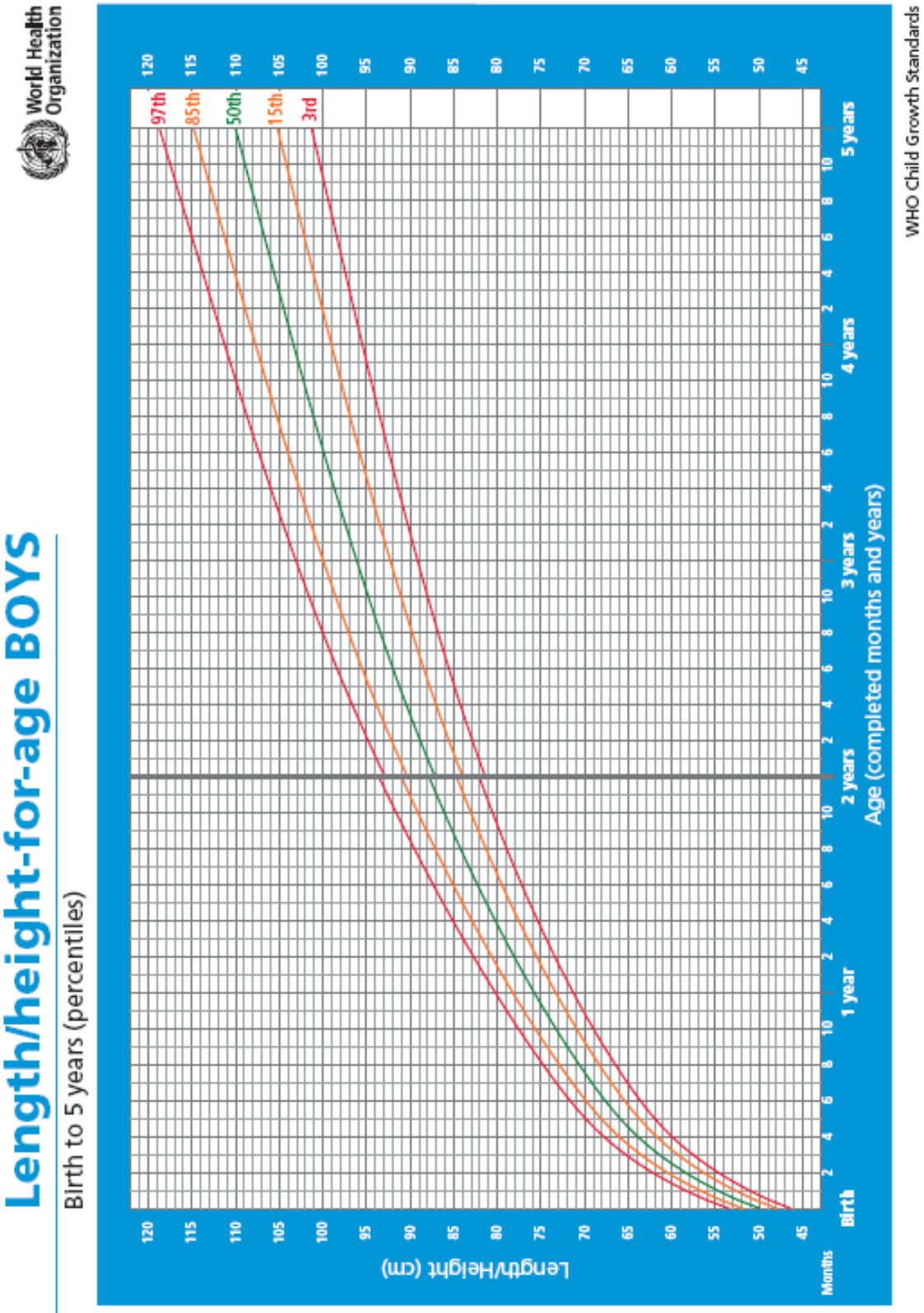
Safe child protein intake requirements by age

Age (years)	Safe protein intake level (g/kg)	
	Girls and boys combined	
1–2	1.20	
2–3	1.15	
3–5	1.10	
5–7	1.00	
7–10	1.00	
	Girls	Boys
10–12	1.00	1.00
12–14	0.95	1.00
14–16	0.90	0.95
16–18	0.80	0.90

Equation for calculating body mass index (BMI)

