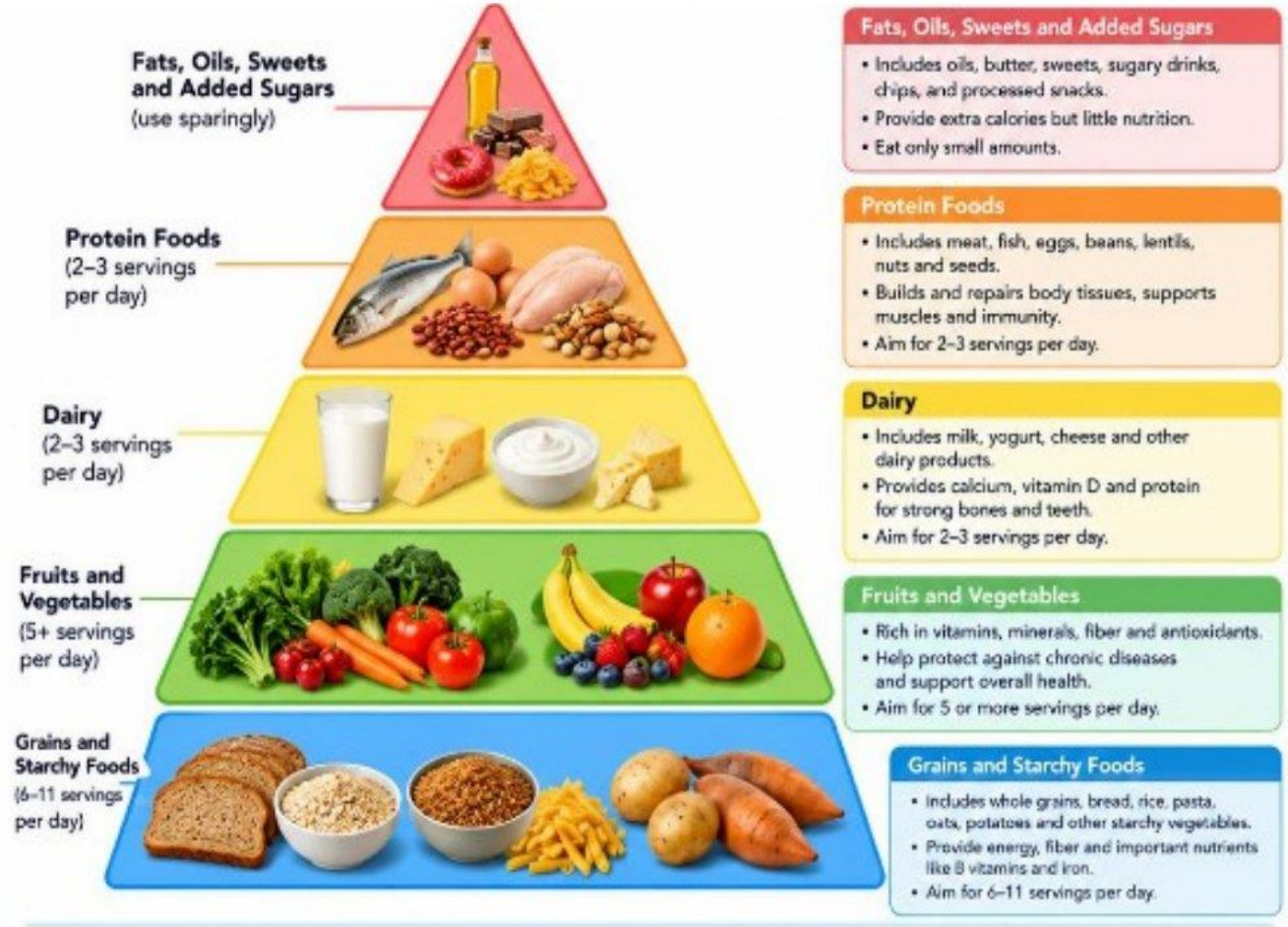
MODULE 6: PUBLIC HEALTH PRIORITY INTERVENTIONS

Unit: Nutrition and Health

COLLEGE OF MEDICINE AND HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH

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Course Outline

01

Introduction:

Definitions and concepts nutrition and health

02

Nutrients and Digestion /Use

03

Energy and Dietary Requirements

04

Nutritional and Dietary Assessment

05

Causes, Determinants and Effects of Malnutrition

06

Nutrition Interventions:

Nutrition-specific vs Nutrition-sensitive

07

Nutritional Surveillance

Course Plan

Mode of lecture: blended (virtual and physical)

Day 1 01/10/2026

Chapter 1

Online class/lecture

Day 2 02/10/2026

Group assignment work

Group work

Days 3 & 4 05–06/10/2026

Chapters 2, 3 and 4

Online class/lecture

Day 5 07/10/2026

Chapters 5, 6 and 7

Physical, in-class lecture

Day 6 08/10/2026

Group assignment work

Group work

Day 7 09/10/2026

Group presentation and discussion

In class

Group Work

1 Maternal and child nutrition programs in Rwanda

Review and analyze national programs: identify and describe them, discuss goals, strategies and target population, analyze effectiveness, and highlight challenges and recommendations.

2 Causes of maternal and child undernutrition

Discuss the causes/determinants of maternal and child undernutrition in Africa and recommend appropriate interventions.

3 Adolescent girls (10–19 years)

Discuss the nutritional status of adolescent girls in Sub-Saharan Africa: assess status and contributing factors, identify programs, and make recommendations.

4 Body composition measurement and its challenges

Discuss the methods used to measure body composition, evaluating their strengths, limitations, and practical challenges, and recommend which approaches are most suitable for research and public health settings in Africa.

5 Review the evidence on how social protection affects nutrition

Using two case studies: Brazil's Bolsa Família and Ethiopia's Productive Safety Net Programme. Summarize and discuss the main findings on nutritional outcomes and the lessons offered.

6 Nutrition transition

Discuss the barriers to healthy eating in Africa within the context of the nutrition transition, and recommend evidence-based strategies to overcome them.

7 Dietary intake and biomarkers

Discuss dietary intake and biomarkers in the Rwandan Population using the 2025 Rwanda Demographic and Health Survey.

Instructions for group assignment

Length

Maximum 25–30 slides and 20-30 minutes presentation including discussions

Presentation

Slides split into equal sections so each group member will present.

Visuals

Using pictures, tables and figures is encouraged.

Added information

Stronger evidence, current statistics and clearer arguments where applicable.

CHAPTER

01

INTRODUCTION

Chapter 1: Learning Objectives

1. Define and distinguish food, nutrition, health, and wellness as related but distinct concepts.
2. Differentiate public health nutrition from community nutrition and from clinical dietetics.
3. Explain the relationship between nutrition and health as well as Describe how nutrition affects health
4. Justify why nutrition is a priority for public health and understand the healthful diet

Food… /Diet

Food: Any substance, solid or liquid, that when consumed provides energy, building material, or regulatory substances for the body.

- Composed of a mixture of nutrients, along with water, fibre, and naturally occurring or added non-nutrient substances (phytochemicals, additives).
- Serves biological, psychological, social, and cultural functions simultaneously — **it is never just fuel**.

Diet: A food containing all the nutrients in a sufficient amount and in proper ratio.
However, people do not eat nutrients, they eat food.

Nutrition

- The science of how the body obtains and uses food for growth, maintenance of tissues, and normal functioning.
- Encompasses ingestion, digestion, absorption, transport, metabolism, and excretion of nutrients.
- Operates at multiple levels: molecular and cellular (biochemistry), whole-body (physiology), and population (public health nutrition).
- Poor nutrition can result from too little, too much, or an imbalance of nutrients — all three are forms of malnutrition.

Health

- WHO (1948): "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity."
- A multidimensional construct — physical, mental, social, and (in many frameworks) spiritual and environmental dimensions.
- A resource for everyday living, not the objective of living itself (Ottawa Charter, 1986).
- Nutrition is one of the most powerful modifiable determinants of health across the entire life course.
- **Public health** is the science and art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts.

Wellness

- An active, ongoing process of becoming aware of and making choices toward a more successful, balanced existence.
- Extends beyond the absence of illness (health) to the deliberate pursuit of an optimal quality of life.
- Commonly described across interconnected dimensions: physical, emotional, social, intellectual, occupational, and spiritual.
- Good nutrition supports wellness by underpinning energy, mood, cognitive function, and long-term disease prevention.

How the Four Concepts Connect

Food and Nutrition

- Food is the input — what is grown, prepared, and eaten.
- Nutrition is the process — how the body converts food into usable energy and tissue.
- Together they determine nutritional status: the body's physiological state relative to nutrient supply and demand.

Health and Wellness

- Health is the resulting physical, mental, and social state — shaped strongly by nutritional status.
- Wellness is the broader, actively pursued quality of life that good health makes possible.
- Public health nutrition works to secure adequate food and nutrition so that health and wellness become achievable for whole populations.

Public health nutrition (PHN)?

Public health nutrition

The science and practice of promoting good health and preventing nutrition-related disease through organised action on food and nutrition at the level of whole populations.

Examples (policy and system level)

- Identify vulnerable groups, and use data to detect emerging problems and guide interventions.
- Policy and regulation: dietary guidelines, labelling, sugar taxes
- Ensure equitable access to healthy food

Community nutrition

Application of nutrition principles within a defined community: assess its needs, plan and deliver local programmes, and evaluate results, with the community taking part at every step.

Examples (local, participatory level)

- Community health workers: screening and feeding counselling
- Growth monitoring and cooking demonstrations
- Kitchen gardens and mother support groups

Clinical nutrition vs PHN

Aspect	Clinical / dietetic nutrition	Public health / community nutrition
Unit of concern	Individual patient or client	Population, community or risk group
Main aim	Treat or manage a diagnosed condition	Promote health and prevent malnutrition in groups
Approach	Individual assessment, diet prescription, follow-up	Community diagnosis, programmes, policy, behaviour change
Setting	Hospital, clinic, dietetic practice	Homes, villages, schools, workplaces, national policy
Key tools	Clinical, biochemical and dietary assessment	Surveys, surveillance, epidemiology, communication, advocacy
Success measured by	Improvement in the individual	Change in prevalence of malnutrition and its determinants

Nutrition and Health Link:

Why PHN Matters

1

Adequate nutrition for all

Balanced nutrient intake is a basic necessity for life, health, and wellbeing — nutrition affects health from conception to old age.

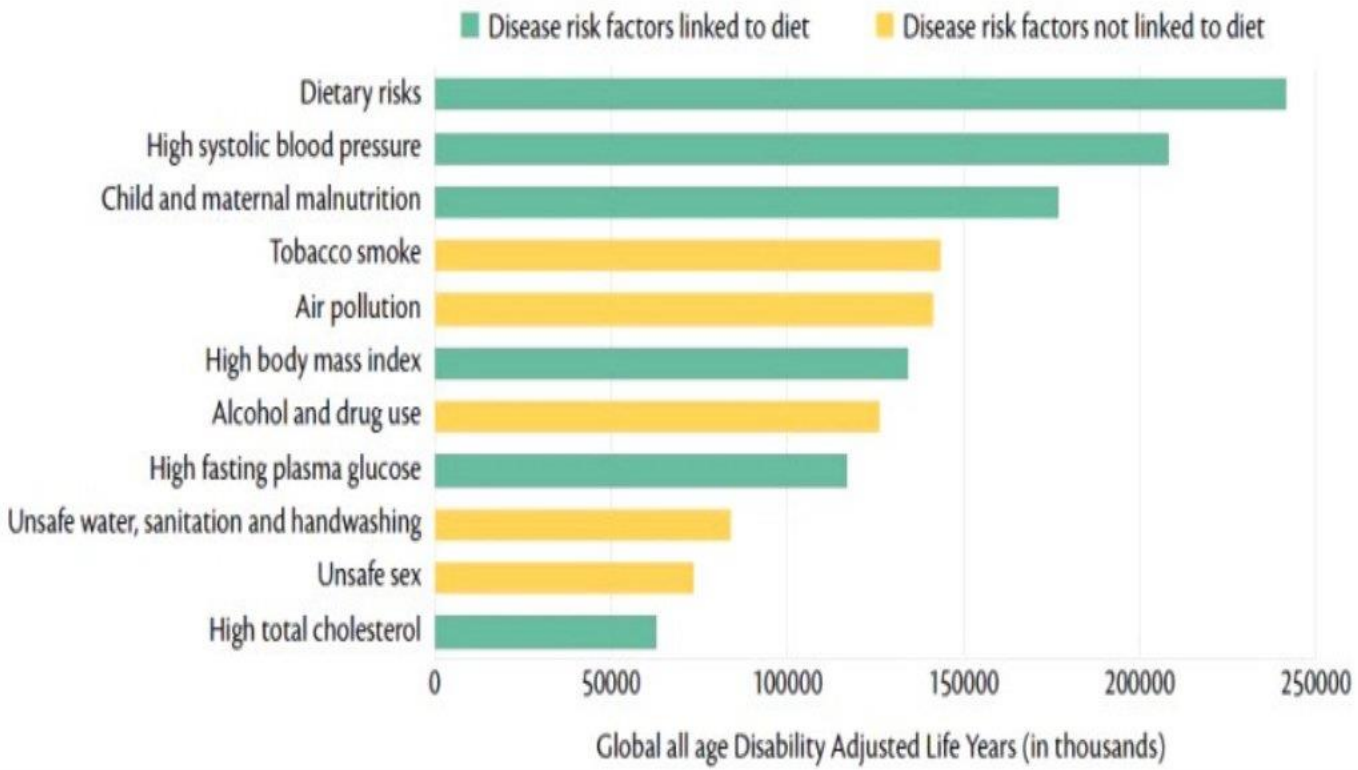
2

Linked to leading causes of death

Dietary factors are associated leading causes of death: coronary heart disease, several cancers, stroke, type 2 diabetes, and atherosclerosis.

Why should we care about diets?

Six of the top 11 risks factors driving the global burden of disease are linked to diet



Diseases in which nutrition plays some role	Osteoporosis Osteoarthritis Some forms of cancer
Diseases with a strong nutritional component	Type 2 diabetes Heart disease High blood pressure Obesity
Diseases caused by nutritional deficiencies or toxicities	Pellagra Scurvy Iron-deficiency anemia Other vitamin and mineral deficiencies Nutrient toxicities

Global burden of malnutrition

150.2 M

children under 5 are stunted (23.2%)

42.8 M

children under 5 are wasted (6.6%); 12.2 M severely

35.5 M

children under 5 are overweight (5.5%)

about 45%

of under-5 deaths are linked to undernutrition

Reading the picture

- Stunting is falling, but far too slowly; only about **a quarter of countries** are on track to halve the number of stunted children by 2030.

Global commitments

- **SDG 2.2:** end all forms of malnutrition by 2030, including the needs of adolescent girls, pregnant and lactating women.

Sources: UNICEF/WHO/World Bank Joint Child Malnutrition Estimates, 2025 edition (2024 data); Black et al., Lancet 2013.