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

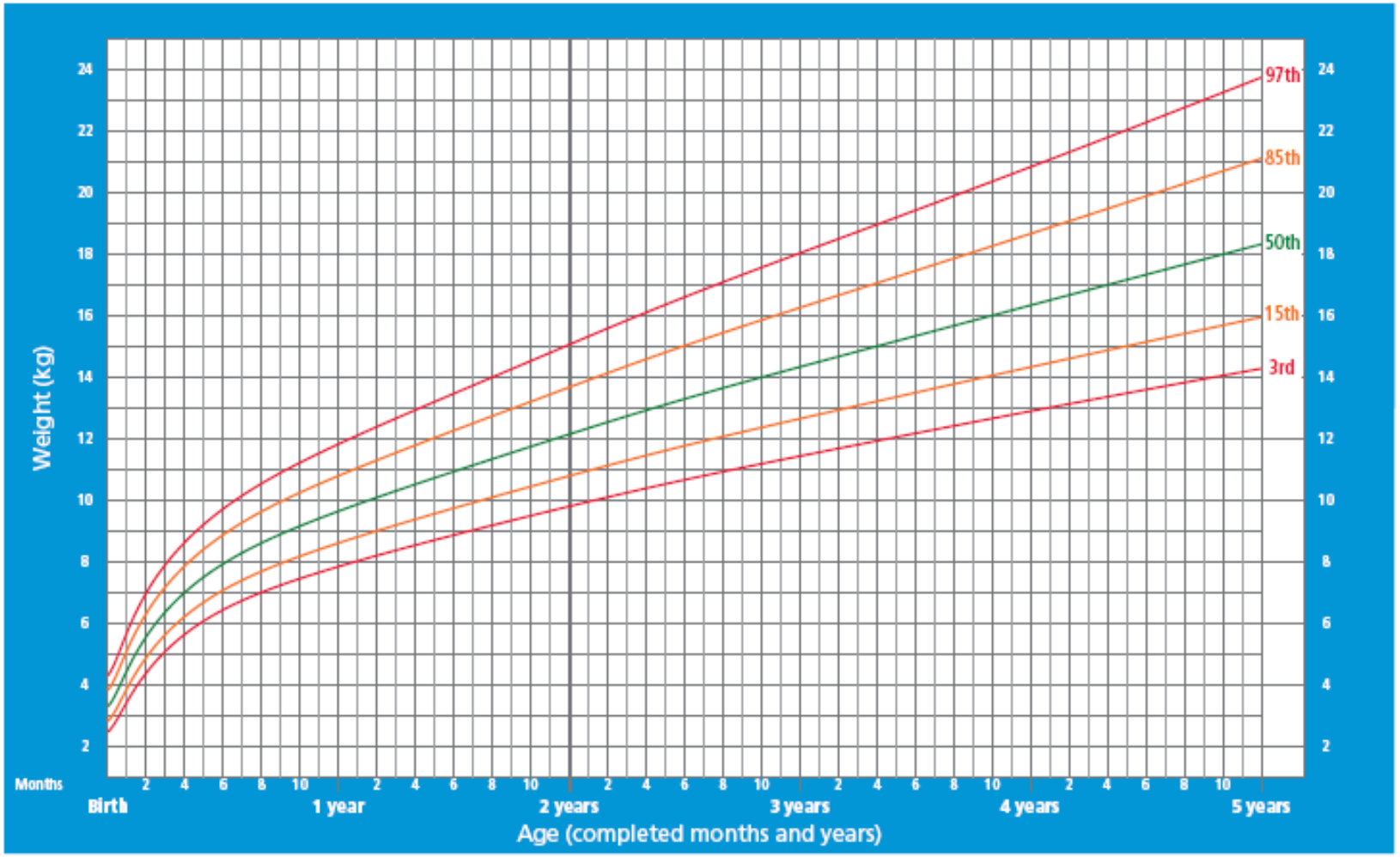
Handout 2.3. Length/Height for Age and Weight for Age



Weight-for-age BOYS

Birth to 5 years (percentiles)

World Health Organization

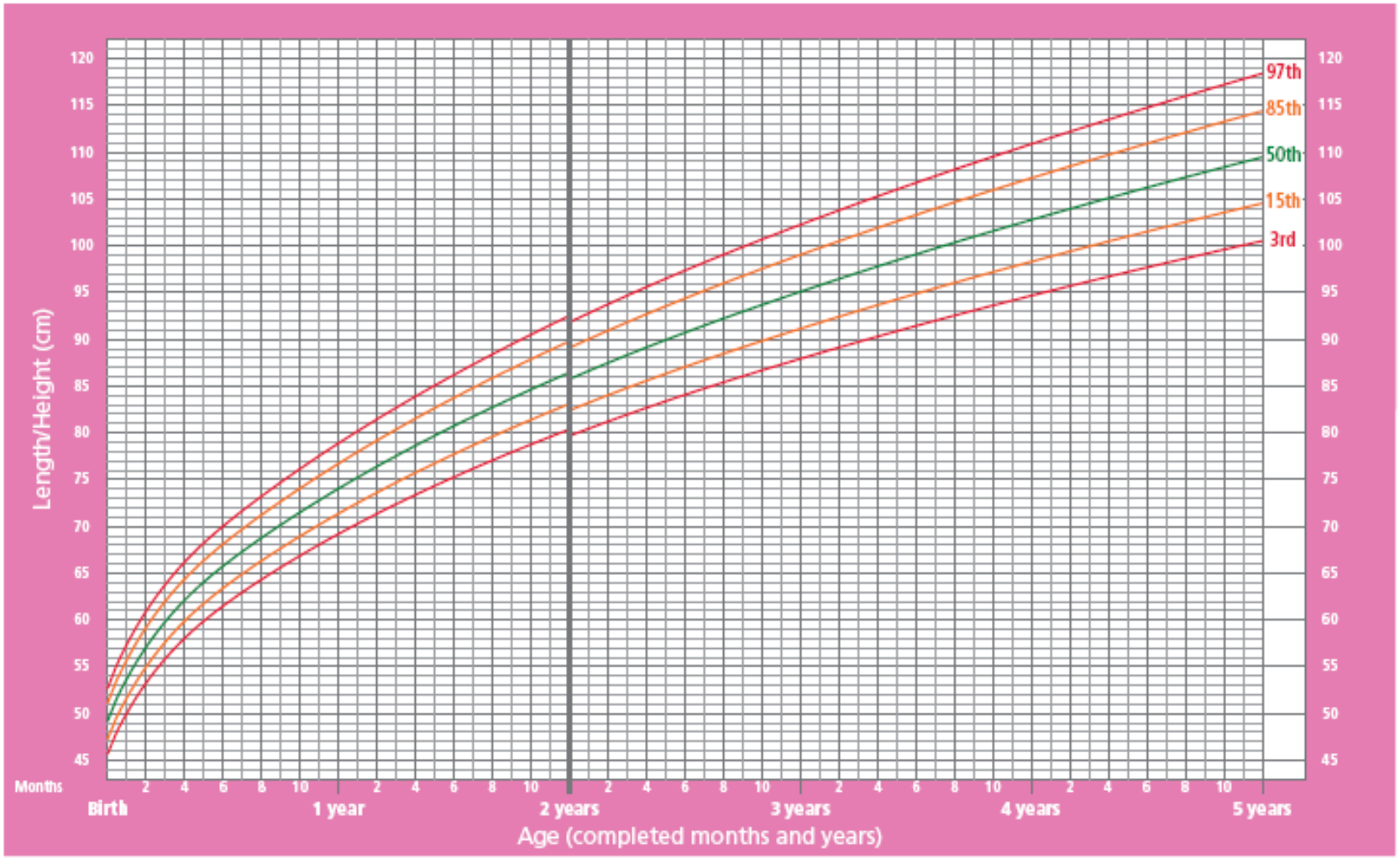


WHO Child Growth Standards

Length/height-for-age GIRLS

World Health Organization

Birth to 5 years (percentiles)