A triple burden

Undernutrition

- **Wasting:** low weight-for-height; recent, acute; high risk of death
- **Stunting:** low height-for-age; chronic, mostly in the first 1,000 days
- **Underweight:** low weight-for-age; a composite measure
- **Low birth weight** (under 2.5 kg) and maternal thinness

Micronutrient deficiency

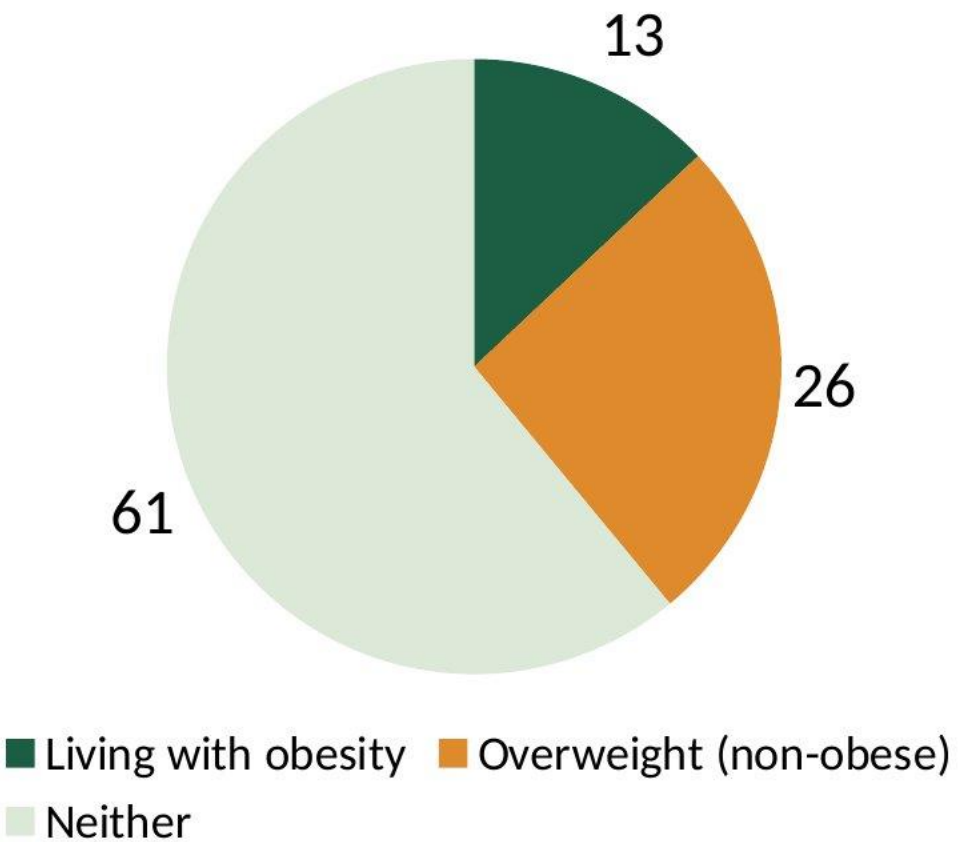
- **Iron, vitamin A, iodine, zinc**, folate, B12, vitamin D
- Sub-clinical deficiency is much more common than clinical signs
- Can coexist with overweight

Overnutrition

- **Overweight and obesity:** excess weight for height or age
- **Diet-related NCDs:** type 2 diabetes, hypertension, heart disease, some cancers
- Driven by energy-dense processed food and low activity
- **Rising fastest in low- and middle-income countries**

Double burden: undernutrition and overweight in the same population, household (stunted child, overweight mother) or the same person.

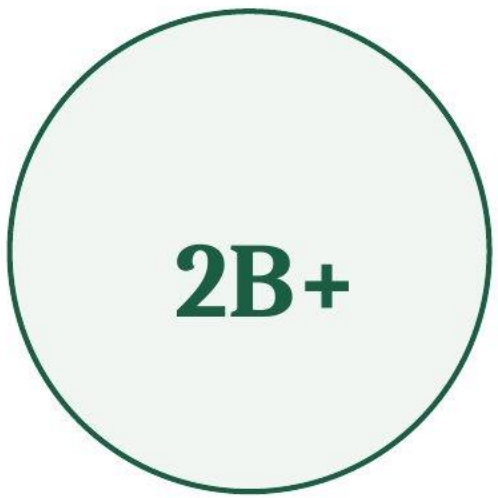
Global Burden: Overweight, Obesity & NCD Risk



Key Insight

- More than 1.9 billion adults worldwide are overweight, of whom over 650 million live with obesity (WHO).
- Obesity coexists with undernutrition in many low- and middle-income countries.

Hidden Hunger: Micronutrient Deficiencies



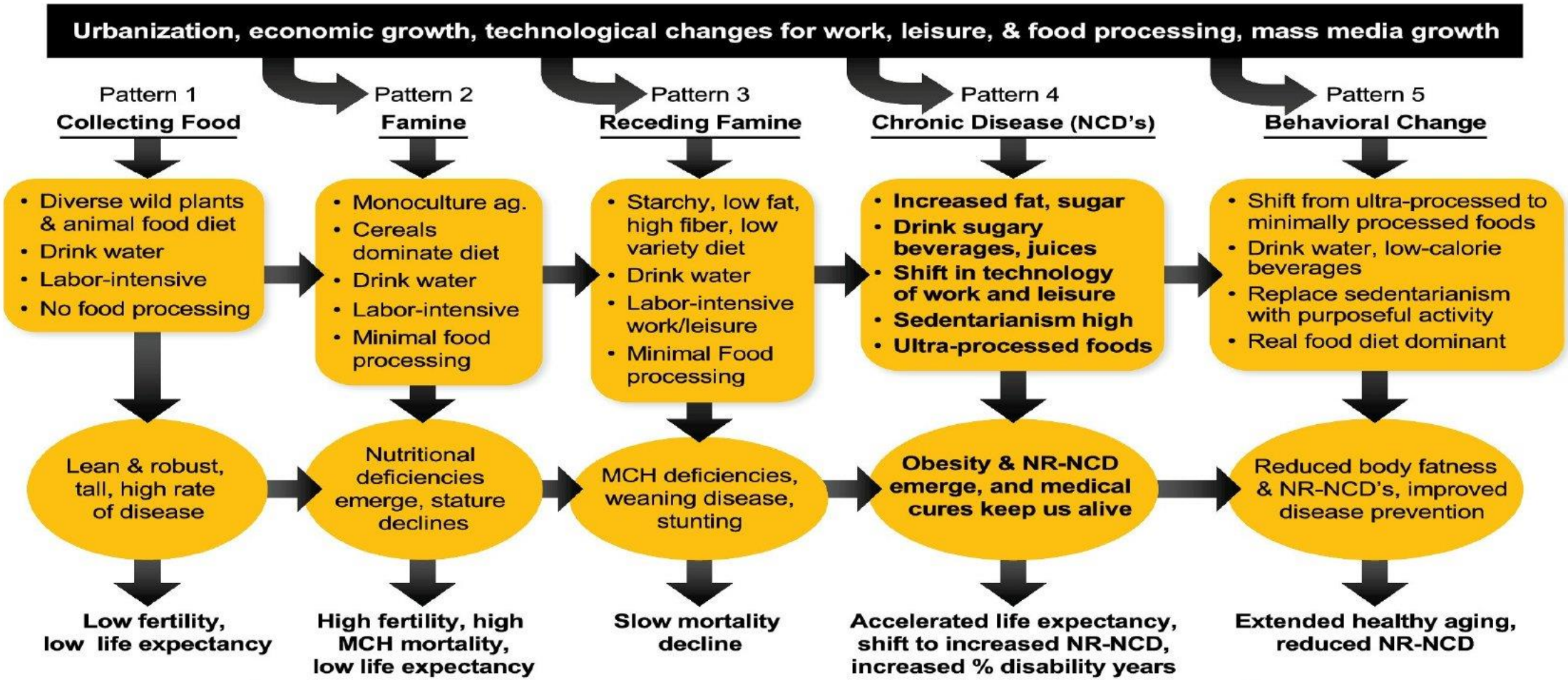
People affected worldwide

Called **"hidden hunger"**: the person may look well fed

- Iron deficiency anaemia affects an estimated 30–37% of women of reproductive age globally, impairing cognition and maternal survival.
- Vitamin A deficiency remains a leading preventable cause of childhood blindness and increased infection risk.
- Iodine deficiency is the world's leading preventable cause of intellectual impairment.
- Zinc deficiency contributes substantially to child stunting and susceptibility to diarrhoeal disease and pneumonia.

Nutrition Transition

A shift in dietary consumption and energy expenditure that coincides with economic, demographic, and epidemiological change — the move from traditional cereal- and fibre-rich diets toward Western-pattern diets high in sugar, fat, and animal-source food.



Healthful Diet

- A diet that provides the proper combination of energy and nutrients.
- Four core characteristics in the source:

Adequate → **Moderate** → **Balanced** → **Varied**

Adequate
Provides enough energy, nutrients and fiber to maintain health.

Moderate
Food is consumed in amounts that are neither too much nor too little.

Balanced
Foods provide nutrients in appropriate proportions; different foods contribute different nutrients.

Varied
Includes many different foods and food groups, increasing the likelihood of meeting nutrient needs.

DASH and MyPlate: examples of dietary guidance

DASH

Eating pattern to lower blood pressure (Dietary Approaches to Stop Hypertension).

Eat more: vegetables, fruits, whole grains, legumes, nuts, fish, lean poultry, low-fat dairy

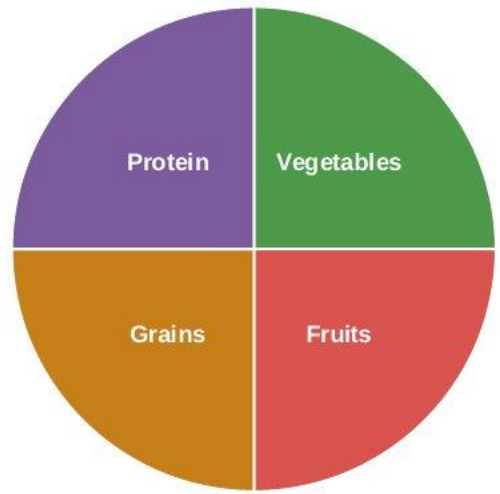
Eat less: salt, red/processed meats, sugary drinks and sweets, saturated and trans fats

Sodium: up to 2,300 mg/day (lower version: 1,500 mg)

Example day: banana; beans, vegetables and brown rice; grilled fish, greens and sweet potato

MyPlate

Food guide introduced by the US Department of Agriculture in 2011. Shows a meal on a plate, with no calorie counting.



Example lunch

Half: vegetables and fruit

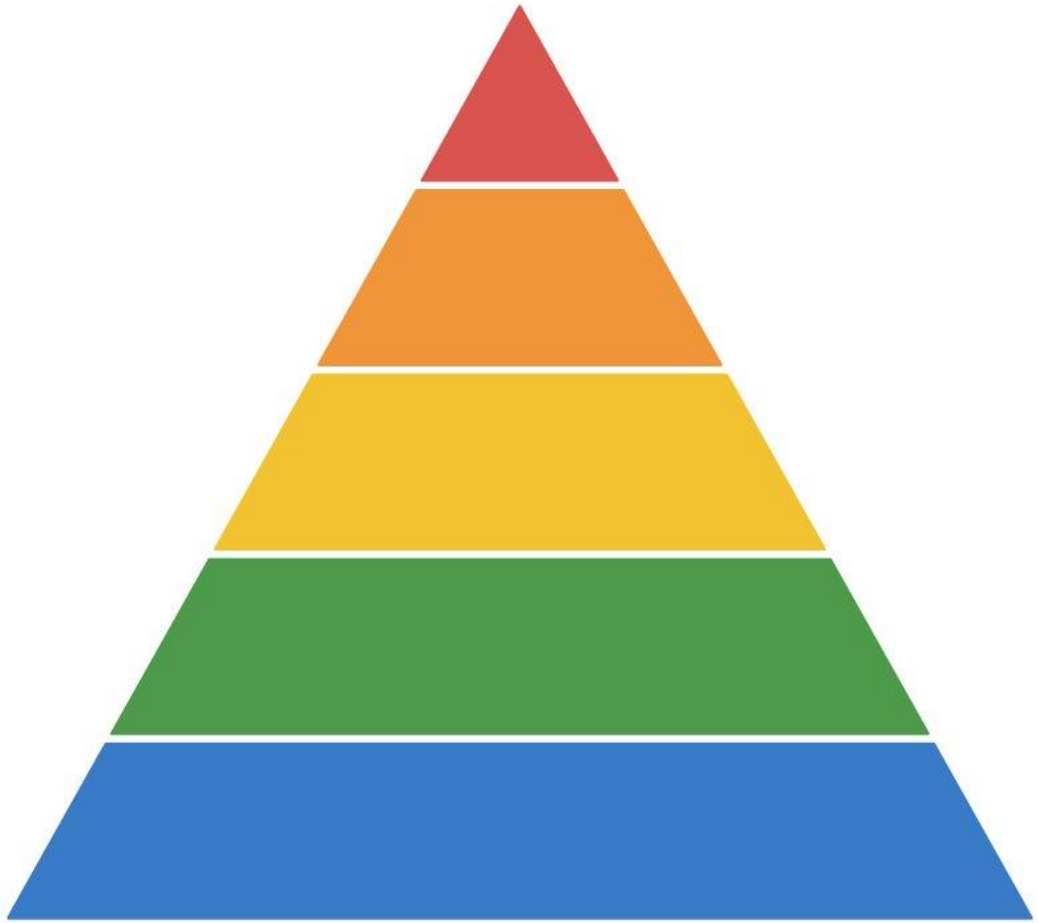
Quarter: rice or potatoes

Quarter: beans, fish or chicken

Side: milk or yoghurt

Rwanda uses Food-Based Dietary Guidelines and local nutritional frameworks, structuring healthy meals around **six core local food groups** to promote dietary diversity.

Nutrition pyramid: eat a variety of foods, in the right amounts



Sparingly small amounts	**Fats, oils, sweets, added sugars** Oils, butter, sugary drinks, chips. Extra calories, little nutrition.
2–3 servings/day	**Protein foods** Meat, fish, eggs, beans, lentils, nuts, seeds. Build and repair tissues.
2–3 servings/day	**Dairy** Milk, yoghurt, cheese. Calcium, vitamin D and protein for bones and teeth.
5+ servings/day	**Fruits and vegetables** Vitamins, minerals, fibre, antioxidants. Protect against chronic disease.
6–11 servings/day	**Grains and starchy foods** Whole grains, bread, rice, pasta, potatoes. Energy, fibre, B vitamins, iron.

Key takeaways

- **Variety** — choose a variety of foods
- **Hydration** — water is best
- **Activity** — be physically active
- **Balance** — keep portions in balance
- **Enjoy** — make healthy choices daily

CHAPTER

02

NUTRIENTS AND DIGESTION / USE

Chapter 2: Learning Objectives

1. Classify categories of nutrients and explain core physiological functions
2. Describe the main sources of carbohydrate, protein, fat, vitamins and minerals
3. Trace the path of food through the gastrointestinal tract and describe digestion at each stage.
4. Explain how carbohydrates, proteins, fats, vitamins, and minerals are absorbed across the gastrointestinal tract /gut wall.

Nutrients

Definition

Nutrients are defined as *the substances found in food that keep your body functioning.*

The food we eat is a source of nutrients.

The body needs nutrients to...

1. Fuel your energy.
2. Help for growth.
3. Repair.
4. Maintain basic bodily functions.

Balance is Key

- *For years, people held to the idea that there are "bad" nutrients and "good" nutrients when, in fact, all nutrients play a certain role in the body.*
- *Even those nutrients once considered "bad" such as fats and carbohydrates perform vital functions in the body, and if one consumes too much "good" nutrients such as vitamins or minerals there can be harmful results, as well.*

Framework of the Food Guide Pyramid:

Balance

- Eat foods from all groups of the Food Guide Pyramid.

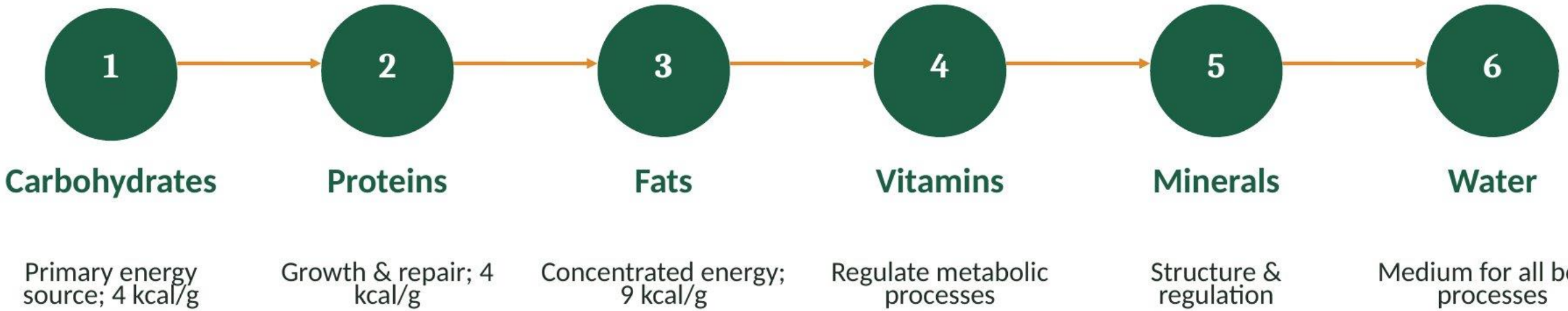
Variety

- Eat different foods from each food group.

Moderation

- Eat more foods from the bottom of the pyramid, and fewer and smaller portions of foods from the top of the pyramid.

Six Classes of Nutrients



Macronutrients (carbohydrates, proteins, fats) are needed in large amounts and supply energy; micronutrients (vitamins, minerals) are needed in smaller amounts but are equally essential.

Macronutrient: Carbohydrates

4 kcal

per gram: carbohydrates are the body's main source of energy

50–70%

of total energy should come from carbohydrates

400–500 g

daily requirement

Food Sources

- Breads, cereals, grains, rice, fruits, milk, yogurt and sweets.

Two types of Carbohydrates

- Starches or Complex Carbohydrates
- Simple Carbohydrates

Carbohydrates also provide the body's need for dietary fiber.

Fiber

Fiber is the plant material that doesn't break down when you digest food. Most, but not all, complex carbohydrates contain fiber.

Food Sources

- Oatmeal,
- fruits,
- vegetables,
- whole grains
- legumes.

Function in the Body

- **Improves Digestion**: Helps waste move quickly through digestive tract, preventing constipation.
- **Supports Gut Health**: Serving as food for the beneficial bacteria in large intestine.
- **Stabilizes Blood Sugar**: Soluble fiber slows down the digestion and absorption of sugar, preventing sudden blood glucose spikes.
- **Lowers Cholesterol:** Soluble fiber binds to cholesterol in the digestive system and helps your body excrete it, supporting a healthy heart.
- **Aids Weight Management:** High-fiber foods take longer to chew and digest, helping feel full longer and reducing overall calorie intake.

Macronutrient: Proteins

Are complex nitrogenous compounds (carbon, hydrogen, oxygen and nitrogen), made of smaller units called amino acids.

10-35%
energy from protein

24
amino acids are needed by the human body

9
"essential" (**indispensable**)– must be supplied by food including Leucine, isoleucine, lysine, methionine, phenylalanine, threonine, valine, tryptophan and histidine.

Food Sources

- Meat, fish, eggs, poultry, dairy products, legumes, nuts and seeds.
- Breads, cereals and vegetables also contain small amounts of protein.

Function in the Body

- Provides energy.
- Helps to build, maintain, and repair body tissues.
- Synthesis of substances like antibodies, plasma proteins, haemoglobin, enzymes, hormones and coagulation factors.

Macronutrient: Fat

- **Fats are hydrocarbons consisting of carbon, hydrogen and oxygen.**
- *The most concentrated form of food energy (calories)*

10–15%
of an adult's body weight

20–30%
of dietary energy from fat

Food Sources

- Butter, vegetable oils, salad dressings, nuts and seeds, dairy products made with whole milk or cream, and meats.

Function of fat in the Body

- Provide substances needed for growth and healthy skin.
- Enhance the taste and texture of food.
- Carry "fat-soluble" vitamins throughout the body.
- Provide energy.

Types of Fat

Saturated Fat

- Fats that are usually solid at room temperature.
- Food Sources: Animal foods and tropical oils.
- The type of fat most strongly linked to high cholesterol and increased risk of heart disease.

Unsaturated Fat: fats that are liquid at room temperature.

Polyunsaturated

- Food Sources: Vegetable and fish oils.
- Provide two essential fatty acids (Alpha-linolenic acid and Linoleic acid) necessary for bodily functions such as build cell membranes, regulate the immune system, support brain development, and manage inflammation

Monounsaturated

- Food Sources: Olive oil, canola oil, nuts, seeds.
- Play a role in reducing the risk of heart disease.

Calculating the total energy from macronutrients

1 slice of bread with 1 tablespoon of peanut butter on it contains 16 grams carbohydrate, 7 grams protein, and 9 grams fat.

calculate the total energy available from a food.

Micronutrients: Vitamins (13 currently recognized)

- Organic compounds required in small amounts to regulate metabolic reactions; do not supply energy directly.
- **Food Sources:** Fruits, vegetables, milk, whole-grain breads, cereals and legumes.
- The body cannot synthesize vitamins; they must be provided by food.
- Vitamins are classified according to their solubility in water as either **fat-soluble** or **water-soluble**

Type	Names	Distinguishing Features
Fat soluble	A, D, E, and K	Soluble in fat Stored in the human body Toxicity can occur from consuming excess amounts, which accumulate in the body
Water soluble	C, B-vitamins (thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, pantothenic acid, biotin, and folate)	Soluble in water Not stored to any extent in the human body Excess excreted in urine Toxicity generally only occurs as a result of vitamin supplementation

Micronutrients: Minerals

- Inorganic elements essential for structural (bone, teeth) and regulatory (nerve conduction, fluid/electrolyte balance) functions.
- **Food Sources:** Meats, beans, nuts, fruits, vegetables, dairy products, and grains.

50+
chemical elements in the human body

1/20
of body weight is minerals

16
minerals required daily

Classification of Minerals

Major minerals

- Calcium
- Phosphorus
- Sodium
- Potassium
- Magnesium

Trace elements with known function

- Iron
- Iodine
- Fluoride
- Zinc
- Copper

Trace elements with no known function

- Lead
- Mercury
- Barium
- Aluminium

Water: The Overlooked Nutrient

½ – ¾

of the human body consists of water!

Functions in the Body

- Water carries nutrients to cells and carries waste from the body.
- Regulates body temperature.
- Dissolves vitamins, minerals, amino acids and other nutrients.
- Lubricates joints.

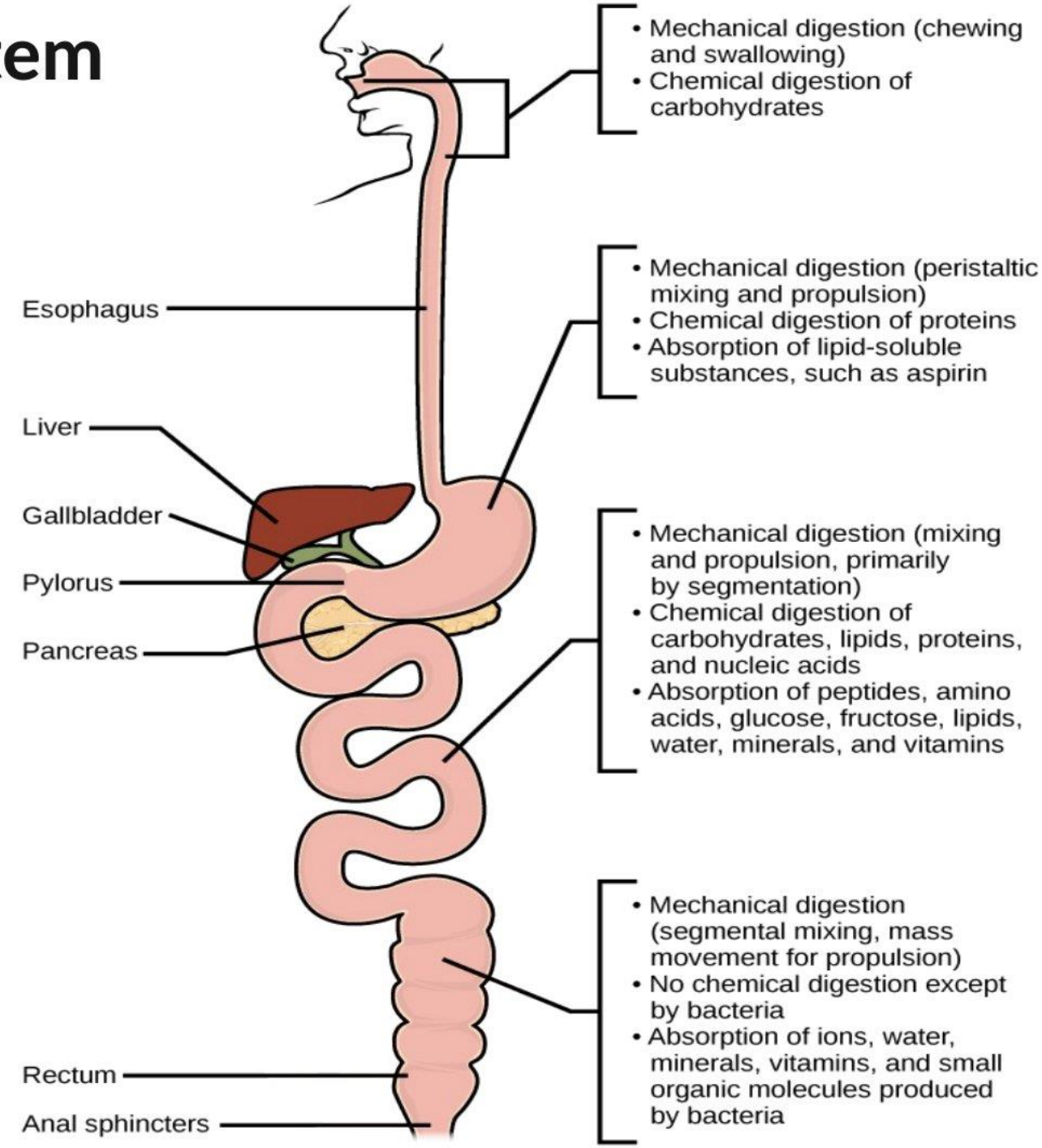
- *It is recommended that teens drink 6–8 glasses of water each day. This is in addition to around 4 cups of water from food each day.*
- Needs vary with climate, activity level, and physiological state; thirst is an imperfect and delayed signal, particularly in young children and older adults.

Digestion and Use

Introduction: Digestive System

When we eat, the food we consume is digested, then the useful nutrients are absorbed, and, finally, the waste products are eliminated

Food takes roughly 24–72 hours to pass through the full digestive tract, though this varies with fibre intake, hydration, and gut health.



Digestion in the Mouth & Esophagus

- Mechanical breakdown begins with chewing, increasing surface area for enzyme action.
- Salivary amylase begins starch digestion; saliva also lubricates food to form a bolus for swallowing.
- The esophagus transports the bolus to the stomach via coordinated muscle contractions (peristalsis).
- The lower esophageal sphincter prevents backflow of stomach contents into the esophagus.

Digestion in the Stomach

- Hydrochloric acid creates a highly acidic environment (pH = 1.5–3.5) that denatures proteins and kills most ingested pathogens.
- Pepsin, activated from pepsinogen by stomach acid, begins protein digestion into smaller peptides.
- Food is churned into a semi-liquid mixture called chyme before being released into the small intestine.

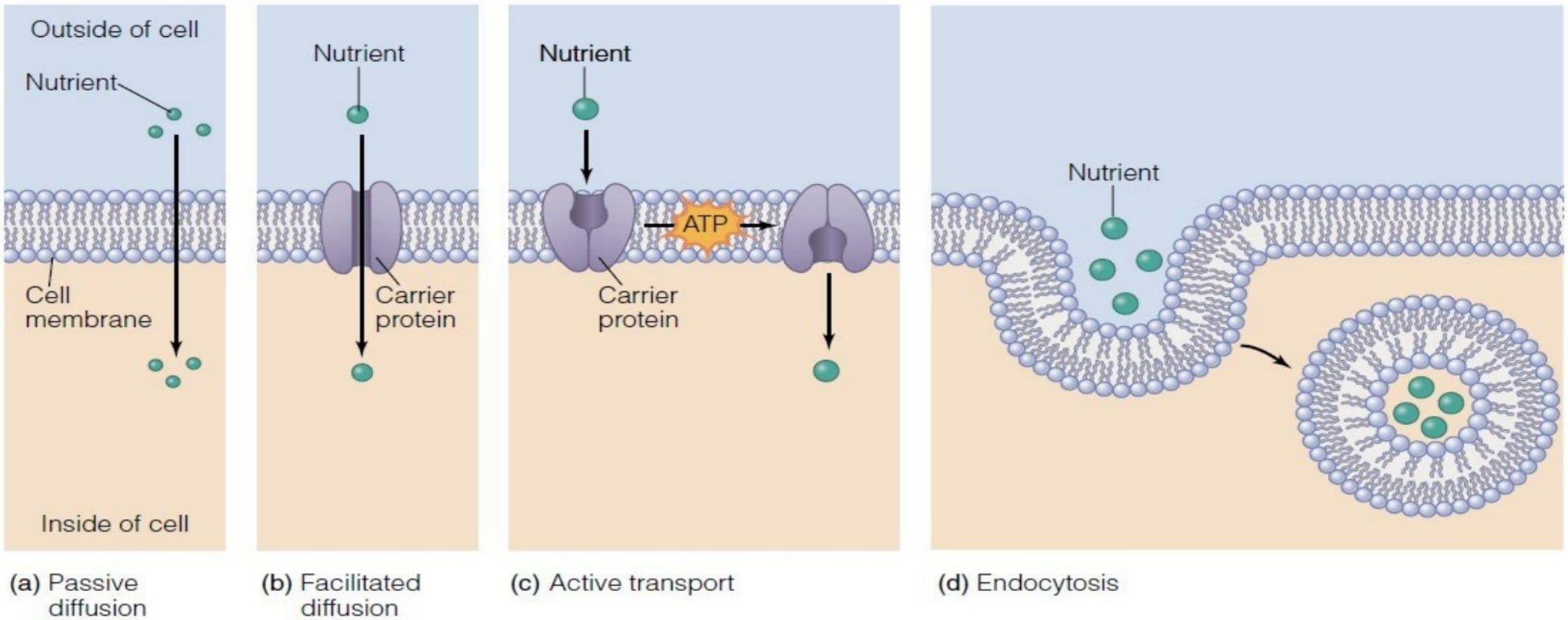
Digestion in the Small Intestine

- The primary site of both digestion and nutrient absorption.
- Pancreatic enzymes (amylase, lipase, proteases) and bile complete the breakdown of carbohydrates, fats, and proteins.
- Nearly all macronutrient and most micronutrient absorption is completed by the end of the small intestine.

Digestion in the Large Intestine

- Receives undigested residue (mainly fibre) and remaining water and electrolytes from the small intestine.
- Reabsorbs water and electrolytes, concentrating waste into stool.
- Home to trillions of gut bacteria (the microbiota) that ferment fibre into short-chain fatty acids, an energy source for colon cells.

Absorption



Most glucose and amino acids use active transport or facilitated diffusion; fatty acids and fat-soluble vitamins rely on passive diffusion.