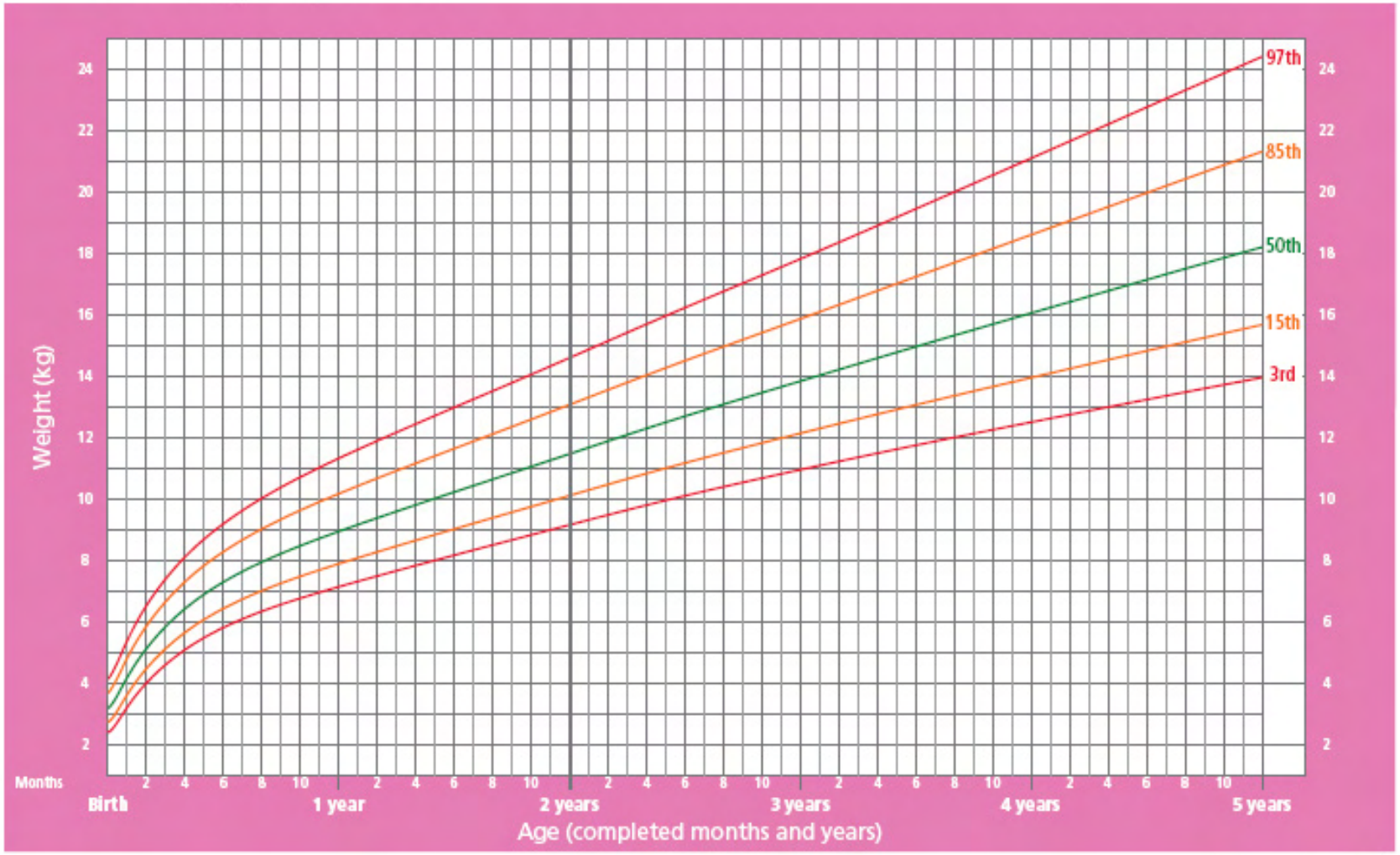


WHO Child Growth Standards

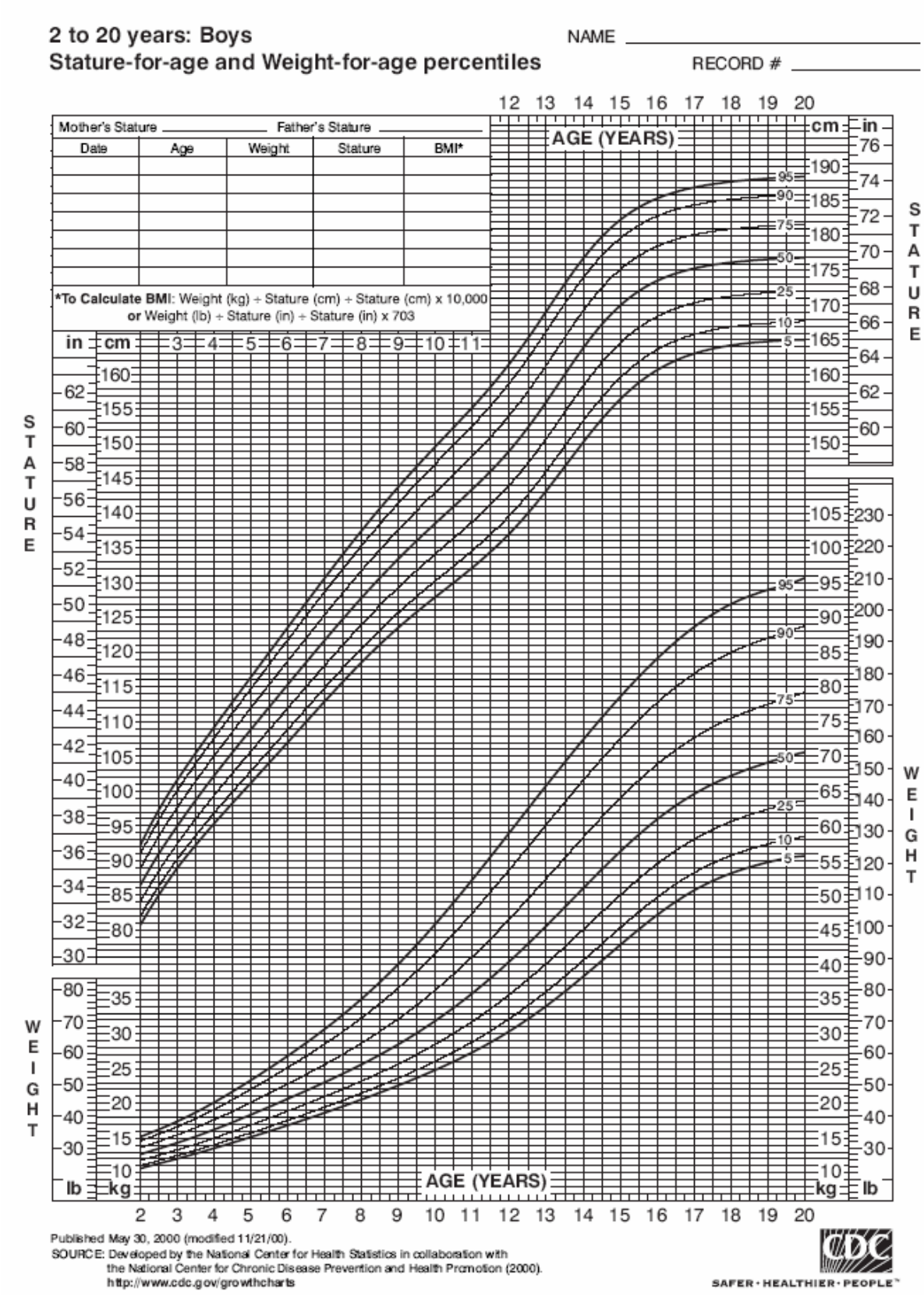