Absorption of Carbohydrates

- Digestion breaks carbohydrates into single sugars called monosaccharides (glucose, fructose, and galactose), and these single sugars are then absorbed from the small intestine into the bloodstream.
- Glucose and galactose are absorbed via active transport (SGLT1 transporter); fructose uses facilitated diffusion (GLUT5).
- Absorbed sugars enter the bloodstream and travel via the portal vein directly to the liver.
- Dietary fibre resists digestion in the small intestine and passes to the large intestine largely intact.

Absorption of Proteins & Fats

- Proteins are broken down into amino acids and small peptides, absorbed via active transport into intestinal cells.
- Dietary fats are emulsified by bile into micelles, allowing fatty acids and monoglycerides to diffuse into intestinal cells.
- Inside intestinal cells, fats are reassembled into triglycerides and packaged into chylomicrons for transport via the lymphatic system.

Absorption of Vitamins & Minerals

- Water-soluble vitamins (B-complex, C) are absorbed largely by active transport in the small intestine.
- Fat-soluble vitamins (A, D, E, K) are absorbed alongside dietary fat within micelles.
- Mineral absorption is often tightly regulated: iron absorption, for example, increases when body stores are low.
- Absorption efficiency is affected by nutrient interactions — for example, vitamin C enhances non-heme iron absorption.

Macronutrient Metabolism

Macronutrient	Central Pathway	Primary Outcome
Carbohydrate	Glycolysis → citric acid cycle	Energy; glycogen storage
Protein	Amino acid pool → transamination	Tissue synthesis; energy if needed
Fat	Beta-oxidation → citric acid cycle	Energy; adipose storage

All three macronutrient pathways converge on the citric acid (Krebs) cycle and the electron transport chain to generate usable cellular energy (ATP).

Carbohydrate Metabolism

- Absorbed glucose is used immediately for energy, stored as glycogen in liver and muscle, or converted to fat if in excess.
- Glycolysis breaks glucose down in the cell cytoplasm, yielding a small amount of ATP (Adenosine Triphosphate) and pyruvate.
- Pyruvate enters the mitochondria and feeds the citric acid cycle, generating the majority of usable cellular energy.
- Between meals, liver glycogen is broken down (glycogenolysis) to maintain stable blood glucose.

Protein Metabolism

- Absorbed amino acids join a shared "amino acid pool" used for synthesizing new proteins, enzymes, and hormones.
- Amino acids not needed for synthesis undergo transamination and deamination, removing nitrogen for excretion as urea.
- The remaining carbon skeleton can be converted to glucose (gluconeogenesis) or used directly for energy.
- Protein turnover is continuous — the body constantly breaks down and rebuilds its own proteins, even in nutritional balance.

Fat Metabolism

- Fatty acids are broken down via beta-oxidation into two-carbon units that feed the citric acid cycle for ATP production.
- Excess dietary fat and carbohydrate are stored as triglycerides in adipose tissue for later use.
- During fasting or prolonged exercise, stored fat is mobilized and broken down to meet energy demands.
- The liver can convert fatty acid fragments into ketone bodies, an alternative fuel source during prolonged fasting or very low-carbohydrate intake.

The Fed State vs. the Fasted State

Fed State

- Occurs after eating, when blood glucose and insulin are elevated.
- The body favours storage: glycogen synthesis, protein synthesis, and fat storage.
- Insulin is the dominant regulatory hormone.

Fasted State

- Occurs between meals or overnight, when blood glucose falls.
- The body favours mobilization: glycogen breakdown, fat breakdown, and, if prolonged, protein breakdown.
- Glucagon and cortisol become the dominant regulatory hormones.

CHAPTER

03

DIETARY REFERENCE INTAKES AND ENERGY REQUIREMENTS

Components of energy requirement and estimating energy expenditure

Chapter 3: Learning objectives

1. Define Dietary Reference Intakes (DRIs) and explain how they are derived.
2. Comprehend DRIs in assessing and planning intakes for individuals and for populations.
3. Describe the components of total energy expenditure.
4. Compare methods for measuring and estimating energy expenditure.
5. Describe how energy and nutrient needs change during pregnancy/lactation, childhood and adolescence.

Dietary Reference Intakes (DRIs)

- DRIs are a set of reference values used to determine how much of a nutrient people need from their diet.
- They are designed for apparently healthy people and are adjusted by age, sex and life stage (including pregnancy and lactation).
- They are not treatment targets for disease or severe malnutrition.

Evolution

- 1941: first US Recommended Dietary Allowances, aimed at preventing deficiency
- 1997–2005: Institute of Medicine (National Academy of Medicine -2015) developed the broader **DRIs** framework.
- Shift from preventing deficiency to reducing chronic disease risk and avoiding excess

Uses

- Assessing nutrient intakes of individuals and groups
- Planning diets, food assistance and fortification
- Setting standards for nutrition policy and food labelling systems

The DRI family of reference values

Value	Definition
EAR (Estimated Average Requirement)	Intake estimated to meet the requirement of 50% of healthy people in a life-stage and sex group
RDA (Recommended Dietary Allowance)	Intake that meets the needs of 97–98% of people (EAR + 2 SD, or EAR x 1.2)
AI (Adequate Intake)	Observed or experimental intake of a healthy group, set when an EAR cannot be derived
UL (Tolerable Upper Intake Level)	Highest daily intake unlikely to cause adverse effects in almost all people
EER (Estimated Energy Requirement)	Average energy intake predicted to maintain energy balance in a healthy person of defined age, sex, weight, height and activity
AMDR (Acceptable Macronutrient Distribution Range)	Range of macronutrient intake (% of energy) linked to lower chronic disease risk while meeting nutrient needs
CDRR (Chronic Disease Risk Reduction Intake)	Intake above which reducing intake is expected to lower chronic disease risk (sodium, 2019)

Macronutrient DRIs for adults

Component	Reference value
Carbohydrate	RDA 130 g/day; AMDR 45–65% (55%) of energy
Total fat	AMDR 20–35% (30%) of energy
Protein	RDA 0.8 g/kg/day; AMDR 10–35% (15%) of energy
n-6 and n-3 polyunsaturated fatty acids	AI: linoleic 12 g (F), 17 g (M); α-linolenic 1.1 g (F), 1.6 g (M)

From EAR to RDA

Core formula

RDA = EAR + 2 × SD

If SD unknown, assume CV = 10%:

`SD = 0.1 × EAR  →  RDA = 1.2 × EAR`

Example

Hypothetical nutrient: EAR = 40 units/day, CV = 10%.

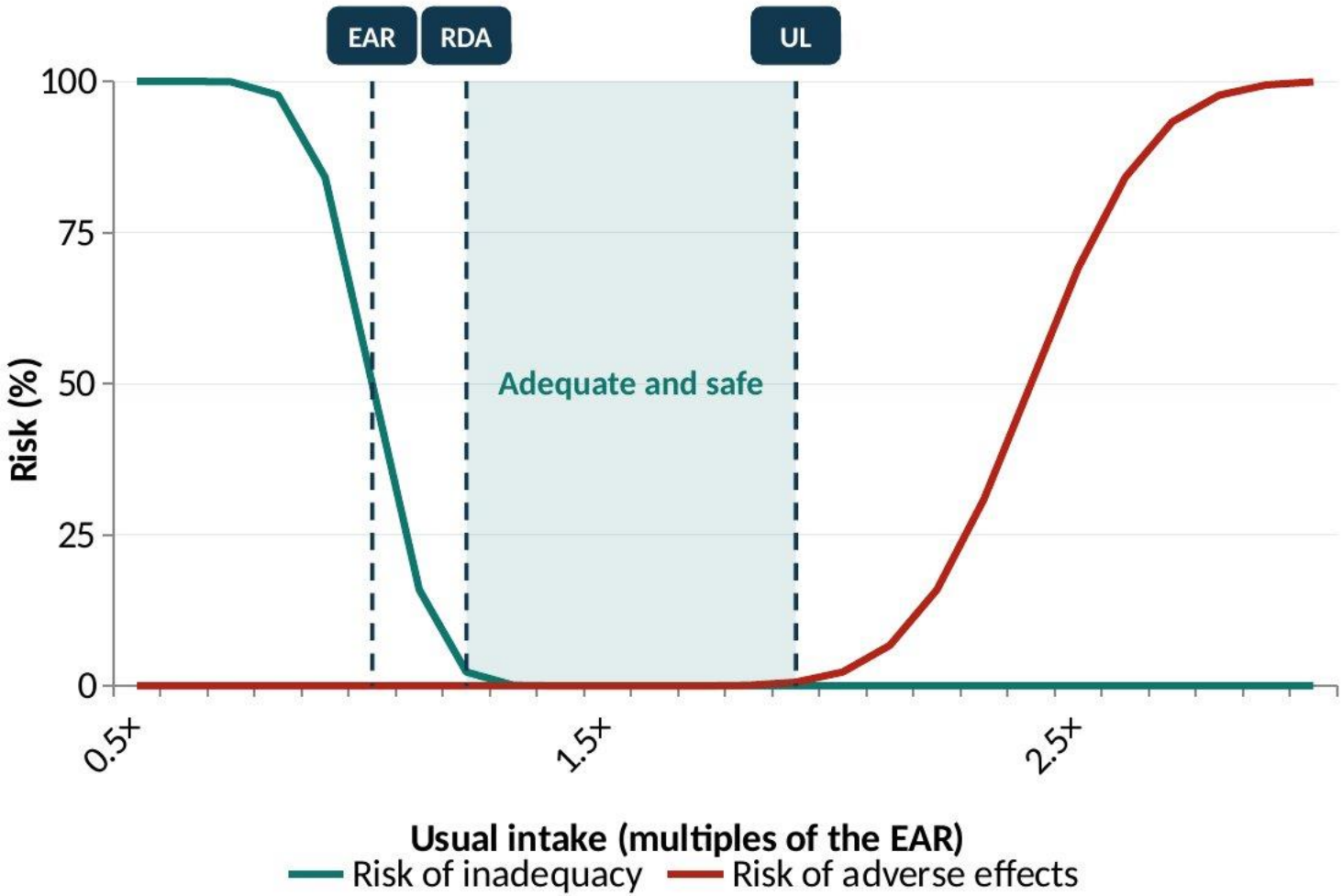
SD = 0.10 × 40 = 4 units.

RDA = 40 + 2 × 4 = 48 units/day (= 1.2 × 40).

Why it matters

- 2 SD above the mean covers 97.5% of a normal requirement distribution.
- The RDA is a target for individuals, not a cut-off for groups.
- If data are too thin to set an EAR, an AI is given instead; the AI cannot be used to estimate prevalence of inadequacy.

Risk curves behind EAR, RDA and UL



How to read it

EAR (1.0×): 50% risk of inadequacy.

RDA (1.2×): risk falls to 2–3%.

UL (schematic, 1.9×): above this, risk of adverse effects begins to rise.

Safe zone: between the RDA and the UL.

Prevalence of inadequacy

Example

- Dietary survey of 200 women aged 19–50 y.
- Nutrient: vitamin A (EAR 500 µg /day, RDA 700).
- 54 women below 500 µg
- 40 women 500–699 µg
- 106 women 700 µg or more

Steps

1. Choose the EAR cut-point (500 µg RAE).

2. Count women with usual intake below the EAR: 54.

3. Prevalence = 54 ÷ 200 = 27%.

4. Check assumptions: usual intake used; requirements roughly symmetric.

27%

Estimated prevalence of inadequacy (EAR cut-point)

47%

Wrong if the RDA is used as cut-point: (54 + 40) ÷ 200

More than 1 in 4 women is at risk: consider fortification or food-based action.

Never use the RDA as a cut-off for a group: it counts people who are probably adequate as inadequate and overstates the problem.

Energy is the exception: Estimated Energy Requirement, not RDA

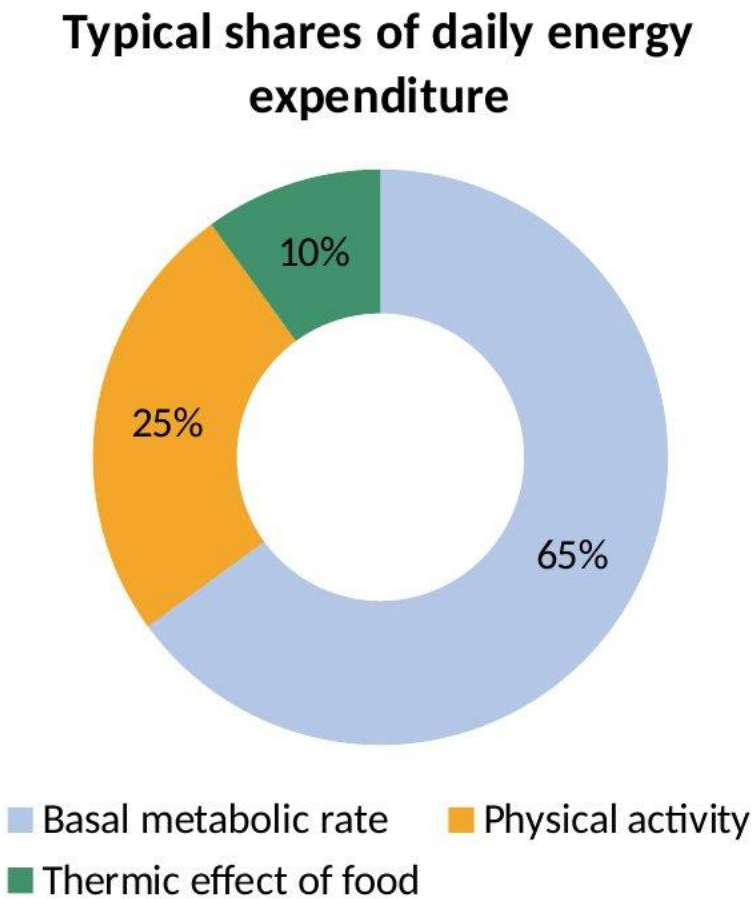
Why there is no RDA for energy

- For most nutrients, intake above the requirement is harmless below the UL.
- For energy, intake above the requirement causes weight gain.
- So the EER is set at the average requirement, not at the upper end.

Limitation: because the data come from healthy people, the EER is a reference for healthy populations. It is not a target for people who are sick or severely malnourished.

Update: the National Academies published new energy DRIs in 2023 (50 EER equations, up from 15).

Components of energy expenditure



Basal metabolic rate (BMR): 60–70%

- Energy for basic functions: organs, ion pumping, temperature, resting.

Thermic effect of food: about 10%

- Energy to digest, absorb, metabolise and store food.

Physical activity: 15–30%

- Most variable component: exercise plus non-exercise activity.

Predictive equations for BMR

Schofield (kcal/day)	Males	Females
18–30 y	15.3 W + 679	14.7 W + 496
30–60 y	11.6 W + 879	8.7 W + 829
Over 60 y	13.5 W + 487	10.5 W + 596

W = body weight in kg. FAO/WHO/UNU standard.

Mifflin–St Jeor (kcal/day)

Men: $10W + 6.25H - 5A + 5$

Women: $10W + 6.25H - 5A - 161$

W kg, H cm, A years

Which one?

- Schofield: the basis of FAO/WHO energy planning, tends to overestimate BMR in many tropical populations.
- Mifflin–St Jeor: developed on a mixed US sample and widely used in clinical practice.

Example: estimating BMR

Given

- Woman, 35 years
- Weight 60 kg
- Height 160 cm
- Community health worker

Calculation

Schofield (women, 30–60 y)

$8.7 \times 60 + 829 = 522 + 829 = 1{,}351$ kcal/day

Mifflin–St Jeor (women)

$10 \times 60 + 6.25 \times 160 - 5 \times 35 - 161$

$= 600 + 1{,}000 - 175 - 161 = 1{,}264$ kcal/day

87 kcal

difference between equations (~7%)

Estimated Energy Requirement (EER) equation (IOM 2005)

Women ≥19 y: $EER = 354 - 6.91 \times A + PAC \times (9.36 \times W + 726 \times H)$

Men ≥19 y: $EER = 662 - 9.53 \times A + PAC \times (15.91 \times W + 539.6 \times H)$

A years, W kg, H metres. Physical activity coefficients (PAC): women 1.00 / 1.12 / 1.27 / 1.45; men 1.00 / 1.11 / 1.25 / 1.48 (sedentary / low active / active / very active)

Example

Example: a woman
Suppose she is:
- Age = 30 years
- Weight = 60 kg
- Height = 1.65 m
- Active → PA = 1.27

EER:
= 354 – (6.91 × 30) + 1.27 × [(9.36 × 60) + (726 × 1.65)]
= 354 – 207.3 + 1.27 × (561.6 + 1,197.9)
= 146.7 + 1.27 × 1,759.5
≈ 2,381 kcal/day

So her estimated energy requirement is approximately **2,380 kcal/day**.

EER is an estimate, not an exact calorie requirement. Actual needs can vary.

Estimating Physical Activity Energy Expenditure Using METs

- *Estimating the energy cost and intensity of a specific physical activity using METs (Metabolic Equivalents)*
- MET is a practical unit used to measure the energy cost of physical activities as a multiple of your resting metabolic rate

Gross kcal = MET × weight (kg) × hours

1 MET = resting energy use ≈ 3.5 mL O_2/kg/min ≈ 1 kcal/kg/h. Intensity: light < 3 METs, moderate 3–5.9, vigorous ≥ 6. Example: woman, 60 kg.

Activity	Intensity	METs	Duration	Gross kcal
Brisk walking (3.5 mph)	Moderate	4.3	45 min	4.3 × 60 × 0.75 = 194
Leisure cycling (<10 mph)	Moderate	4.0	30 min	4.0 × 60 × 0.50 = 120
Running (6 mph)	Vigorous	9.8	20 min	9.8 × 60 × 0.33 = 196

Planning energy for a population

Group	Share of population	Mean need (kcal/day)	Share × need
Children under 5 y	15%	1,200	180
Children 5–14 y	25%	1,900	475
Women 15–59 y	28%	2,000	560
Men 15–59 y	27%	2,400	648
Adults 60 y and over	5%	1,800	90
Population mean	**100%**		**1,953**

- As cereal at 3,500 kcal/kg: about 5.6 tonnes/day if cereal supplied all energy.

19.5 million

kcal/day for 10,000 people (1,953 × 10,000)

Rwandan food based dietary guidelines adapted for healthy diet construction

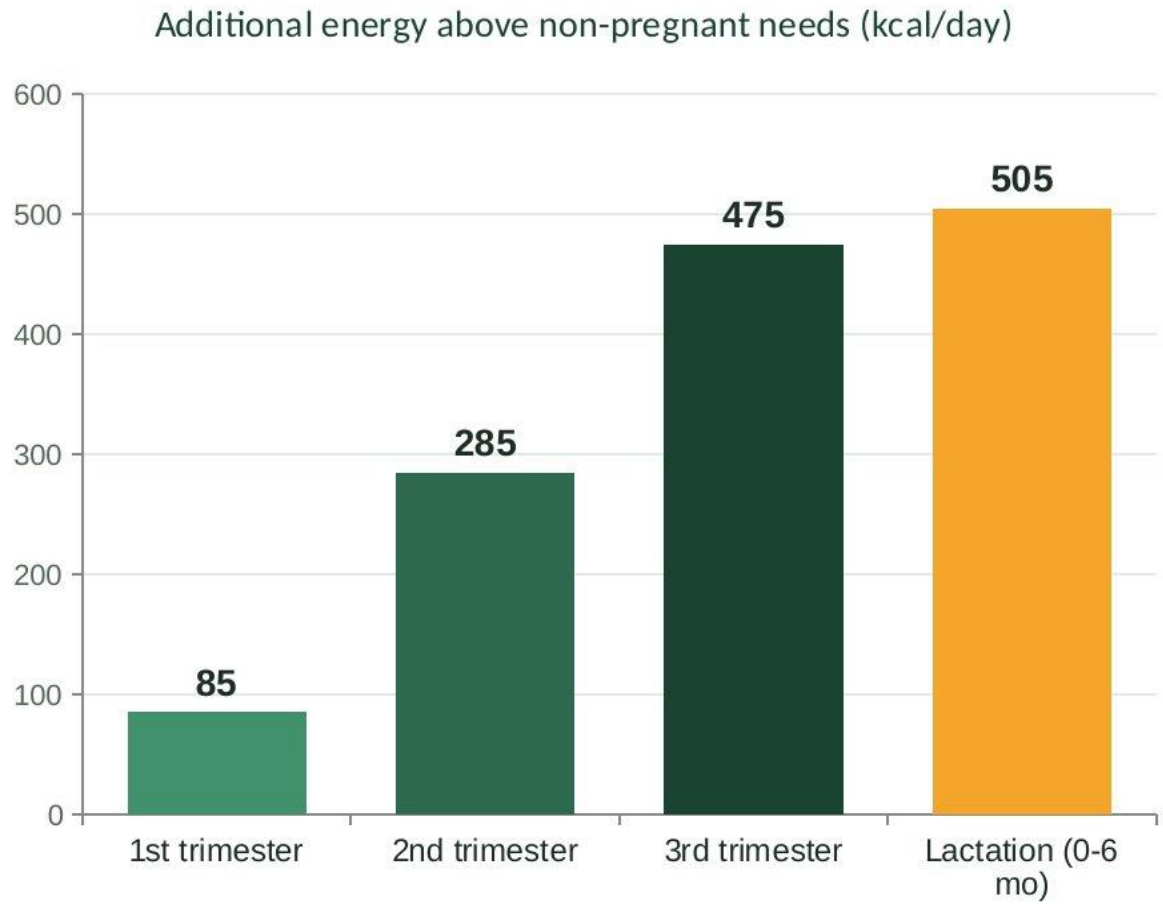
Food Groups	Number of Food Items	Recommended Amount per Group (grams/day)	Recommended Amount per Item (grams/day)
Animal sourced foods	2	111.19	55.60
Starchy staples (cereals, roots & tubers)	2	441.75	220.88
Fruits and vegetables	5	429.53	85.91
Oils and fats	1	51.25	51.25
Legumes, pulses, and nuts	1	203.06	203.06

Pregnancy: why needs rise and energy requirement

Why needs increase

- Growth of the **fetus, placenta** and amniotic fluid
- Expansion of **maternal tissues**: uterus, breasts, blood volume (up about 40–50%)
- **Fat stores** laid down as a reserve for lactation
- Higher **basal metabolic rate**, especially in the third trimester
- Total extra energy cost of the order of **75,000–80,000 kcal** across pregnancy

Poor or no weight gain in the second trimester is a warning sign needing dietary review.



Pregnancy: key micronutrients

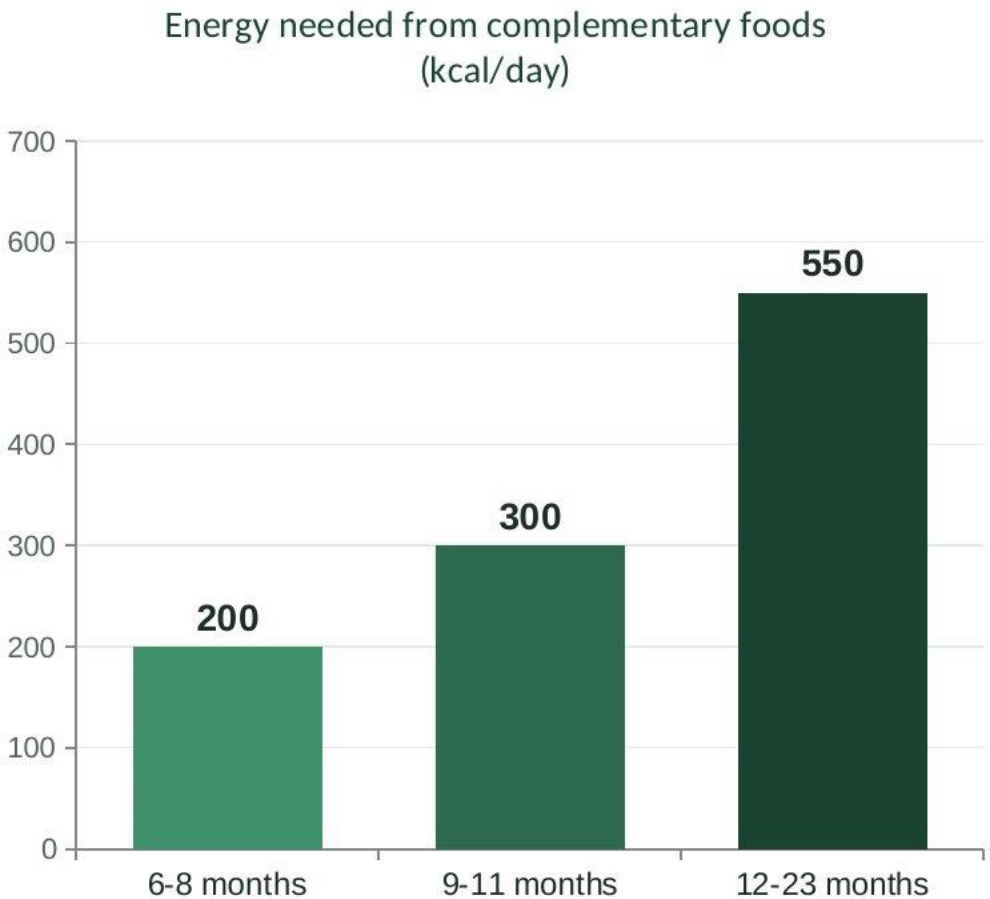
Nutrient	Recommendation in pregnancy	Why it matters	Good sources
Iron	30–60 mg elemental iron daily as supplement (WHO); dietary RNI about 27 mg	Expanded blood volume, fetal stores; prevents anaemia and low birth weight	Liver, red meat, fish, legumes, dark leafy greens, fortified cereals
Folic acid	400 µg daily supplement, ideally from before conception; about 600 µg DFE total	Prevents neural tube defects and megaloblastic anaemia	Leafy greens, legumes, citrus, fortified flour
Calcium	1.5–2 g elemental calcium daily where dietary intake is low (WHO); intake about 1,000 mg	Fetal bones and teeth; lowers pre-eclampsia risk	Milk, yoghurt, small fish with bones, leafy greens
Iodine	250 µg/day (WHO); use iodised salt	Fetal brain development; prevents cretinism	Iodised salt, seafood, dairy
Vitamin A	About 800 µg RE/day; supplement only if deficiency is severe (up to 10,000 IU daily)	Fetal growth and immunity; excess is teratogenic	Liver, orange fruits and vegetables, dark leafy greens, eggs
Zinc	About 11 mg/day (IOM RDA)	Cell growth and immunity; fetal development	Meat, seafood, legumes, nuts, whole grains

DFE = dietary folate equivalents; RE = retinol equivalents. Sources: WHO antenatal care guidelines (2016, 2018); IOM.

Lactation: energy and nutrient needs

Nutrient	While breastfeeding	Note
Vitamin A	About 850 µg RE/day	Milk content depends on maternal intake; routine postpartum megadose no longer advised (WHO 2011)
Iodine	250 µg/day	Secreted into milk; essential for infant brain development
Calcium	About 1,000 mg/day (1,300 mg if adolescent)	Maternal bone is mobilised; adequate intake protects stores
Iron	About 9 mg/day (10 mg if adolescent)	Lower than pregnancy as periods are suppressed; continue IFA per national policy
Zinc	About 12 mg/day	Needed for milk synthesis and infant growth
Fluids	Total water about 3.8 L/day	About 1 L more than non-lactating women; drink to thirst
Protein	+19g protein/day in the first 6 months (about +13 g after 6 months)	
Energy	+500 kcal/day kcal/day extra in the first 6 months of exclusive breastfeeding	

Infants and young children (0–23 months)



Age	What to feed
0–5 months	Exclusive breastfeeding on demand
6–8 months	Breastfeeding + 2–3 meals/day of thick, mashed foods
9–11 months	Breastfeeding + 3–4 meals + 1–2 snacks; finely chopped foods
12–23 months	Breastfeeding + 3–4 meals + 1–2 snacks; family foods

Quality matters as much as quantity

- **Minimum dietary diversity:** at least 5 of 8 food groups
- Include animal-source foods and vitamin A-rich fruits and vegetables
- **Responsive feeding:** feed patiently, encourage, never force; clean hands and utensils

Childhood (1–13 years): reference intakes

Age	Energy (kcal/day)	Protein (g/day)	Fat (% of energy)	Calcium (mg)	Iron (mg)
1–3 years	about 1,000–1,400	13	30–40	700	7
4–8 years	about 1,400–1,800	19	25–35	1,000	10
9–13 years	about 1,800–2,300	34	25–35	1,300	8

Feeding pattern

Three meals and two nutritious snacks daily from the family pot; include a vitamin A-rich and an iron-rich food each day.

Limit

Sugar-sweetened drinks, salty and fried snacks and ultra-processed foods: they displace nutritious foods and promote overweight.

Monitor growth

Regular weight and height with WHO growth standards (0–5 y) and BMI-for-age (5–19 y); refer growth faltering early.

Energy ranges approximate (both sexes, moderate activity). Protein, fat, calcium, iron: IOM DRIs (RDA/AMDR).

Adolescent girls: why they matter

Growth spurt

High needs for energy, protein, calcium, iron and zinc; the girls' spurt starts earlier than boys'.

Menarche

Menstrual blood loss raises iron needs; iron-deficiency anaemia is the commonest problem.

Bone bank

About 90% of peak bone mass is laid down by late adolescence; calcium and vitamin D are critical.

Future mothers

Status at conception shapes pregnancy outcome and the next generation; early pregnancy competes for nutrients.

about 1 in 6

people worldwide is an adolescent (10–19 years)

15–20%

of adult height is gained during adolescence

about 50%

of adult body weight is gained during adolescence

Adolescent girls: energy and nutrient requirements

Nutrient	9–13 years	14–18 years	Public health note
Energy (kcal/day)	about 1,800–2,000	about 2,000–2,400	Depends on growth stage and physical activity
Protein (g/day)	34	46	About 0.85–0.95 g per kg body weight
Calcium (mg/day)	1,300	1,300	Peak bone mass; pair with vitamin D (600 IU)
Iron (mg/day)	8	15	Menstruation raises needs; anaemia is commonest problem
Folate (µg /day)	300	400	Assure before conception to prevent neural tube defects
Zinc (mg/day)	8	9	Growth and sexual maturation
Vitamin A (µg /day)	600	700	Growth, vision and immunity
Iodine (µg/day)	120	150	Iodised salt; thyroid function and brain function

Energy ranges approximate (moderate activity). Other values: IOM RDAs for girls. RAE = retinol activity equivalents; DFE = dietary folate equivalents.

CHAPTER

04

ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY ASSESSMENT

Chapter 4: Learning Objectives

1. Describe the basic **concept** of nutritional/dietary assessment
2. Describe **reasons** why nutritional/ dietary assessment is needed
3. Explain common nutritional and dietary assessment **methods**
4. Identify the **benefits and drawbacks** of each type of the method
5. Explain measurement **error** in dietary assessment

Nutritional assessment and nutritional status

Nutritional assessment	Defined as the interpretation from dietary, laboratory, anthropometric, and clinical studies/surveys. It is used to determine the nutritional status of individual or population groups.
Nutritional status	Is the condition of a person's health resulting from the balance between nutrient intake, digestion, absorption, and the body's physiological requirements for growth, maintenance, and repair.