Weight-for-age GIRLS

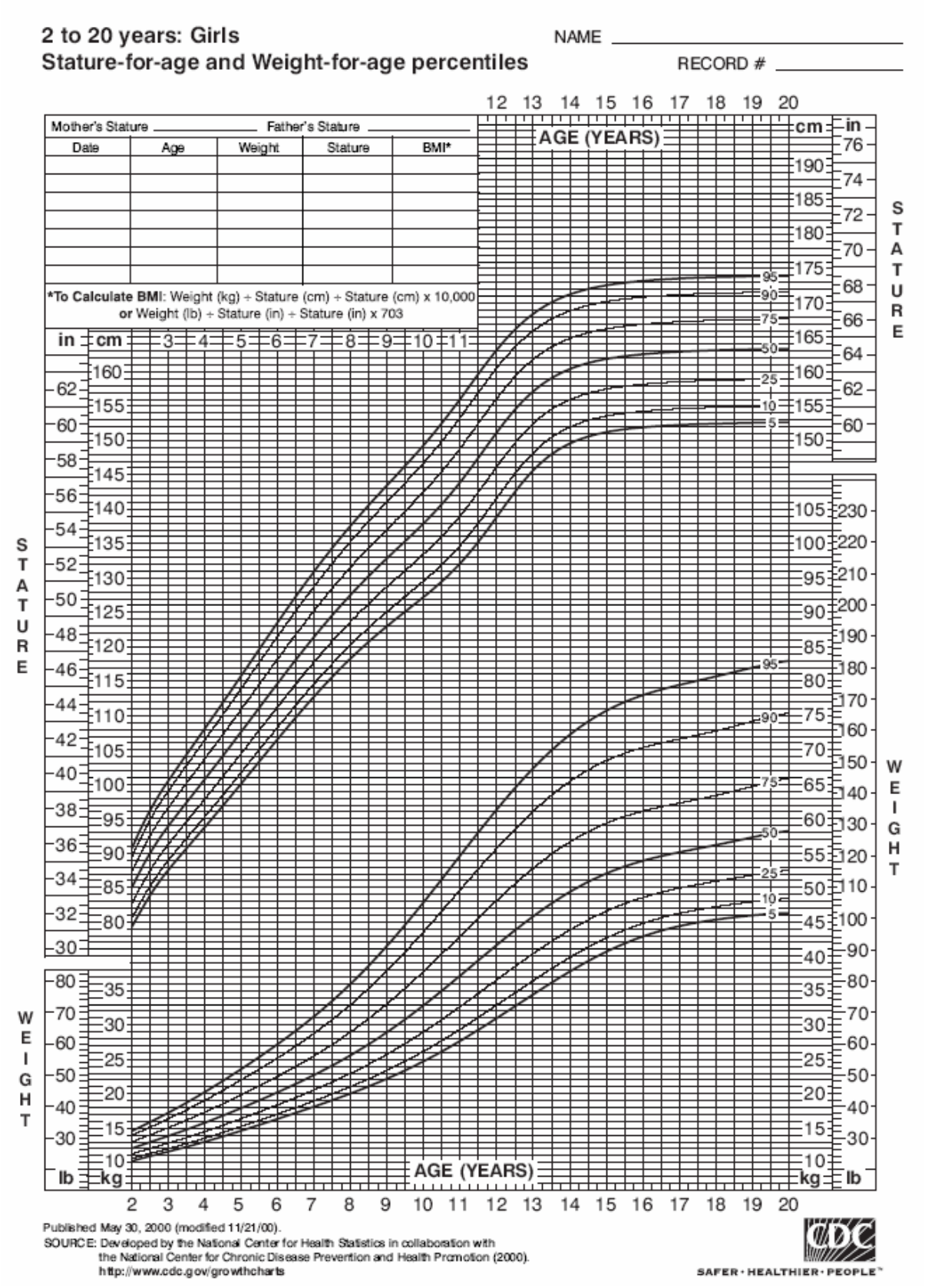
World Health Organization

Birth to 5 years (percentiles)

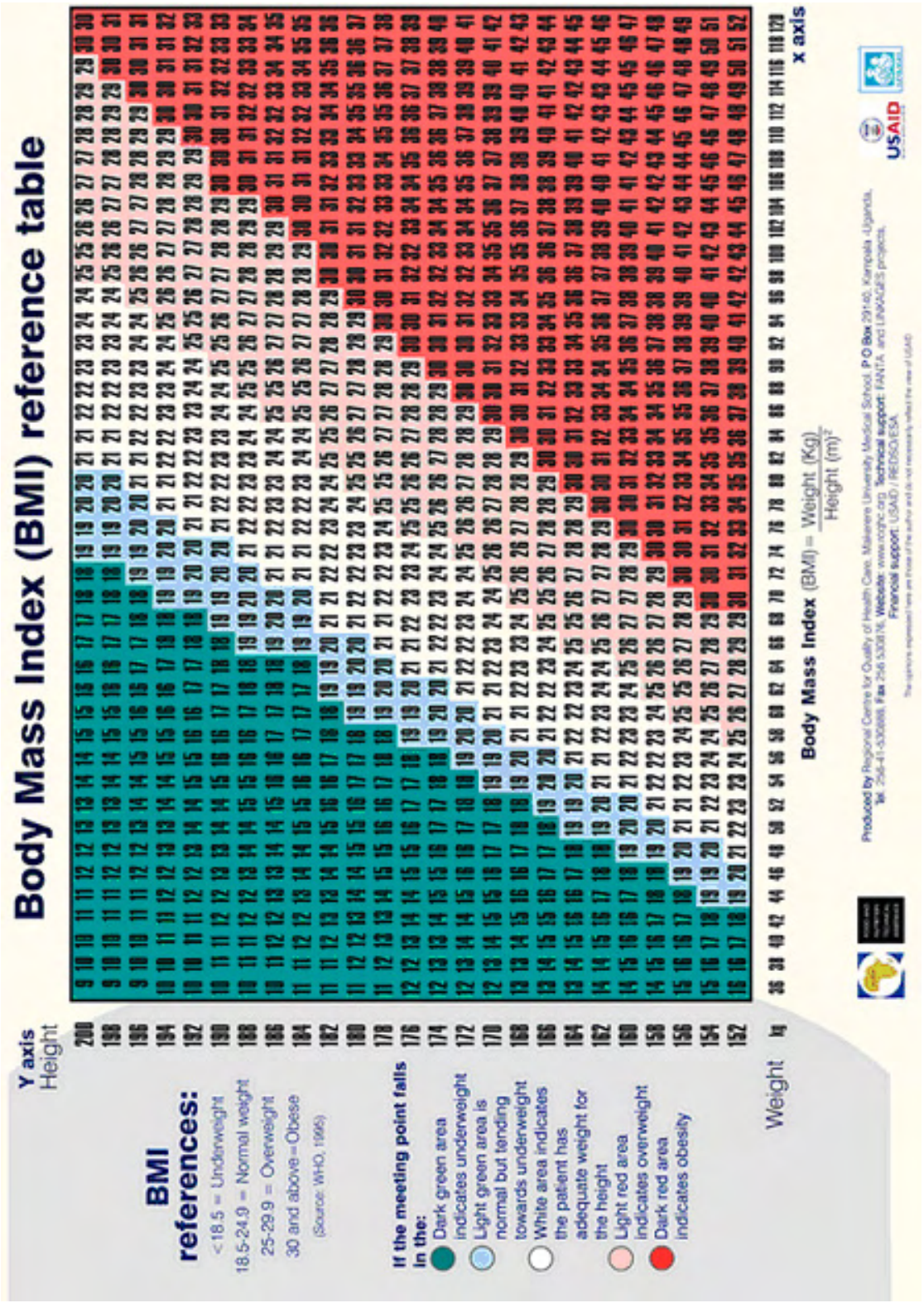


WHO Child Growth Standards


2 to 20 years: Boys
Stature-for-age and Weight-for-age percentiles
NAME
RECORD #
Mother's Stature
Father's Stature
Date
Age
Weight
Stature
BMI*
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
AGE (YEARS)
STATURE
WEIGHT
95
90
75
50
25
10
5
Published May 30, 2000 (modified 11/21/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts
SAFER · HEALTHIER · PEOPLE™


2 to 20 years: Girls
Stature-for-age and Weight-for-age percentiles
NAME
RECORD #
Mother's Stature
Father's Stature
Date
Age
Weight
Stature
BMI*
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
AGE (YEARS)
STATURE
WEIGHT
95
90
75
50
25
10
5
Published May 30, 2000 (modified 11/21/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts
SAFER · HEALTHIER · PEOPLE™

Handout 2.4. Body Mass Index Reference Table



Appendix 1. Answers to Exercises

Exercise 1

BMR = 1,275 kcal/day (14.7 x 23 kg + 496)
Total kcal/day = 2,091 (1,275 x 1.64)

Exercise 2

BMI = 17.2 (57 kg ÷ 1.822)
Body type = Thinness grade 1 (mild undernutrition)

Exercise 3

Protein energy malnutrition manifested as kwashiorkor. The child should be admitted to a treatment center or hospital immediately for rehydration and special food formulas to help her recover. Once she is admitted from the recovery facility, health staff should follow up with the child and engage community leaders in ensuring that households have adequate access to food energy sources.

Exercise 4

Anemia. Because of the potential risk to the fetus and the possibility of complications with childbirth, the mother should be given iron supplementation and encouraged to eat more fresh fruits and vegetables and animal products high in iron.

Exercise 5

According to the growth charts, the child is below the 5^{th} percentile for height, suggesting that he may be stunted and suffering from chronic undernutrition. However, he is at the 50^{th} percentile for weight, suggesting he is of average weight for age.

Session Two: Basics of Nutrition

Purpose

Provide basic nutrition information, including food sources of nutrients, roles of nutrients in the body, and disorders associated with inadequate nutrition.

2

Learning Objectives

- Understand the importance of good nutrition.
- Identify food sources of nutrients.
- Describe the roles of nutrients in the body.
- Understand the causes and consequences of undernutrition.
- Describe strategies to combat undernutrition.