Why is nutrition assessment important?

1. To identify people at risk of malnutrition for early intervention or referral before they become malnourished

2. To identify malnourished people for treatment—malnourished people who are not treated early have slower recovery from infection and complications, and higher morbidity and mortality

3. To track child growth

4. Detect practices that raise the risk of malnutrition and infection. It looks at behaviors, such as stopping breastfeeding early, giving poor-quality complementary foods.

5. To inform nutrition education and counseling

6. To establish appropriate nutrition care plans

Nutritional assessment systems

Four forms in which nutritional assessment methods are applied

1 Surveys

- National cross-sectional studies of a selected population
- Assess nutritional status and identify groups at risk of malnutrition (acute or chronic)
- Inform evidence-based policy; compare baseline vs. final to assess an intervention

2 Surveillance

- Continuous, systematic collection and analysis of nutrition related data over a longer period
- Identifies risk factors for malnutrition in a whole population or vulnerable group
- Supports planning, monitoring and evaluation of nutrtion programs and policies

3 Screening

- Identifies malnourished individuals
- Applied to whole populations, at-risk subgroups or selected individuals
- Uses simple, cheap and rapid measurements

4 Interventions

- Target at-risk subgroups found by surveys or screening (e.g. supplementation, fortification)
- Need monitoring and evaluation to prove efficiency

How often should nutrition assessment be done?

The frequency depends on age, pregnancy and disease status, and on national policies.

Group	When to assess
Pregnant/postpartum women	On every antenatal visit
Infants 0–< 6 months of age	At birth and on every scheduled postnatal visit
Infants 6–59 months of age	During monthly growth monitoring sessions for children under 2 and every 3 months for older children
Children 5 years of age and over	On every clinic visit
Adolescents and adults	On every clinic visit
People with HIV	On every clinic visit and when initiating or changing antiretroviral therapy

Techniques in assessing nutritional status

1. **Anthropometric assessment –** estimation of nutritional status on the basis of measurements of the physical dimensions and gross composition of an individual's body

2. **Clinical assessment –** estimation of nutritional status on the basis of recording a medical history and conducting a physical examination to detect signs (by a qualified observer) and symptoms associated with malnutrition

3. **Biochemical assessment –** estimation of nutritional status on the basis of measurements of nutrient stores, functional forms, excreted forms, and/or metabolic functions

4. **Dietary assessment –** estimation of nutrient intakes from evaluations of diets, food availability, and food habits (using such instruments as food frequency questionnaires, food recall procedures, diet histories, food records)

1. Anthropometric technique

Non-invasive measurement of body size, proportions and composition

- Anthropometry measures physical dimensions: weight, length or height, circumferences and skinfold thickness
- Reflects long-term nutritional status, growth and body energy and protein reserves
- Used for screening, surveys, surveillance and monitoring interventions
- Detects both undernutrition (stunting, wasting) and overnutrition (overweight, obesity)

Strengths

- Simple, quick, cheap and portable
- Non-invasive; suits large populations

Limitations

- Insensitive to short-term change or specific nutrient deficiencies
- Needs trained staff, standard technique and good reference data

Common anthropometric measurements

Choice of measure depends on age group and purpose

Weight

- Body mass; weight-for-age

Length / height

- Recumbent length under 2 years, standing height from 2

BMI

- Weight (kg) divided by height (m) squared

Mid-upper arm circumference

- Quick screen for acute malnutrition

Waist and hip circumference

- Central fat distribution; waist-hip ratio and waist size indicate cardiometabolic risk

Skinfold thickness

Calipers at triceps, biceps, subscapular and suprailiac sites estimate body fat



.....Body composition

.....is what the body is made of: fat mass, fat-free (lean) mass, body water, and bone mineral. It describes the body's makeup, anthropometry is the measurement of the body's physical dimensions

Method	What it measures	Practicality
Skinfold calipers	Subcutaneous fat, converted to body fat by equations	Cheap, field-friendly; operator-dependent
Bioelectrical impedance (BIA)	Body water, then fat-free mass, from electrical resistance	Quick, portable; affected by hydration

Interpreting of Anthropometric measurements

Waist-Hip/height Ratio (WHR) measures central or abdominal obesity. It is calculated by dividing the waist size by the hip measurement.

< 0.81

Females (WHR)

Above 0.81 is an indicator of obesity.

< 1

Males (WHR)

Above this ratio is a sign of abdominal obesity.

≤ 0.50

Waist-height ratio

For both males and females, it should not be greater than 0.50.

Interpretation ....

Weight and height during pregnancy

< 45 kg

Weight

A weight below 45 kg indicates malnutrition.

< 145 cm

Height

Indicates chronic malnutrition (from childhood to adolescence). Height of mother is associated with the pelvis width: if < 145 cm, there is a risk of complications during delivery.

…BMI in adults

$$\text{BMI} = \text{weight (kg)} \div \text{height (m)}^2$$

A simple, widely used screening tool

1. Developed as a population-level screening tool, not a diagnostic measure for any single individual.
2. Correlates reasonably well with body fatness at the population level, though less precisely for individual.
3. Remains the most widely used anthropometric indicator in global adult nutrition surveillance due to its simplicity.

WHO BMI classification for adults

BMI range (kg/m²)	Classification	General health implication
Below 18.5	Underweight	Increased risk of nutritional deficiency
18.5 – 24.9	Normal range	Lowest average health risk
25.0 – 29.9	Overweight	Increased risk of NCDs
30.0 and above	Obese	Substantially increased risk of NCDs

Some national and regional guidelines use lower BMI cut-offs for certain populations, reflecting evidence of elevated health risk at lower BMI thresholds.

Limitations of BMI

1

Does not distinguish fat mass from muscle mass — very muscular individuals may be misclassified as overweight.

2

Does not indicate fat distribution, even though abdominal (visceral) fat carries greater metabolic risk than fat elsewhere.

3

Standard adult cut-offs may not perform equally well across all ethnic groups, ages, or body types.

…MUAC cutoffs to classify nutritional status in women

Non-pregnant / non-postpartum	Pregnant / postpartum	Nutritional status
< 185 mm	< 190 mm	SAM
≥ 185 to < 220 mm	≥ 190 to < 230 mm	Moderate malnutrition
≥ 220 mm	≥ 230 mm	Normal nutritional status

…MUAC cutoffs: children 6 months to 14 years

Age	Severe acute malnutrition (SAM)	Moderate acute malnutrition (MAM)	Normal nutritional status
6–59 months	< 115 mm	≥ 115 to < 125 mm	≥ 125 mm
5–9 years	< 135 mm	≥ 135 to < 145 mm	≥ 145 mm
10–14 years	< 160 mm	≥ 160 to < 185 mm	≥ 185 mm

Gestational weight gain recommendations

Pre-pregnancy BMI	Total weight gain at term	Rate of weight gain in 2nd and 3rd trimester; mean (range)
Underweight (<18.5 kg/m²)	12.5–18 kg	0.51 (0.44–0.58) kg/week
Normal weight (18.5–24.9 kg/m²)	11.5–16 kg	0.42 (0.35–0.50) kg/week
Overweight (25.0–29.9 kg/m²)	7–11.5 kg	0.28 (0.23–0.33) kg/week
Obesity (≥ 30.0 kg/m²)	5–9 kg	0.22 (0.17–0.27) kg/week

Total weight gain of 16 to 20.5 kg is consistent with a favorable outcome of a full-term twin pregnancy.

Weight gain in twin and singleton pregnancies

Period of gestation, wk	Single	Twin
13–20	0.42	0.60
20–30	0.47	0.54
30–36	0.40	0.64
0–36	11.1 kg total gain	14.6 kg total gain

Birth weight

> 2500 g

Normal birth weight

1500–2499 g

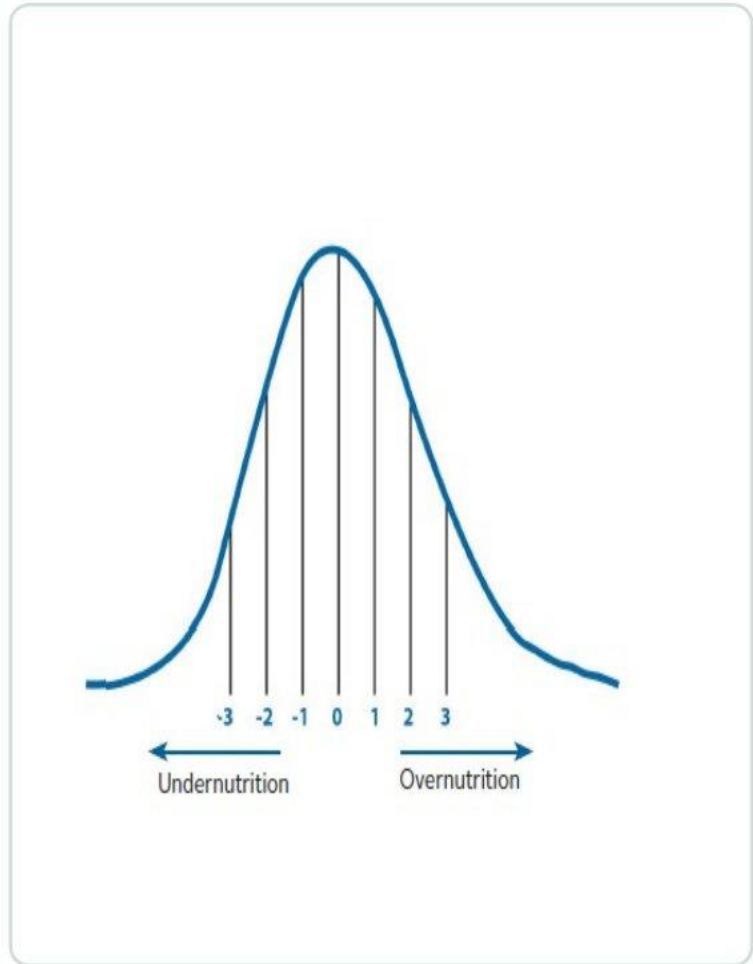
Low birth weight

< 1500 g

Very low birth weight

Anthropometric measurements presented as indexes

- Each of the indexes is recorded as a z-score. Z-scores are measured in standard deviations (SD), and describe how far and in what direction an individual's anthropometric measurement deviates from the measurement for a healthy person of the same age and sex (median).
- In the bell curve figure, the z-score for the median (middle) measurement is 0. Z-scores lower than the median have minus signs (e.g., −1). Z-scores higher than the median have plus signs or no signs (e.g., +2 or 2).



Converting measurements to indices

1. **Weight-for-age** is an index used in growth monitoring for assessing children who may be underweight.

2. **Height-for-age** is an index used for assessing stunting (chronic malnutrition in children).

3. **Weight-for-height** is an index used for assessing wasting (acute malnutrition).

4. **Body mass index** is the weight of a child or adult in kg divided by their height in metres squared: Weight (kg)/(Height in metres)^2

Indicators of underweight and malnutrition derived from the weight and height of children relative to their age

Index	Cut-off value based on standard deviation (SD)/percentage	What it indicates
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	Moderate acute malnutrition (MAM)
Height-for-age	Less than -3	Severe acute malnutrition (SAM)

BMI-for-age z-score

BMI-for-age	Nutritional status
< −3 z-score	Severe malnutrition
≥ −3 and < −2 z-score	Moderate malnutrition
≥ −2 z-score and ≤ +1 z-score	Normal nutritional status
> +1 and ≤ +2 z-score	Overweight
> +2 z-score	Obesity

BMI-for-age (children & adolescents)

1. Applies the BMI concept, adjusted for age and sex, to growing children and adolescents.
2. Used from age two through adolescence, replacing weight-for-height as children grow older.
3. Plotted on percentile or Z-score growth charts specific to age and sex, unlike the fixed cut-offs used for adults.
4. Increasingly important globally given rising childhood overweight and obesity alongside persistent undernutrition.

Reference population

The nutritional status of the community is assessed based on the reference population. If a national reference population is available it is recommended to use it. Otherwise the international reference population can be used.

Prior to April 2006

- The reference population was the NCHS / CDC / WHO references used from 1977 up to 26 April 2006.
- They were based on a sample from American children from Iowa and Massachusetts states (= selection bias), thus not representative at international level.

From 27 April 2006

- **2006 WHO Child Growth Standards** replaced the old references, based on the international sample (from Brazil, Ghana, India, Oman, Norway and USA = developed + developing countries).
- They were adopted on 27 April 2006.

www.who.int/childgrowth/standards

Classification of malnutrition severity by prevalence (children under 5)

Indicator	Prevalence	Interpretation
Underweight	< 10 %	Malnutrition is not an important problem
	10–29 %	Malnutrition is an important problem, ranged among priority health problems
	≥ 30 %	Critical situation = emergency food aid
Stunting	< 20 %	Not an important problem
	20–39 %	Malnutrition is an important problem
	≥ 40 %	Emergency food aid
Wasting	< 5 %	Not an important problem
	5–14 %	Malnutrition is an important problem
	·≥ 15 %	Emergency food aid

2. Biochemical assessment

This method requires taking blood, urine, stools samples, finger nails, or hair to determine the protein, fat, or vitamins contents.

Anemia during pregnancy	Hemoglobin (g/dl)	<11.0

Strengths and limits

Biochemical assessment is one of the reliable techniques in assessing nutritional status, but it requires highly trained personnel and expensive tools.

3. Clinical assessment: Physical signs of malnutrition

1. Bilateral pitting oedema
2. Dull, dry, thin or discoloured hair
3. Dry or flaking skin
4. Pallor of the palms, nails or mucous membranes
5. Lack of fat under the skin
6. Fissures and scars at the corner of the mouth
7. Swollen gums
8. Goitre
9. Bitot’s spots in the eyes

4. Dietary survey

Levels and scope

- Comprehensive evaluation of food consumption at national, household and individual level
- Includes: food supply, production at national level, food purchase at national level, food consumption at individual level

Methods

1. Food balance sheet
2. Inventory
3. Weighing
4. **24-hour recall**
5. Dietary score
6. **Food frequency questionnaire**
7. **Recording / food recording**
8. Diet history

24-hour recall method

- Assesses food and beverage consumption during the previous day or preceding 24 hours
- Strengths: low respondent burden; easy administration; minimises bias from altering food intake
- Limitations: forgetting; misreporting; needs a trained observer; cost of computerised analysis; several days needed to estimate usual intake

Food frequency questionnaire (FFQ)

- Gives information on an individual's food intake over a specific period
- Organises foods that have common nutrients
- Face to face, by telephone or self-administered
- Describes dietary patterns or food habits, not nutrient intake

- **Strengths**: captures intake over a long period; a large food list can be included; high response rate; can be done online or in person

- **Limitations**: relies on memory; requires complex calculation to estimate frequency; requires literacy; does not quantify intake

Food recording

- Subjects self-record dietary intake over a specified period (not more than 7 days)
- Respondents must be trained to record food items adequately

- **Strengths**: Does not rely on memory and a large sample can be covered quickly with proper instruction

- **Limitation**: validity is not established and social desirability … reporting to look favorable

Assessing household food security

No single indicator captures all four dimensions, so assessments combine several

Availability
Enough food nearby?

Access
Can households obtain it?

Utilization
Is it used well?

Stability
Is it reliable over time?

Method	Example tools	What it shows
Experience-based scales	Household Food Insecurity Access Scale, FAO Food Insecurity Experience Scale, Household Hunger Scale	Reported worry, reduced intake and hunger
Diet-based indicators	Household Dietary Diversity Score, Food Consumption Score	Diversity and frequency of foods eaten
Coping strategies	Reduced Coping Strategies Index	What households do when food runs short
Economic indicators	Food share of expenditure, income, assets	Economic capacity to obtain food
Availability and context	Production, market prices, early warning	Supply and shocks at community level

Complementary feeding indicators

WHO/UNICEF infant and young child feeding indicators for children aged 6 to 23 months

Minimum dietary diversity (MDD)

- Share of children who ate from at least 5 of 8 food groups the previous day
- Groups: Breast milk; Grains, roots, tubers and plantains; Pulses; Dairy products; Flesh foods; Eggs; Vitamin A-rich fruits and vegetables; Other fruits and vegetables

Minimum meal frequency (MMF)

- Share of children fed solid, semi-solid or soft foods the minimum number of times
- Breastfed: 2 times at 6-8 months, 3 times at 9-23 months
- Non-breastfed: at least 4 feeds, including milk feeds

Minimum acceptable diet (MAD)

- Share of children who meet both the diversity and frequency minimums
- Non-breastfed children also need at least 2 milk feeds
- The overall measure of adequate complementary feeding

Minimum Dietary Diversity for Women (MDD-W)

A population-level indicator of micronutrient adequacy for women aged 15 to 49

The 10 food groups

1. Grains, white roots and tubers, plantains
2. Pulses (beans, peas, lentils)
3. Nuts and seeds
4. Dairy
5. Meat, poultry and fish
6. Eggs
7. Dark green leafy vegetables
8. Other vitamin A-rich fruits and vegetables
9. Other vegetables
10. Other fruits

Interpretation

- Women who ate at least 5 of the 10 food groups in the previous day and night count as meeting MDD-W.

Limits

- Gives a group estimate, not a score for an individual woman
- Does not measure amounts, energy, or specific nutrient intake

Source: https://www.fao.org/3/i5486e/i5486e.pdf

CHAPTER

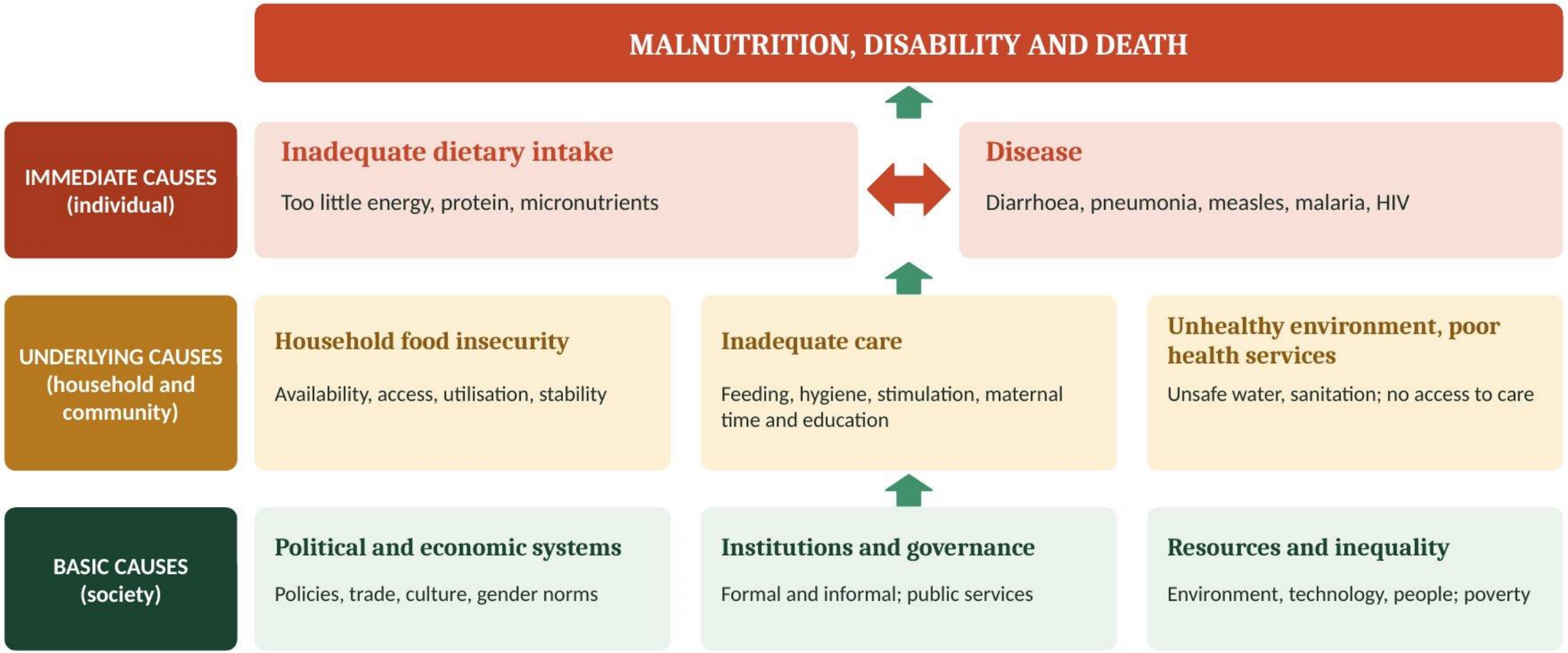
05

CAUSES, DETERMINANTS AND EFFECTS OF MALNUTRITION

Chapter 5: Learning Objectives

1. Explain the UNICEF conceptual framework and distinguish immediate, underlying, and basic causes of malnutrition.
2. Identify gender inequality, climate change, conflict, and economic shocks as key determinants of malnutrition.
3. Describe the malnutrition-infection cycle and how it can be interrupted.
4. Identify the short-term and long-term effects of undernutrition, micronutrient deficiencies, and overnutrition.
5. Describe the intergenerational cycle of malnutrition and double burden of malnutrition

Causes of malnutrition: the UNICEF conceptual framework



Gender inequality, climate, conflict and economic shocks as drivers of undernutrition

Gender inequality

- **Unequal food distribution** within households, especially in pregnancy and adolescence
- **Heavy workload:** less time for childcare, food preparation and rest
- **Limited decision-making power** over household income and food choices
- **Lower education** for girls is linked to worse child nutrition outcomes

Climate change

Droughts, floods and shifting rainfall reduce yields and livestock survival; extreme weather destroys food and water infrastructure; rising CO_2 can lower the nutrient content of staple crops.

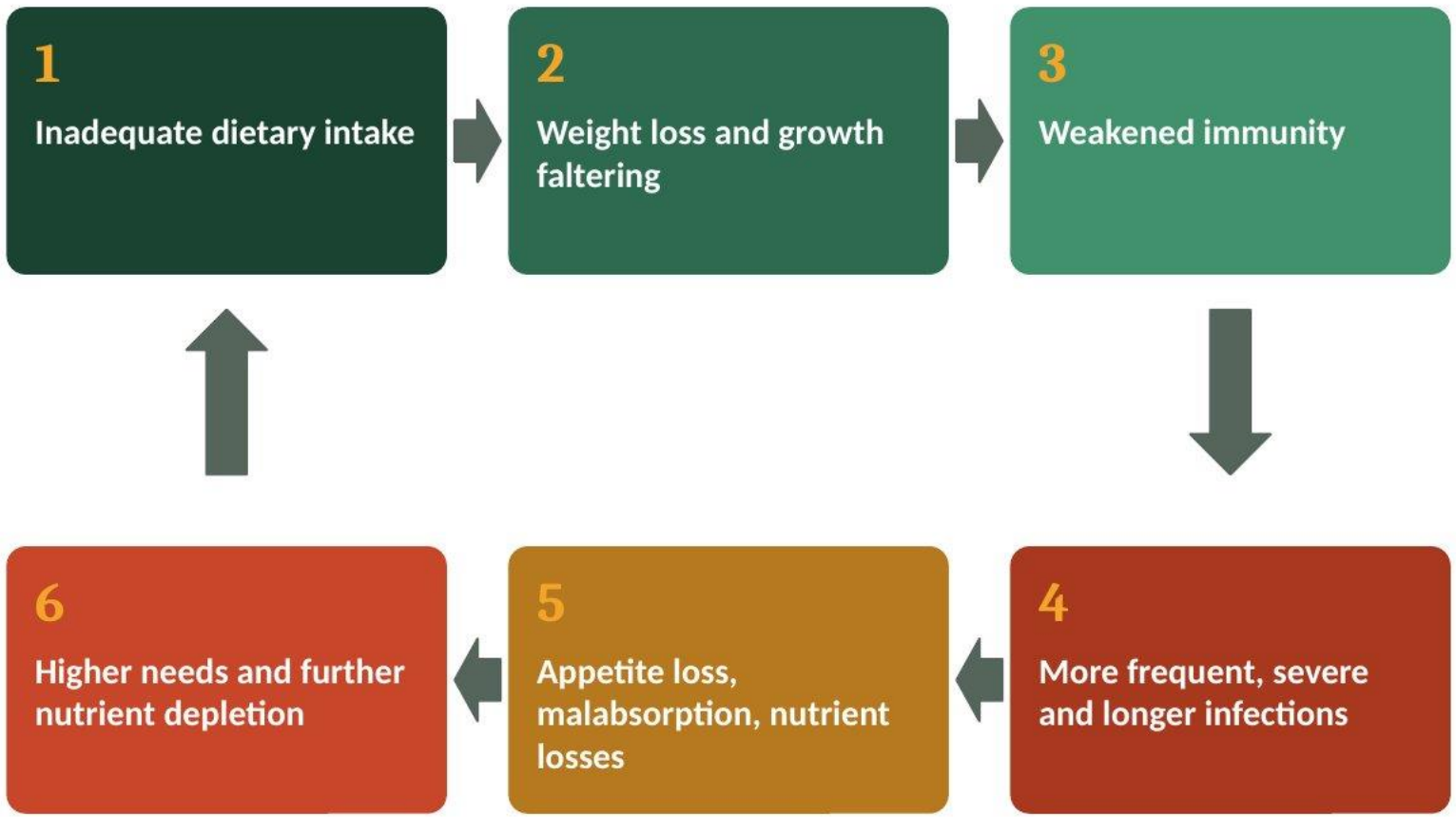
Conflict and displacement

Disrupts production, markets, health services and caregiving; refugee and displaced populations show higher acute malnutrition.

Economic and price shocks

Falling real incomes push households toward cheaper, less nutritious diets, worsening both under- and overnutrition.

The malnutrition-infection vicious cycle



Breaking the cycle

- **Immunisation:** measles, rotavirus, pneumococcus
- **Zinc + ORS** for diarrhoea; continued feeding during illness
- **Vitamin A** and periodic **deworming**
- **WASH:** safe water, sanitation, handwashing
- **Exclusive breastfeeding** and good complementary feeding
- Early treatment of wasting

Effects of Undernutrition

Short-Term

- Undernutrition underlies an estimated 45% of deaths in children under five, mostly through increased vulnerability to common infections.
- Causes wasting, growth faltering, and low birth weight in affected children.
- Reduces energy for play and exploration, delaying motor and cognitive development even before long-term effects set in.
- Raises immediate health-care costs for affected families.

Long-Term

- Stunting occurring in the first 1,000 days is largely irreversible after age two, producing shorter adult stature.
- Associated with impaired cognition, poorer school performance, and lower adult earnings and work capacity.
- The DOHaD hypothesis (Developmental Origins of Health and Disease): early undernutrition followed by later rapid weight gain raises the risk of obesity, type 2 diabetes, hypertension, and cardiovascular disease in adulthood.
- Stunted women face higher risk of poor obstetric outcomes, continuing the cycle into the next generation.

Effect of Micronutrient Deficiencies (Hidden Hunger)

Deficiency	Main Consequence	Most At Risk
Iron	Anaemia; poor cognition; maternal haemorrhage	Women, adolescent girls, children under 2
Vitamin A	Night blindness; higher mortality from measles/diarrhoea	Pre-school children; pregnant/lactating women
Iodine	Goitre, cretinism, impaired brain development	Pregnant women and infants in iodine-poor areas
Zinc	Stunting; more diarrhoea and pneumonia	Young children
Folate / B12	Neural tube defects; anaemia	Women of reproductive age

Iron deficiency remains the most common nutrient deficiency worldwide; universal salt iodisation is credited as one of the most successful public health interventions in history.

Effects of Overnutrition

Physical Health Effects

- Type 2 diabetes, hypertension, heart disease, and stroke.
- Some cancers, fatty liver disease, and gallbladder disease.
- Musculoskeletal problems, including osteoarthritis and back pain.

Psychosocial & Economic Effects

- Stigma, low self-esteem, and depression associated with obesity in many settings.
- Rising health-care costs across the life course.
- Lost productivity, compounding the same economic burden undernutrition creates.

The intergenerational cycle and the double burden



The double burden of malnutrition

Population level

A country can show both high child stunting and rising adult overweight and diabetes at the same time.

Household level

A stunted young child and an overweight mother in the same household, often driven by a poor-quality, low-diversity diet rather than too little food.

Individual level

A person stunted in early childhood is at higher risk of becoming overweight as an adult (metabolic programming), especially with an energy-dense diet later in life.

The challenge of coexistence of malnutrition

- Low birth weight and undernutrition in early life can be associated with increased risk of NCDs later in life
- In US, some women who are food insecure, particularly women with children, are more likely to be affected by obesity and consume poor quality diets (pattern NOT SEEN in other settings)

CHAPTER

06

INTERVENTIONS: NUTRITION-SPECIFIC AND NUTRITION-SENSITIVE ACTIONS

Chapter 6: Learning Objectives

1. Distinguish nutrition-specific, nutrition-sensitive, and enabling-environment interventions
2. Compare the four micronutrient strategies: supplementation, fortification, dietary diversification, and public health measures.
3. Describe nutrition-sensitive interventions delivered through agriculture, social protection, WASH, education, and health.
4. Explain why combining nutrition-specific, nutrition-sensitive, and enabling actions is necessary to reduce undernutrition meaningfully.

Steps to Deliver Services in Community Nutrition

1

Assessment

Identify the nutrition problem(s) in the community.

2

Planning

Plan how to meet the community's nutrition needs.