3

Session Outline

- Good nutrition
- Essential nutrients and food sources
- Role of nutrients in the body
- Nutrient requirements
- Measuring nutritional status
- Causes and consequences of undernutrition
- Strategies to combat undernutrition
- National nutrition guidelines, policies, and strategies

4

Good Nutrition

- Consuming food and nutrients and using them to function healthily
- Both cause and result of good or poor health
- Not the same as “food” and “nutrients”
- Food = products eaten or taken into the body that contain nutrients for
  - Development, growth, and maintenance of tissues and cells
  - Resisting and fighting infection
  - Producing energy, warmth, and movement
  - Carrying out the body’s chemical functions

5

Essential Nutrients

- Macronutrients
  - Carbohydrates
  - Fats (lipids)
  - Proteins
- Micronutrients
  - Vitamins
  - Minerals
- Water

6

Macronutrients: Carbohydrates

- Energy-giving foods composed of sugars
- Common staple eaten regularly, accounting for up to 80% of the diet in developing countries
- Quickly absorbed by the body
- Sources
  - Cereals (e.g., millet, sorghum, maize, rice)
  - Root crops (e.g., cassava, potatoes)
  - Starchy fruits (e.g., bananas)

7

Macronutrients: Fats and Oils (Lipids)

- Energy-giving foods
- Not produced by the body
- Absorbed more slowly than carbohydrates
- Account for small part of diet in developing countries
- Fats (solids): Butter, ghee, lard, margarine
- Oils (liquids): Corn oil, soybean oil, peanut oil

8

Macronutrients: Proteins

- Body-building foods
- Form main structural components of cells
- Help produce and maintain tissues and muscles
- Sources
  - Plants (e.g., beans, nuts, chickpeas)
  - Animals (meat, poultry, fish, dairy products, insects)

9

Micronutrients: Vitamins

- Organic compounds mostly from outside the body
- Do not provide energy
- Fat soluble: Dissolve in lipids, can be stored, not needed daily (e.g., vitamins A, D, E, K)
- Water soluble: Dissolve in water, absorbed into bloodstream immediately, needed daily
- Sources
  - Fruits
  - Dark leafy vegetables
  - Animal foods

10

Micronutrients: Minerals

- Inorganic compounds not synthesized by the body
- Needed in very small quantities but possibly essential
- Important for biochemical processes and formation of cells and tissues
- Sources
  - Plants
  - Animal products

11

Water

- Main component of the body (60 percent of body mass)
- Needed for digestion, absorption, and other body functions
- Regularly lost through sweating, excretion, and breathing
- Approximately 1,000 ml (4−8 cups) needed each day

12

Essential Nutrient Food Products

- What local foods are rich in these essential nutrients?
  - Proteins
  - Carbohydrates
  - Fats and oils
  - Vitamins (water soluble and fat soluble)
  - Minerals (including iodine and iron)

13

Energy Requirements

- Amounts needed to maintain health, growth, and appropriate physical activity
- Vary according to age, gender, and activity
- Met through an age-appropriate balanced diet
- Based on
  - Basal metabolism: Energy needed for basic body functions
  - Metabolic response to food: Energy needed to digest, absorb, and utilize food
  - Physical activity: Work, rest, and play
  - Physiology: Pregnancy, lactation, and maturation increase energy needs

14

Energy Requirements of Adults > 19 Years Old

- Basal metabolic rate (BMR) = Number of kilocalories (kcal) needed each day
- Energy needs = BMR x activity factor
- Additional energy needed by pregnant and lactating women

15

Energy Requirements of Children and Adolescents < 18

- Calculated based on age, physical activity, and energy needs for growth
- Increase after age 10 to support changing body composition and growth
- Kcals required per day (FAO, WHO, UNU 2004)
  - Boys 1−18 years old: 948−3,410
  - Girls 1−18 years old: 865−2,503

16

Energy Requirements of Infants 0−12 Months Old

- Mainly for growth
- Vary by age and gender
- All energy and nutrient needs met by breastmilk for the first 6 months of life

17

Protein Requirements

- Needed daily to replenish continuous depletion
- May vary by age, health status, physiological status, and occupation
  - Higher for pregnant and lactating women
  - Fluctuate in children based on weight, age, and gender

18

Undernutrition

- The manifestation of inadequate nutrition
- Common in sub-Saharan Africa
  - 1/3 of all children < 5 years old underweight
  - 38% of children with low height for age
- Many causes
  - Inadequate access to food/nutrients
  - Improper care of mothers and children
  - Limited health services
  - Unhealthy environment

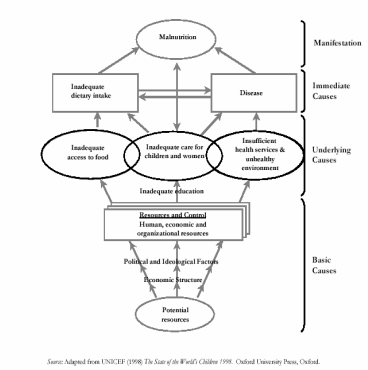
19

Conditions Associated with Under- and Overnutrition

- Vitamin deficiency disorders
  - Scurvy (deficiency of vitamin C)
  - Rickets (deficiency of vitamin D)
  - Mental, adrenal disorders (deficiency of B vitamins)
- Mineral deficiency
  - Osteoporosis (deficiency of calcium)
- Diet-related non-communicable diseases
  - Diabetes
  - Coronary heart disease
  - Obesity
  - High blood pressure

20

Causes of Undernutrition



Source: Adapted from UNICEF (1998) *The State of the World's Children 1998*. Oxford University Press, Oxford.