3

Implementation

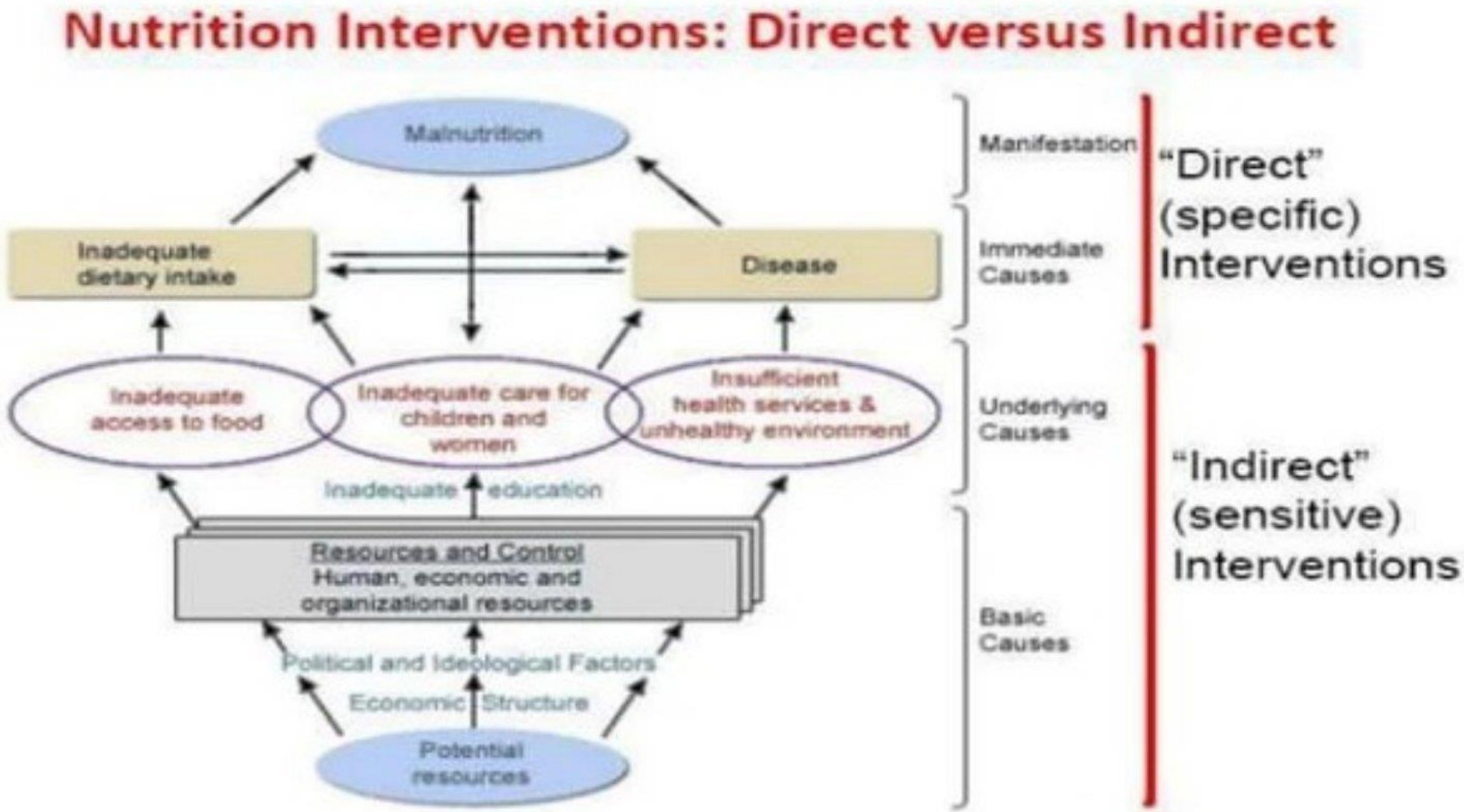
Develop systems and act to reduce the problem.

4

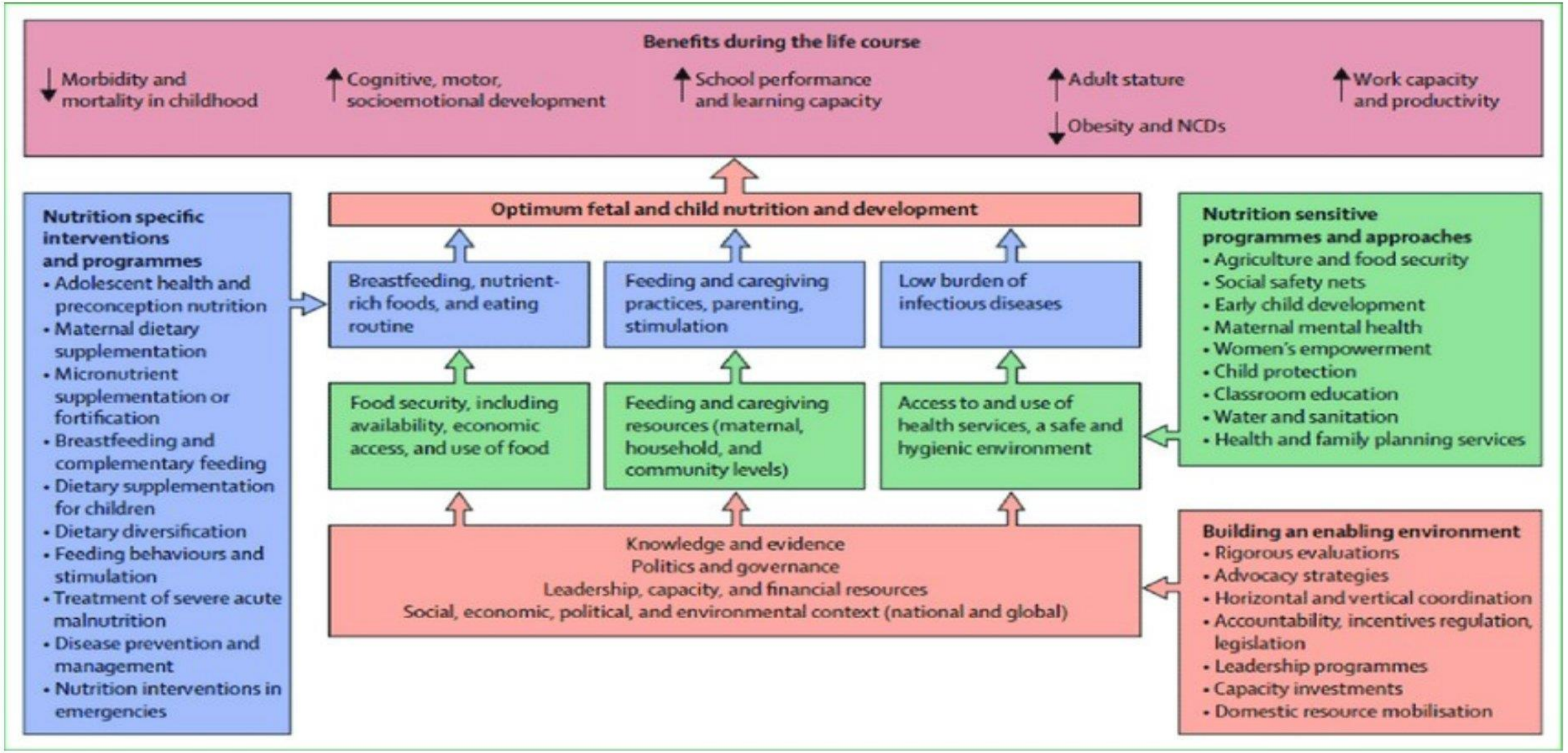
Evaluation

Assess whether the problem has been reduced or solved.

Framework for cause and intervention of malnutrition



Framework for actions to improve nutrition (LANCET)



Nutrition-Specific vs. Nutrition-Sensitive

- **Nutrition-specific interventions** target immediate causes (diet and disease) and are delivered mainly through the health sector.
- **Nutrition-sensitive interventions** target underlying causes (foo - ' care, environment) through agriculture, social protection, education, and WASH.
- The enabling environment targets basic causes (politics, resources, institutions) through policy, financing, and coordination platforms.
- **Key message: even 90% coverage of nutrition-specific interventions alone cuts stunting by only about a fifth — sensitive.**

Nut-Specific VS Nut-Sensitive

❑ Working only on nutrition-specific interventions is like scratching the tip of the 'ice burg"



Nutrition-specific interventions across the life course

Adolescence and before pregnancy

- Weekly iron-folic acid
- Folic acid before conception
- Family planning; delay first pregnancy

Pregnancy

- Daily iron + folic acid; calcium
- Iodised salt; energy-protein supplements
- Deworming, malaria prevention, counselling

Birth and newborn

- Early initiation of breastfeeding
- Exclusive breastfeeding to 6 months
- Delayed cord clamping; kangaroo care

6–23 months

- Complementary feeding counselling
- Micronutrient powders
- Continued breastfeeding; responsive feeding

Children 6–59 months

- Vitamin A supplementation; deworming
- Zinc + ORS for diarrhoea
- Growth monitoring and promotion

Micronutrient strategies: the four-pronged approach



Supplementation

Targeted, fast: iron-folic acid for women, vitamin A and zinc for children.

Trade-offs: Needs supply chain, compliance and delivery platform. Short-term.



Fortification

Salt (iodine), wheat/maize flour (iron, folic acid), oil (vitamin A/D); biofortified crops; home fortification with powders.

Trade-offs: Wide reach and low cost per person; needs regulation and monitoring.



Dietary diversification

Home gardens, small livestock, fish ponds, nutrition education, cooking demonstrations.

Trade-offs: Sustainable and cheaper long-term; slow and needs behaviour change.



Public health measures

Deworming, malaria control, immunisation, WASH, family planning.

Trade-offs: Reduce infection and nutrient losses; support all other strategies.

Mandatory fortification achieves far higher and more sustained coverage than voluntary fortification: universal salt iodisation is mandatory in most countries since the 1990s.

Biofortification: breeding nutrition into staple crops



Orange-fleshed sweet potato

Beta-carotene (vitamin A)

Most studied; shown to improve vitamin A status in young children



Iron beans and pearl millet

Iron

Scaling up in parts of Africa and Latin America and South Asia



Zinc wheat and rice

Zinc

Growing adoption in South Asia



Vitamin A cassava and maize

Beta-carotene (vitamin A)

Adopted in parts of sub-Saharan Africa and Latin America

Nutrition-sensitive interventions by sector

Agriculture and food systems

Biofortified crops, home gardens, small livestock and dairy, post-harvest handling; involve women farmers.

Social protection

Cash and food transfers, school feeding, public works; link to health visits and nutrition education.

Water, sanitation and hygiene

Safe water, sanitation, handwashing with soap, food hygiene: fewer infections and less enteric dysfunction.

Education and women's empowerment

Girls' schooling, delayed marriage, women's income and decision-making, maternity protection.

Health and family planning

Antenatal care, birth spacing of 24 months or more, immunisation, IMCI, maternal mental health.

Early child development

Responsive caregiving, stimulation and parenting programmes alongside feeding (Nurturing Care Framework).

Evidence: what works against malnutrition

about 15%

of under-5 deaths could be averted by 90% coverage of 10 specific interventions (Lancet 2013)

Bhutta et al. (2008)

Interventions with the greatest potential: ….. could reduce all child deaths by about a quarter.

Habtu et al. (2022),

Integrated nutrition-specific and nutrition-sensitive package: 77% reduction in maternal undernutrition and 66% lower risk of low birth weight

Why specific interventions are not enough

- They address diet and disease but not poverty, food access or sanitation
- Coverage and quality are rarely 90% in practice

Best practice

- **Combine** specific, sensitive and enabling actions
- **Prioritise** the first 1,000 days, adolescent girls and the poorest households using the **essential nutrition action**

Multi-sectoral action and programme examples

Programme or policy	Type
Scaling Up Nutrition (SUN) Movement	Enabling: country-led multi-sector platform
Baby-Friendly Hospital Initiative; marketing code for breast-milk substitutes	Specific + enabling
Universal salt iodisation; flour fortification	Specific (fortification)
Community-based management of acute malnutrition	Specific (treatment)
School feeding and mid-day meal programmes	Sensitive (social protection, education)
Conditional cash transfers	Sensitive (social protection)

Case studies for further reading

1. Social protection and nutrition: Bolsa Familia, Brazil and Productive Safety Net Programme, Ethiopia

2. A national multi-sectoral programme (Integrated Child Development Services (ICDS) Scheme

CHAPTER

07

NUTRITION SURVEILLANCE

Chapter 7: Learning Objectives

1. Differentiate surveillance, monitoring, screening and surveys
2. Describe the surveillance cycle and its purposes
3. Compare the types of surveillance systems and their data sources
4. Explain the strengths and limits of routine surveillance
5. Identify the main challenges in implementing surveillance
6. Propose ways to strengthen nutrition surveillance systems

Surveillance, monitoring, screening and surveys

Nutrition surveillance

Continuous, systematic collection, analysis and interpretation of nutrition-related data to guide planning, implementation and evaluation of public health action.

Nutrition monitoring

Routine tracking of nutrition indicators and program performance over time to check that activities are on course.

Nutrition screening

Rapid, low-cost identification of malnourished individuals using simple measures such as MUAC.

Nutrition survey

A one-time, usually cross-sectional study that gives a snapshot of a population's nutritional status.

The surveillance cycle

1

Collect

Anthropometry, health-facility and survey data

2

Analyze

Clean data; calculate prevalence and trends

3

Interpret

Compare with cut-offs and reference standards

4

Disseminate

Share reports and alerts with decision-makers

5

Act

Adjust programs, policy and resources

Surveillance is a cycle: what is learned at each round feeds back into better data collection and program design.

Purposes of nutrition surveillance

1. Describe the magnitude and distribution of malnutrition
2. Identify groups at risk and possible risk factors
3. Track trends over time and give early warning of emerging problems
4. Guide policy, planning and allocation of resources
5. Trigger timely action, including emergency response
6. Evaluate whether programs and policies are working

Types of surveillance systems

1

Routine (continuous)

Ongoing data from health facilities, such as growth monitoring and antenatal visits.

2

Periodic surveys

Repeated cross-sectional surveys (e.g. DHS, SMART) giving representative estimates.

3

Sentinel sites

Selected communities or facilities followed regularly to detect trends.

4

Emergency and early warning

Rapid assessments and triggers to act quickly in food crises.

The choice of system depends on the purpose, the level of information needed, time and available resources.

Routine (continuous) surveillance: what and why

What it is

- Ongoing collection of nutrition data at every routine health-service contact
- Sources: growth monitoring, antenatal care, immunization, outpatient and treatment programs
- Reported through the HMIS and reviewed regularly, e.g. monthly

Why it matters

- Continuous, so it shows seasonal change and gives early warning
- Covers many facilities, not only sampled sites
- Uses existing staff and systems, so added cost is low
- Supports follow-up of individual clients and program decisions

Routine surveillance compared with other systems

	Routine	Periodic surveys	Sentinel sites	Emergency / early warning
Frequency	Continuous	Every few years	Regular, at selected sites	During crises
Coverage	All facility users; may miss non-attenders	Representative sample	A few selected sites	Affected areas
Cost	Low (existing systems)	High	Moderate	Moderate to high
Timeliness	Monthly or quarterly feedback	Results after months	Timely for the sites	Very rapid
Main limitation	Data quality varies	A snapshot, not continuous	Not representative	Short-term and narrow

Routine surveillance is the only continuous system, so it works best alongside periodic surveys that check representativeness.

Where surveillance data come from

Population surveys	DHS, SMART and national nutrition surveys give representative prevalence estimates every few years.
Routine health information	Growth monitoring, antenatal and immunization visits give continuous facility data through the HMIS.
Sentinel sites	Selected communities or facilities are followed regularly to detect trends and early warning signs.
Community screening	Community health workers screen with MUAC to find and refer children early.

Challenges of implementing nutritional surveillance

1 Limited resources

Funding, staff, transport and equipment are often scarce.

2 Poor data quality

Measurement error, untrained staff and uncalibrated equipment reduce accuracy.

3 Incomplete, late reporting

Delays and missed areas or vulnerable groups weaken timely action.

4 Fragmented systems

Parallel data systems with weak links to the HMIS duplicate effort.

5 Weak analysis and use

Limited capacity to analyze data and feed results into decisions.

6 Poor sustainability

Dependence on donor projects and short-term funding threatens continuity.

Strengthening nutrition surveillance systems

1 Integrate systems

Build nutrition indicators into the national HMIS.

2 Invest in people

Train and supervise staff; supply reliable equipment.

3 Go digital

Use simple mobile tools for faster, cleaner data.

4 Close the loop

Give regular feedback to facilities and communities.

5 Link to decisions

Present results at planning and review meetings.

6 Secure funding

Build local ownership and sustainable budgets.

Thank You

Questions & Discussion

Health and Nutrition / Master of Public Health Program