21

Nutritional Status Determined by Anthropometry

- Underweight: Low weight for age compared to reference standard, a composite measure of stunting and wasting
- Stunting: Low height for age compared to reference standard, an indicator of chronic or past growth failure
- Wasting: Low weight for height, an indicator of short-term nutritional stress

22

Other Anthropometric Measurements

- MUAC (mid-upper arm circumference)
- BMI (body mass index): Compares height and weight

  BMI = Weight (kg) ÷ height $(m)^2$

23

Manifestations of Protein-Energy Malnutrition (PEM)

- Marasmus: Severe growth failure
  - Weight < 60% weight for age
  - Frailty, thinness, wrinkled skin, drawn-in face, possible extreme hunger
- Kwashiorkor: Severe PEM
  - Weight 60−80% weight for age
  - Swelling (edema), dry flaky skin, changes in skin and hair, appetite loss, lethargy
- Marasmic kwashiorkor: Most serious form of PEM, combining both conditions above
  - Weight < 60% weight for age

24

Strategies to Prevent and Control Undernutrition

- Improve household food security.
- Improve diversity of diet.
- Improve maternal nutrition and health care.
- Improve child feeding practices.
- Ensure child health care (immunization, medical care, growth monitoring).
- Provide nutrition rehabilitation.

25

Nutritional Anemia

- Most common type of anemia
- Caused by malaria, hookworm, and inadequate iron and vitamin intake resulting in low hemoglobin levels
- Affects mainly children < 5 years old and pregnant women
- Detected by measuring blood hemoglobin levels

26

Effects of Anemia

- Adults
  - Reduced work capacity
  - Reduced mental capacity
  - Reduced immune competence
  - Poor pregnancy outcomes
  - Increased risk of maternal death
- Infants and children
  - Reduced cognitive development
  - Reduced immune competence
  - Reduced work capacity

27

Strategies to Prevent and Control Anemia

- Promote iron, folic acid, and B12-rich foods.
- Treat and prevent anemia-related diseases (malaria and worms).
- Provide iron and folic acid supplements to infants and pregnant and lactating women.
- Fortify foods.
- Promote vitamin C-rich foods with meals.
- Discourage drinking coffee or tea with meals.

28

Iodine Deficiency Disorders (IDD)

- Caused by inadequate intake of iodine
- Only 1 tsp. needed over entire lifetime
- Iodine in food sources varies by geography.
  - Less in highlands and mountain regions
  - Leached from soil and carried to lowlands

29

Manifestations of IDD

- Goiter: Enlarged neck region from overactive thyroid gland
- Hypothyroidism: Dry skin, weight gain, puffy face, lethargy from underactive thyroid
- Hyperthyroidism: Rapid pulse and weight loss from overactive thyroid
- Cretinism: Mental retardation, physical development problems, spasticity from IDD in mother during pregnancy

30

Strategies to Control IDD

- Iodize salt, dairy products, and bread where where iodine is deficient in local foods.
- Provide iodine drops.
- Inject people with iodized oil (expensive).

31

Causes of Vitamin A Deficiency (VAD)

- Low consumption of vitamin A-rich foods.
- Dietary deficiency due to food processing
- Limited consumption of fats and oils
- Poor breastfeeding (no colostrum, insufficient breastfeeding)
- Diseases affecting absorption (e.g., worms, chronic diarrhea)

32

Manifestations of VAD

- Xerophthalmia (eye conditions)
  - Blindness (VAD is the leading cause of blindness in children < 5 years old)
  - Bitot's spots
  - Damage to the cornea
- Slowed growth and development
- Reduced reproductive health
- Increased risk of anemia

33

Strategies to Control VAD

- Promote vitamin A-rich foods (fruits, vegetables, red palm oil).
- Give infants and women low-dose iron supplements according to WHO protocols.
- Improve food security.
- Feed children properly.
- Prevent disease and treat disease early.
- Fortify foods.

34

National Nutrition Strategies, Policies, and Guidelines

- General nutrition
- Infant feeding
- Nutrition and HIV
- Food security

35

Case Study 1

- Food has been in short supply in your area. A mother brings her 3 year-old daughter to the clinic. She is worried because the child has a poor appetite, skin conditions that won't go away, and excessive diarrhea. Her hair has gotten lighter. You notice swelling around the child's ankles. What might she suffer from? What is the appropriate course of action?

36

Case Study 2

- A 28-year-old pregnant woman attending the antenatal clinic complains of shortness of breath, dizziness, a fast heart rate, and extreme fatigue. When asked about the foods she has been eating, she says she's had little access to meat and fish since her pregnancy. What nutrition deficiency might she be suffering from? What action would you recommend?

37

Case Study 3

- You and another nurse are community health workers making rounds to households to assess the general health of children under five. You notice that most children seem small or thin for their age and decide to assess weight for age and height for age using a hanging scale and height board. In the first household, a 24-month-old boy weighs 13 kg and is 80 cm tall. Using the growth charts in the Appendix, assess this child.

38

Conclusions

- Good nutrition is essential for health and well-being.
- Daily well-balanced diets should include foods containing essential nutrients and meeting energy requirements.
- Inadequate nutrition can lead to PEM and vitamin and mineral deficiencies (anemia, VAD, IDD).
- Nutrition interventions include improved household food security, food fortification, vitamin and mineral supplementation (for women and children), and improved child feeding.

39